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Addendum to the Interim Final Baseline Risk Assessment: Oxbow Area

Part I – Human Health

Part II – Ecological

Centredale Manor Restoration Project Superfund Site North Providence, Rhode Island

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INTERIM FINAL

Part I

Addendum to the Interim Final Baseline Human Health Risk Assessment: Oxbow Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

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EXECUTIVE SUMMARY

An Addendum to the Interim Final Baseline Human Health Risk Assessment (BHHRA) has been prepared to characterize risks for the Oxbow Area at the Centredale Manor Restoration Project Superfund Site (CMRPSS) located in North Providence, Rhode Island (hereafter referred to as "the Site"). The Oxbow Area is a forested wetland area located to the southwest of Allendale Dam. A site location map is provided as Figure ES-1. An aerial photograph of the Oxbow Area and the surrounding areas is provided as Figure ES-2. This Addendum has been conducted in accordance with the United States Environmental Protection Agency (USEPA) Risk Assessment Guidance for Superfund (RAGS) Parts A, D, and E (USEPA, 1989, 2001c, 2001b), as well as USEPA Region I risk assessment guidance contained in Risk Updates (USEPA, 1994, 1995, 1999).

The main area of the CMRPSS, consisting of approximately 9.04 acres, is located in North Providence, Rhode Island, just south of Route 44 on the eastern bank of the Woonasquatucket River. The main area of the Site is known as 2072 and 2074 Smith Street, including two apartment complexes and two capped areas. The remaining portions of the CMRPSS consist of reaches, man-made ponds, and wetlands associated with the Woonasquatucket River.

To the southwest of Allendale Dam is a forested wetland floodplain area with an abandoned channel, referred to as the Oxbow Area. This area is an undeveloped parcel, the majority of which is located within the 100-year floodplain. The abandoned channel previously received flow at its western end and flowed eastward to the Woonasquatucket River. The abandoned channel now is relatively stagnant except during rainfall events; the amount of water present in the channel is seasonal, with little or no water present during the summer months. Figure ES-2 shows the abandoned channel which is the surface water feature running from west to east.

Available data indicate that flooding of the Woonasquatucket River may have deposited CMRPSS-related contaminants in and on the surficial soils and sediment in the Oxbow Area. Floodplain sediment (surficial soils for the purposes of this Addendum) sampling and analysis at the Site have detected elevated (above typical background) levels of dioxin (particularly 2,3,7,8-

tetrachlorodibenzo-p-dioxin (TCDD)), some pesticides and polychlorinated biphenyls (PCBs) (primarily Aroclor-1254), and selected metals (Battelle, 2004).

Currently, local residents and visitors to the area may enter the Oxbow Area and walk along a riverside earthen trail. There is some evidence that adolescents or young adults have at some time been present in the area, since a weather-worn wooden tree-house was observed within the area. There is no evidence that hunting is an activity in the Oxbow Area. It is possible that as the CMRPSS and the Woonasquatucket River are restored, the Oxbow Area might become a more attractive area for passive recreation (hiking, bird-watching, picnicking, etc.). It is assumed that recreational visitors to the Site could contact these floodplain soils and sediment during passive recreational activities within the Oxbow Area. The goal of this Addendum is to evaluate current and potential future risks to human health associated with human contact with floodplain surface soils and sediment in the Oxbow Area.

The Addendum analyzes potential adverse human health effects for both current and likely future conditions caused by hazardous substance releases from the site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action). Current and potential future exposure to floodplain soils and sediment may occur at the Oxbow Area.

HAZARD IDENTIFICATION

The purpose of the hazard identification section is to present a compilation of the available sampling data for the hazardous substances present at the site, to identify data sets suitable for use in a quantitative risk evaluation, and to identify contaminants of potential concern in floodplain soils in the Oxbow Area. The Addendum is based on data collected in the June 2004 floodplain soil sampling event. The Addendum also compares Oxbow Area floodplain soil risks to those calculated for floodplain soils at the background area referred to as Greystone Mill Pond Area.

The data evaluation report (DER) indicates the analytical data collected at the Site have undergone data validation procedures consistent with USEPA guidelines (Battelle, 2004). The data validation activities determined that overall, the data that have been collected meet the data quality objectives (DQOs) for the risk assessment activities. The available data were reviewed to

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identify those data that were representative of current and potential future site conditions and uses and that are therefore suitable for evaluating current and potential future human health risks.

Chemicals of potential concern (COPC) selection for floodplain surface soil.

Using the data collected for floodplain soil, chemicals were initially identified as COPCs for the site and the reference/background areas. COPCs require further evaluation in the risk assessment if the chemical concentrations are above risk-based screening concentrations.

Consistent with USEPA Region I guidance, COPCs were selected based on frequency of detection and comparison of detected concentrations to risk-based screening criteria. USEPA Region 9 residential soil Preliminary Remediation Goals (PRGs) were used in the selection of COPCs for floodplain soil. In floodplain soil at the Oxbow Area, the identified COPCs for floodplain soil include dioxins and furans, Aroclors 1254, seven pesticides, and eight inorganics/metals (including copper, lead, and zinc). In floodplain soil at the upstream background area (Greystone Mill Pond Area), COPCs include dioxin-like compounds (hexachloroxanthene (HCX), dioxins and furans, and coplanar PCBs), Aroclors 1254 and 1268, two pesticides, several polycyclic aromatic hydrocarbons (PAHs), and eleven inorganics/metals (including copper and lead).

Overall, the number of COPCs for each medium are reasonably consistent between the background area and the Oxbow Area. However, there were more COPCs at the background area because the analyte list was longer at the background area than at the Oxbow Area.

TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to characterize the relationship between the dose of COPC administered or received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values (e.g., slope factors (SFs), reference dose (RfD) values, or reference concentrations (RfCs)) are derived that can be used to estimate the likelihood of adverse effects as a function of human exposure to an agent. These toxicity values are used in the risk characterization process to estimate the potential for adverse effects occurring in humans at different exposure levels.

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The dose-response information may be divided into two major categories:

- toxicity information associated with threshold (non-carcinogenic) health effects.
- toxicity information concerning carcinogenicity, either from human epidemiologic data or from laboratory studies.

All the chemicals selected as COPCs are evaluated for potential non-carcinogenic health effects. In addition, any substance considered to be a known, probable, or possible human carcinogen is also evaluated for its potential carcinogenic effects. The classification of a chemical as a carcinogen does not preclude an evaluation of that same chemical for potential non-carcinogenic health risks, as all potentially carcinogenic chemicals may also exert non-carcinogenic health effects.

Toxicity values were obtained from USEPA recommended sources, including the USEPA's Integrated Risk Information System (IRIS), USEPA Region III Risk-Based Concentration Table, the USEPA Region 9 PRGs Table, and the USEPA's National Center for Environmental Assessment publications, and various USEPA reports.

EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of receptors' exposures to COPCs at or migrating from the site. The exposure assessment is conducted to: 1) characterize the populations of humans potentially exposed via direct contact with floodplain soil; 2) identify the mechanisms by which receptors may be exposed; and 3) identify the intake, or dose, of COPCs that receptors may receive through the identified exposure pathways.

Identification of Potentially Exposed Human Populations

The potentially exposed human populations identified for evaluation in the Addendum include: Passive Recreational Visitors who may or may not live in the immediate vicinity of the Site, but who would visit the Oxbow Area for passive recreational activities. The Oxbow Area is in close proximity to the Woonasquatucket River and to residential properties along the river in the area of the CMRPSS. People who visit the Oxbow Area for hiking, bird-watching, picnicking, and other passive recreational activities would most likely live in the general area of the Woonasquatucket River. This Addendum focuses only on the potential exposures to floodplain

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soils in the Oxbow Area, since potential exposures to surface water and sediment in the river and fish consumption have previously been evaluated in the BHHRA for the CMRPSS. The same receptor has been evaluated at the background area as well to establish a baseline for calculation of incremental risks.

Identification of Exposure Points

A single exposure point, identified as the entire Oxbow Area, has been identified for evaluation of floodplain soil by the Passive Recreational Visitor. This exposure point is represented by the seven samples (plus two duplicates) that were collected in the area. There is no indication that a hot spot exists that would require a separate evaluation. In addition, a single upstream background exposure point (Greystone Mill Pond Area) has also been identified an exposure points for use in calculating incremental risks.

Exposure Scenarios and Routes of Exposure

The Passive Recreational Visitor is assumed to be exposed to floodplain soil via incidental ingestion and dermal contact. It is assumed that Passive Recreational Visitors include young children (ages 1 through 6), older children (ages 7 through 18), and adults (assumed ages 19 through 30).Exposures were evaluated based on two scenarios, the CT and reasonable maximum exposure (RME) scenarios. The CT exposure is the typical or average exposure that would be expected in a population. The RME is the highest exposure that is reasonably expected to occur at a site. It is assumed that for the RME scenario the Passive Recreational Visitor is exposed to soil 78 days per year and 39 days per year for the CT scenario. The RME values assume that a receptor uses the Site for all of their outdoor activities (e.g., recreational play/exploration, recreational angling, or subsistence angling). The CT parameters accommodate the assumption that a more "typical" or "average" receptor would spend a portion of their outdoor time at the Site (i.e., would access other, non-Site related areas for recreational purposes).

Exposure Point Concentrations

A single concentration is selected as representative of the actual concentration for each COPC in a floodplain soil for a given exposure point. This value, called the exposure point concentration (EPC), is used in the estimates of health risks at the site. An EPC is selected for every COPC identified in the screening process described earlier. For both RME and CT, the 95% Upper Concentration Limit (UCL) on the mean is typically used as the EPC. However, because there

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are less than ten samples at both the Site and the background area, the maximum concentration was used to represent the RME EPC and the arithmetic mean was used to represent the CT EPC.

Identification of Exposure Models and Parameters

Chemical-specific intakes were calculated in a manner consistent with USEPA guidance for risk assessment. Average daily doses (ADDs) of COPCs were calculated as the measure of exposure. The ADDs are expressed as milligrams of contaminant per kilogram of bodyweight per day (mg/kg/day). For non-cancer health effects calculations, the ADD was averaged over the duration of exposure. For cancer risk calculations, the ADD was averaged over a 70-year lifetime (a lifetime average daily dose or LADD). The following exposure parameters are included in the dose calculations:

- Concentrations in floodplain soil (C)
- Consumption rate (IR)
- Exposure frequency (EF)
- Fraction ingested from contaminated source (FI)
- Exposure duration (ED)
- Body weight (BW)
- Averaging time (AT) – cancer and non-cancer
- Skin surface area exposed (SA)

Consistent with USEPA guidance (USEPA, 1989), exposures were assessed for both RME, expressed as the highest estimate of exposure that is likely to occur and Central Tendency (CT) exposure, which represents typical or average exposure conditions. The two scenarios are assessed to place some boundaries on the estimates of exposure, since the exposures are not actually measured and there is variability among people who might be present at the Site with respect to frequency and duration of exposure, the contact rates and consumption rates, and the locations where they are present now and in the future.

RISK CHARACTERIZATION

Using USEPA-approved toxicity values as well as RME and CT exposure assumptions, potential risks associated with current and future exposure for the Passive Recreational Visitor were evaluated based on exposure to floodplain soil within the Oxbow Area and the Greystone Mill Pond Area (background area).

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Chemical-Specific Excess Lifetime Cancer Risk was calculated using the following equations:

$$Risk_i = CDI_i \times CSF_i$$

where:

$Risk_i$	=	unitless probability of an individual developing cancer as the result of exposure to a chemical i
CDI_i	=	chronic daily intake of chemical i averaged over 70 years (mg/kg-day)
CSF_i	=	USEPA cancer slope factor (CSF) for chemical i $(mg/kg\text{-}day)^{-1}$

Pathway-Specific Incremental Lifetime Cancer Risk:

$$Risk_T = \Sigma\, Risk_i$$

where:

$Risk_T$	=	unitless probability of an individual developing cancer as the result of multiple chemical exposures
$Risk_i$	=	unitless cancer risk estimate for a single chemical associated with floodplain soil exposure

The results from the carcinogenic risk assessment are compared to acceptable risk ranges established by the USEPA. The USEPA's guidelines, established in the National Hazardous Substances and Pollution Contingency Plan (NCP) identify acceptable exposure levels as those concentration levels "that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} [one in ten thousand] and 10^{-6} [one in one million] using information on the relationship between dose and response" (USEPA 1990). Where the cumulative RME site risk to an individual exceeds the upper end of this range, action is generally warranted at a site. Where the cumulative RME site risk to an individual is less than 10^{-4}, action is generally not warranted. However, EPA may also decide that a lower level of risk is unacceptable and that action is warranted, if there are extenuating circumstances, such as uncertainties in the risk assessment.

Following are the equations used to determine the Hazard Quotient (HQs) and HIs.

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The following equation is used to determine the HQ:

$$HQ_i = \frac{I_i}{RfD_i}$$

where:

HQi	=	HQ of chemical i
Ii	=	intake of chemical i averaged over the exposure period (mg/kg-day)
RfDi	=	RfD for chemical i corresponding to the same exposure duration as the intake (mg/kg-day)

The following equation is used to determine the hazard index (HI):

$$HI = \Sigma\ HQ_i$$

where:

HI	=	potential for noncarcinogenic effects from multiple chemical exposures
HQi	=	HQ for each chemical associated with floodplain soil exposure

An HI of less than 1 indicates that noncarcinogenic toxic effects are unlikely. An HI greater than 1 indicates a greater possibility of a noncarcinogenic toxic effect occurring. EPA typically considers action if the HI is greater than one.

The incremental cancer and non-cancer risks (the difference between the risks at the Site and the upstream background area, Greystone Mill Pond) have been identified for the Passive Recreational Visitor at the Oxbow Area. The incremental risks (Site-related risks) have been compared to the Superfund cancer risk range of 10^{-6} to 10^{-4} and to a non-cancer HI value of 1.

RISK SUMMARY

The cancer and non-cancer risk estimates have been developed for both RME and CT Passive Recreational Visitor exposure scenarios. Table ES-1 and Table ES-2 present the risks calculated for Passive Recreational Visitor at the Oxbow Area and the upstream background area, and also present the incremental risks associated with the Oxbow Area. As shown in Table ES-1, for both RME and CT scenarios for the Passive Recreational Visitor, among the age groups evaluated, the

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child age group has the highest non-cancer HI at both the background area and at the Oxbow Area. The HI values are similar for the background area and the Oxbow Area. The risks associated with the portion of Table ES-1 marked "Greystone [a]" are those associated with only those analytical parameter groups that were analyzed at the Oxbow Area. This calculation "normalizes" the background risk estimates so that a direct comparison can be made between the background area and the Oxbow Area. In other words, risks associated with the same chemical groups are evaluated for both areas. The HI does not have a single, dominant chemical contributor. Ingestion of chromium, vanadium, manganese, arsenic, and Aroclor-1254 in floodplain soil is responsible for the majority of the calculated HI.

As shown in Table ES-2, for both RME and CT scenarios for the Passive Recreational Visitor, the calculated cancer risk for exposure to floodplain soil is greater at the Oxbow Area than at the background area. Dioxin equivalents (toxic equivalent quotient (TEQ)) represent the largest single chemical contributor (by a factor of more than 20) to RME and CT cancer risk for the Passive Recreational Visitor's exposure to floodplain soil at the Oxbow Area. At the background area, benzo(a)pyrene, arsenic, and dioxin TEQ are, in that order, the largest contributors to cancer risk. The RME and CT incremental cancer risks for the Oxbow Area are 3×10^{-4} and 8×10^{-6} respectively.

Relationship Between Risk Estimates and the EPA Risk Range

As shown in Table ES-1, both RME and CT incremental non-cancer risks associated with floodplain soil exposure at the Oxbow Area are well below the non-cancer HI benchmark of one for the Passive Recreational Visitor. Also as shown in Table ES-2, the RME incremental cancer risks associated with floodplain soil exposure at the Oxbow Area for the Passive Recreational Visitor are higher than the upper end of the Superfund risk range. The CT incremental cancer risk is within the Superfund risk range.

UNCERTAINTY ANALYSIS

The uncertainty analysis includes a discussion of major limitations of the analyses, any sources of uncertainties, and, if possible, any indication as to whether these uncertainties and limitations may have resulted in and over- or under-estimation of risk. The uncertainty section may also

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include unusual site conditions or extenuating circumstances that may be pertinent to risk management decisions.

The values for receptor-specific exposure parameters such as soil contact rates and soil ingestion rates have been identified in a conservative manner. Default USEPA residential values have been applied to this passive recreational scenario. Values have been identified based on available guidance and professional judgment. In risk assessment, when values are assigned in lieu of actual measurements, there is some uncertainty in the values, and that uncertainty may have an impact on the results of the risk assessment. In that context, the exposure estimates and associated risk estimates in this assessment would likely be overestimated rather than underestimated. Some factors that were not specifically addressed in the calculations could result in lower risk estimates.

Non-cancer risk was not quantitatively evaluated for potential exposures to dioxins and furans. There is not currently a published USEPA oral RfD available for 2,3,7,8-TCDD, any other dioxin or furan congener. USEPA has concluded that the current average dioxin exposure to the human population is greater than the RfDs that would be calculated based on available data. USEPA, therefore, concluded that RfD values would not be informative for safety assessment (USEPA, 2000). Non-cancer effects such as effects on reproduction and development, suppression of the immune system, and chloracne (USEPA, 2000) have been associated with these compounds in animal studies and it is likely that similar effects might occur with human exposure. Therefore, the non-cancer risk associated with potential exposure to dioxins and furans are understated in this Addendum.

Overall, the risk characterization provides conservative estimates of non-cancer and cancer risks consistent with USEPA risk assessment guidance (USEPA, 1989).

MAJOR FINDINGS

The major findings of the Addendum include the following:

- RME incremental cancer risks associated with floodplain soil exposure at the Oxbow Area for the Passive Recreational Visitor are higher than the upper end of the Superfund risk range. Dioxin TEQ is the largest single contributor to the incremental cancer risk. The CT incremental cancer risk is within the Superfund risk range.

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- The RME and CT incremental (above background) non-cancer HI associated with floodplain soil exposure at the Oxbow Area are well below the non-cancer HI benchmark of one for the Passive Recreational Visitor.

NEXT STEPS

The Remedial Investigation (RI) has recently been completed and the Feasibility Study (FS) will soon be completed. The RI determined and summarized the sources, nature and extent of contamination at the Site, characterized the fate and transport of contaminants, and evaluated potential human health and ecological risks resulting from exposure to Site-related contaminants. The FS will evaluate risk management strategies and alternatives for remediating contamination that is found to pose an unacceptable risk to human health or the environment. The FS will also evaluate the long-term effectiveness of the short-term removal actions and determine whether additional action is required to affect a permanent remedy.

In support of the FS, PRGs for the floodplain exposure pathway at the Oxbow Area may be estimated for Chemicals of Concern or COCs (those chemicals that are associated with an excess lifetime cancer risk greater than one-in-one-million and/or a non-cancer HQ greater than one in any medium).

Development of the PRGs may be discussed in further detail in a separate document. The calculated risks for the reference area and background area obviously will be a consideration in the derivation of PRGs and the selection of remedial objectives.

The results of the RI and FS will be used to formulate a Proposed Plan for the Site. The Proposed Plan will recommend remedial actions that will result in overall protection of human health and the environment, fulfill Superfund requirements, be acceptable to stakeholders, and satisfy USEPA remedial guidelines.

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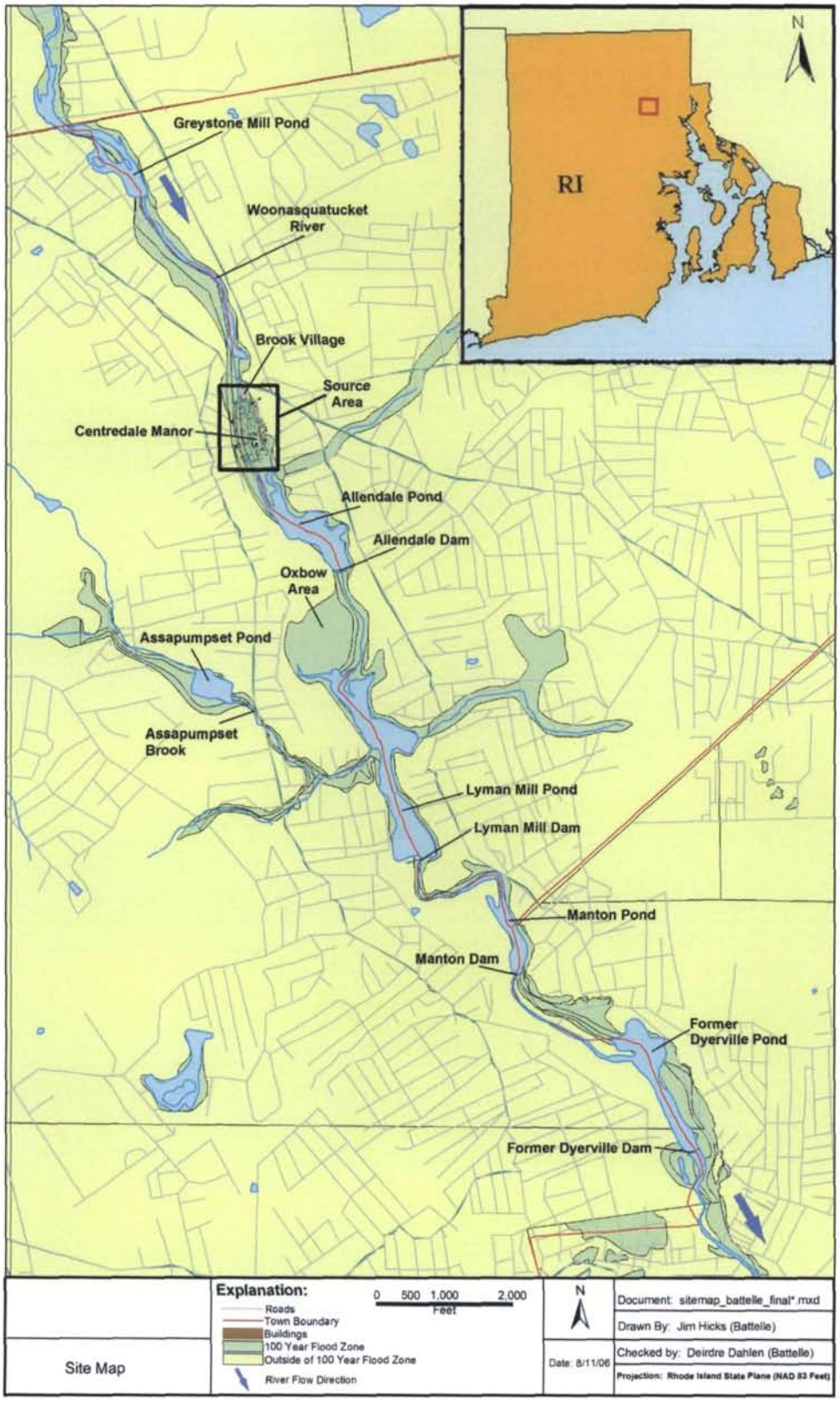

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Figure ES-1. Site Location Map

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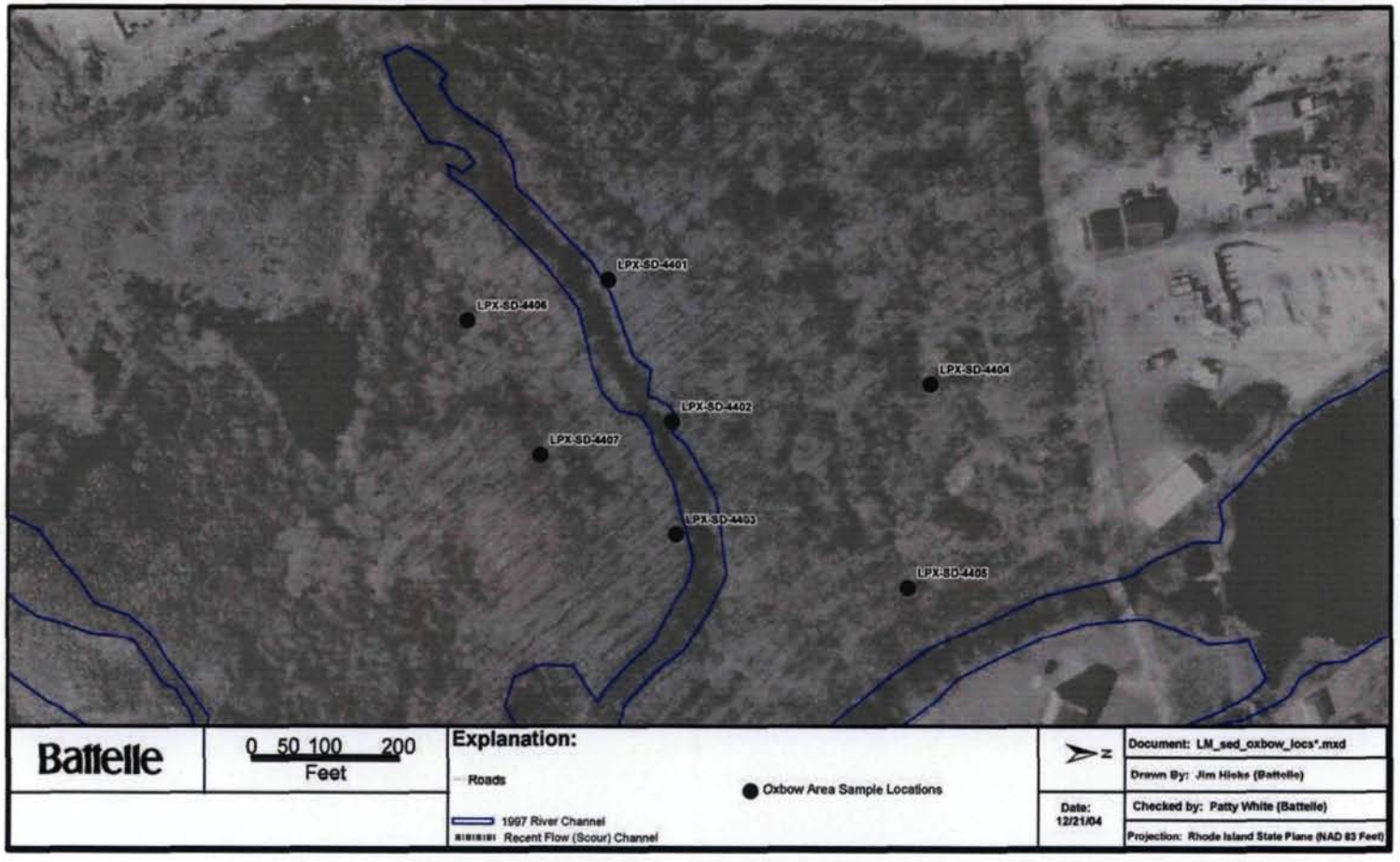

Figure ES-2. Oxbow Area Surface Sediment Sample Locations

(Samples from boring locations LPX-SD-4401, LPX-SD-4402 and LPX-SD-4403 do not appear to be within the channel, however, sediment samples from these locations were collected by wading into the channel as far as possible (waist deep). Sample location coordinates are accurate to 4-6m, although the presence of heavy vegetation may have impacted the accuracy of coordinate readings.)

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Table ES-1
Summary of Non-Cancer Risks

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Non-Carcinogenic Risk			Floodplain Soil		Incremental Hazard Index	
			CT	RME	CT	RME
Passive Recreational Visitor						
Current & Future	Greystone					
		Child	0.2	1	--	--
		Older Child	0.03	0.2	--	--
		Adult	0.02	0.1	--	--
	Greystone [a]					
		Child	0.2	1	--	--
		Older Child	0.03	0.2	--	--
		Adult	0.02	0.1	--	--
	Oxbow Area					
		Child	0.1	1	0	0.003
		Older Child	0.03	0.3	0	0.06
		Adult	0.01	0.1	0	0.007

CT = Central Tendency
RME = Reasonable Maximum Exposure

[a] Greystone area hazard index for Pesticides, Metals, and Dioxin only. Calculated for use with Oxbow Area to calculate incremental hazard index.

Incremental Receptor Risk = Difference in risk between the exposure point and the background exposure point.
-- = Incremental risk is not calculated for background on reference areas.
BOLDED incremental risk are above the Superfund Noncancer Hazard Index benchmark of 1.

Prepared by: KJC
Checked by: MJM

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Table ES-2
Summary of Cancer Risks

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Carcinogenic Risk		Floodplain Soil		Incremental Receptor Risk	
		CT	RME	CT	RME
Passive Recreational Visitor					
Current & Future	Greystone	2E-06	4E-05	--	--
	Greystone [a]	7E-07	2E-05	--	--
	Oxbow Area	9E-06	3E-04	8E-06	**3E-04**

CT = Central Tendency
RME = Reasonable Maximum Exposure

[a] Greystone area risks for Pesticides, Metals, and Dioxin only. Calculated for use with Oxbow Area to calculate incremental risk.

Incremental Receptor Risk = Difference in risk between the exposure point and the background exposure point.
-- = Incremental risk is not calculated for background on reference areas.
BOLDED incremental risk are above the high end of the Superfund Cancer Risk Range (1E-04 to 1E-06).

Prepared by: KJC
Checked by: MJM

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) Region I and U.S. Army Corps of Engineers (USACE), New England District are preparing an Addendum to the Baseline Human Health Risk Assessment (BHHRA) and a Baseline Ecological Risk Assessment (BERA) for the Oxbow Area at the Centredale Manor Restoration Project Superfund Site (CMRPSS) located in North Providence, Rhode Island (hereafter referred to as "the Site"). A site location map is provided as Figure 1. An aerial photograph of the Oxbow Area and the surrounding areas is provided as Figure 2.

1.1 BACKGROUND AND INVESTIGATION HISTORY

There had not been previous environmental investigations of the Oxbow Area as part of the CMRPSS Investigation. In June 2004 an investigation of floodplain soils and sediments was conducted as described in Section 1.3.1. The data collected during that investigation are the focus of this Addendum.

The Addendum analyzes potential adverse human health effects for both current and likely future conditions caused by hazardous substance releases from the site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action). Current and potential future exposure to floodplain soils and sediment may occur at the Oxbow Area.

1.2 ORGANIZATION OF REPORT

This report is divided into seven sections: an introduction is provided in Section 1.0; a hazard identification is presented in Section 2.0; exposure assessment including receptor identification, development of exposure profiles and exposure point concentrations (EPCs) are presented in Section 3.0; the toxicity assessment is presented in Section 4.0, the risk characterization is contained in Section 5.0, the uncertainty analysis is discussed in Section 6.0, and the Conclusions and Recommendations are presented in Section 7.0, and the development of Preliminary Remediation Goals is discussed in Section 8.0. Appendix A addresses sample selection considerations for the risk assessment. The toxicity assessment supporting information is presented in Appendix B.

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The table numbering in this report is consistent with the numbering of Tables in the USEPA's *Risk Assessment Guidance for Superfund (RAGS): Volume I - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments) Final* (USEPA, 2001c). That guidance includes standardized tables (with a specific numbering scheme) for reporting risk assessment activities. For each group of tables (such as the Table 2s that present the selection of chemicals of potential concern (COPC)), the tables are numbered consecutively.

1.3 DESCRIPTION OF SITE

The main area of the CMRPSS, consisting of approximately 9.04 acres, is located in North Providence, Rhode Island, just south of Route 44 on the eastern bank of the Woonasquatucket River. The main area of the Site is known as 2072 and 2074 Smith Street where currently there are two apartment complexes and two capped areas. The remaining portions of the CMRPSS consist of reaches, man-made ponds, and wetlands associated with the Woonasquatucket River.

One of those portions of the CMRPSS is the forested wetland floodplain area to the southwest of Allendale Dam, referred to as the Oxbow Area. The Oxbow Area is an undeveloped parcel, the majority of which is located within the 100-year floodplain. Allendale Pond sediments are a reservoir of contamination from the source area and disturbance of those sediments may release sediment associated contaminants into the water column and into downstream areas, including the Oxbow Area. The abandoned channel previously received flow at its western end and flowed eastward to the Woonasquatucket River. The abandoned channel now is relatively stagnant except during rainfall events and the amount of water present in the channel is seasonal, with little or no water present during the summer months. Figure 2 shows the abandoned channel which is the surface water feature running from west to east.

Floodplain sediment (treated as surficial soils for the purposes of this Addendum) sampling and analysis at the Site have detected elevated (above typical background) levels of dioxin (particularly 2,3,7,8-TCDD), some pesticides and polychlorinated biphenyls (PCBs) (primarily Aroclor-1254), selected metals (Battelle, 2004a).

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1.3.1 Site Investigations and Actions

In June 2004 floodplain samples (combination of floodplain soils and sediment) were collected from the forested wetland referred to as the Oxbow Area which is located southwest of Allendale Dam to investigate the nature and extent of the CMRPSS contamination in that area. Sampling targeted low-lying areas and excluded areas of artificial fill or gravel. Three surface (0-0.5 feet) sediment samples (LPX-SD-4401, LPX-SD-4402, and LPX-SD-4403) were collected within the abandoned channel within the Oxbow Area. Two surficial (0 to 0.5 feet) wetland soil samples (LPX-SD-4404 and LPX-SD-4405) were collected north of the channel and two surficial (0 to 0.5 feet) wetland soil samples (LPX-SD-4406 and LPX-SD-4407) were collected south of the abandoned channel. These sample locations are shown in Figure 4-25 of the RI Report and which has been reproduced here as Figure 2.

The surface soil/sediment samples collected during the field sampling program were analyzed for chemical, physical, and biological parameters by laboratories at several organizations, including:

PARAMETERS	LABORATORY
• Dioxin/Furan	Pace Analytical Services, Inc., Minneapolis, MN
• PCB Aroclor and Chlorinated Pesticides	Battelle, Duxbury, MA
• Metals	Battelle, Sequim, WA
• Total organic Carbon	Applied Marine Sciences, Inc.

Available data indicate that flooding of the Woonasquatucket River may have deposited CMRPSS-related contaminants in and on the surficial soils and sediment in the Oxbow Area. Recreational visitors to the Site could contact these floodplain soils and sediment during passive recreational activities within the Oxbow Area.

1.4 EXPOSURE AREAS

The low-lying forested wetland referred to as the Oxbow Area is identified as the single exposure area for recreational visitors to the site. Although three of the samples were collected from beneath standing water in the abandoned channel, it appears that there is not standing water in the abandoned channel year-round. Therefore, the three sediment samples have been treated as soil samples for the purposes of this Addendum. Since exposure to soils is generally a higher level of exposure than for sediments beneath standing water, this choice to treat these three samples as soil is a conservative (health-protective) choice.

The contamination and risk levels have been compared to the contamination and risk levels at an upstream background location identified as the Greystone Mill Pond area. The background location was identified based on the following criteria and considerations: the background location is not impacted by the Superfund Site under study or any other Superfund Site; the background location has the same basic physical and habitat characteristics as the study area; and the location should reflect any upstream impacts that may be affecting the study area. In this case, the background area includes the area of the Woonasquatucket River upstream of the site, from Route 44 north, to and including Greystone Mill Pond. There were no identified migration pathways linking site contaminants to that area. Greystone Mill Pond is likely affected by the discharge of the Smithfield Wastewater Treatment Plant and the impacts of that wastewater treatment plant likely extend into at least some portion of the site. In the Addendum, Greystone Mill Pond is considered the most appropriate comparison location for the purposes of determining site-related incremental risk because Greystone is a riverine environment directly upstream of the study area. Differences between the background area and the Site would generally be expected to be associated with Site-related activities.

Four floodplain soil samples were collected from the background area. Those samples are identified as RWR-FP-5001 through RWR-FP-5004. A field duplicate of RWR-FP-5003 was also collected. Those samples were analyzed for dioxins and furans, pesticides and PCBs, semi-volatile organic compounds (SVOCs), and metals. Several compounds were detected in all of the background flood plain soil samples, including Aroclor-1254, Aroclor-1268, technical chlordane, dieldrin, 4,4-DDD, 4,4-DDD, 4,4-DDT and alpha chlordane. The 2,3,7,8-TCDD congener was detected in only one of the four background flood plain soil samples, at a concentration of 0.0567 ug/kg.

The reference area, Assapumpset Pond and Brook was selected for characterization during the investigation of CMRPSS because the Pond and Brook are tributaries to Lyman Mill Pond. The pond and brook are upstream of the lower portion of the Site (Lyman Mill, Manton, and Dyerville Ponds). The Woonasquatucket River flows north to south and Assapumpset Brook flows west to east into Lyman Mill Pond Reach. The pond and brook carry considerable flow from an area of open space upgradient and west of the site. The reference area was characterized in order to assess possible sources of contamination to Lyman Mill Pond and downstream areas in the event

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that Lyman Mill Pond and downstream areas contaminant characteristics that differed from those of Allendale Pond, which is located adjacent to and immediately downstream of the source area. The site investigation and the BHHRA did not identify any likely input of contaminants from Assapumpset Pond to the Site. Therefore, it was not necessary to evaluate Lyman Mill Pond in the context of potential inputs from Assapumpset Pond and Brook. In addition, no floodplain soils were sampled as part of the characterization of the Assapumpset Pond and Brook Reference Area. Therefore, this Addendum does not include any comparison of risks for the Oxbow Area and Assapumpset Pond and Brook. The incremental risks for the Site have been identified as the difference between Oxbow Area risks and the risks at the background area (Greystone Mill Pond Area).

In this Addendum, the term "exposure point" has been used to identify locations or areas of exposure. The exposure points correspond to the exposure areas (EAs) identified above as follows:

- The Oxbow forested wetland is referred to as the Oxbow Area exposure point;
- The upstream background area is referred to as the Greystone Mill Pond Area exposure point.

1.5 CURRENT AND REASONABLY FORESEEABLE USES OF THE SITE

The Oxbow Area is an undeveloped, forested wetland. There are no buildings or other constructed features other than some earthen dikes located near the eastern end of the abandoned channel, in close proximity to the Woonasquatucket River. Most of the Oxbow Area is within the 100-year flood plain of the river. Currently, local residents and visitors to the area may enter the Oxbow Area and walk along a riverside earthen trail. There is some evidence that adolescents or young adults have at some time been present in the area, since a weather-worn wooden tree-house was observed within the area. There is no evidence that hunting is an activity in the Oxbow Area. It is possible that as the CMRPSS and the Woonasquatucket River are restored, the Oxbow Area might become a more attractive area for passive recreation (hiking, bird-watching, picnicking, etc.). Therefore, potential future land use is identified as passive recreation.

1.6 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) identifies potential source areas from which chemicals may have been released, the migration pathways through which oil and/or hazardous materials (OHM) may have been transported and/or translocated to other environmental media, and where possible

exposure may occur. The CSM provides a framework for understanding sources of OHM, migration pathways, identification of potential receptors, and development of exposure profiles. The CSM for the Oxbow Area is presented here.

1.6.1 Source Area

Releases of hazardous substances from former industrial operations have occurred at the CMRPSS. The source area consists of two parcels located at 2072 and 2074 Smith Street (Lots 200 & 250) that cover approximately 9 acres (see Figure 2). Evidence suggests that operations at the former chemical company and drum reconditioning facility resulted in waste disposal onto surface soil and beneath the ground surface. Wastes have also been released directly into the Woonasquatucket River, which runs along the western side of the source area (Tetra Tech NUS Inc., 2000). Dioxins and furans have been detected in soils and sediments as well as in fish tissue collected in 1996 from the Woonasquatucket River. Much of the impacted soils have been stabilized or capped. Other contaminants detected in Site media include PCBs, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), hexachloroxanthene (HCX), phthalates, and metals. The sediments of the Woonasquatucket River immediately adjacent to the source area have been stabilized with a covering and rip-rap. Allendale Pond sediments are a reservoir of contamination from the source area and disturbance of those sediments may release sediment associated contaminants into the water column and into downstream areas.

1.6.2 Migration of OHM

The forested wetland soils of the Oxbow Area are subject to frequent flooding of the Woonasquatucket River. During flood events, suspended sediments from Allendale Pond and even from upstream areas of the Woonasquatucket River are carried with the flood waters that flow over the Allendale Dam into the Oxbow Area where some portion of the suspended sediments is deposited on the ground surface. With the partial breaching of Allendale Dam in 1991 and the more recent breach in 2001, contaminants have migrated downriver, presumably to some extent into the Oxbow Area, and to Lyman Mill Pond.

1.6.3 Potential Human Receptors

Currently, local residents and visitors to the area may enter the Oxbow Area and walk along a riverside earthen trail. As previously discussed, there is some evidence that adolescents or young adults have at some time been present in the area, since a weather-worn wooden tree-house was

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observed within the area. There is no evidence that hunting is an activity in the Oxbow Area and according to the North Providence Police Department, hunting is prohibited in North Providence. Therefore, hunters have not been identified as potential receptors. It is possible that as the CMRPSS and the Woonasquatucket River are restored, the Oxbow Area might become a more attractive area for passive recreation (hiking, bird-watching, picnicking, etc.). Therefore, potential future land use is identified as passive recreation.

Visiting recreational anglers and residents living along the river who engage in angling would be expected to primarily be present at the river's edge (along the western shore of the river) rather than throughout the forested wetland of the Oxbow Area. The western shore of the river is easily accessible along the Oxbow Area, and there are footpaths that follow the edge of the river in that area.

- Table 1.1 indicates which receptors and exposure pathways are evaluated for this Oxbow Area Addendum. Other receptors (Visiting Recreational Angler and Resident Living Along the River) and exposure pathways associated with the Woonasquatucket River and surrounding area have previously been evaluated in the Interim Final BHHRA for the CMRPSS (MACTEC, 2005) and are therefore not re-evaluated here.

Consistent with USEPA objectives, the following pathways are evaluated for the Addendum as summarized in Table 1.2:

1) Potential exposure to COPC via flood plain soil contact. Passive Recreational Visitors (from the surrounding neighborhoods or from other areas) are evaluated in the Addendum, focusing on three age groups that include the child (ages 1 through 6), the older child (ages 7 through 18), and the adult (ages 19 through 30) that might come into contact (ingestion and dermal contact) with floodplain soil in the Oxbow Area.

1.6.4 Summary of Data

Table 2.1 presents a statistical summary of the analytical data collected for the wetland soils from the Oxbow Area and evaluated in this assessment. This table presents a summary of the Toxicity Equivalency Quotient (TEQ) for dioxins and furans. Table A-1 presents all of the data for the seven samples and the field duplicate. This table presents all of the dioxin and furan congener and homolog group data as well as the TEQ. All seven soil samples were analyzed for dioxins and furans, four of the samples and a duplicate (LPX-SD-4401, LPX-SD-4402, LPX-SD-4404, LPX-SD-4407, and duplicate of LPX-SD-4401) were analyzed for metals, and three of the samples (LPX-SD-4402, LPX-SD-4404, LPX-SD-4407 and a duplicate of LPX-SD-4402) were analyzed for pesticides and PCBs. The dioxin congener 2,3,7,8-TCDD was detected in all seven

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samples and a duplicate. Dioxins and furans congeners and homolog groups are well represented in the soil sample data (not limited to a single congener or homolog group). The 2,3,7,8-substituted congeners with the highest concentrations are typically the 1,2,3,4,6,7,8-HpCDD and 2,3,7,8-TCDD and the total octachlorinated dibenzo-p-dioxin (OCDD) concentration is generally in the same order of magnitude as the 1,2,3,4,6,7,8-HpCDD and 2,3,7,8-TCDD concentrations. The 2,3,7,8-TCDD congener is by far the largest contributor to the TEQ for all samples except one. The 2,3,7,8-TCDD congener accounts for between 98.31% and 99.51% of the total TEQ for six of the seven samples (and a duplicate). For sample LPX-SD-4404, however, the 2,3,7,8-TCDD congener accounts for only 3.52% of the total TEQ, and the actual concentration of 2,3,7,8-TCDD (0.0000122 milligrams per kilogram (mg/kg)) is substantially lower than in the other samples (range of 0.0004 mg/kg to 0.004 mg/kg. Sample LPX-SD-4404 has the lowest TEQ among the seven samples that were collected (excluding the duplicate). It appears the location of LPX-SD-4404 may have been impacted by flood-related deposition to a lesser extent than the other sample locations.

Among the Aroclors, Aroclor-1254 was detected in 4 of 5 samples with a range of detected concentrations from 0.637 mg/kg to 3.583 mg/kg and Aroclor-1268 was detected in one of four samples with the detected concentration of 0.103 mg/kg. No other Aroclors were detected. The pesticide and PCB analysis for Sample LPX-SD-4402 was conducted on both a wet sample (very high moisture content) and on a freeze-dried portion of the sample (reduced moisture content). For the wet sample, because of the high moisture content, the results for most of the analytes were rejected during data validation. Results for Aroclor-1254, 4,4,-DDD, 4,4-DDE, endosulfan II, and dieldrin in the wet sample were not rejected. The results of the freeze-dried samples were not rejected in data validation. Therefore, all of the pesticide and PCB analytical results for the "freeze dried" preparation of sample LPX-SD-4402 have been used in the risk assessment. The analytical results for Aroclor-1254, 4,4,-DDD, 4,4-DDE, and dieldrin in the freeze-dried samples are higher than the corresponding results from the wet sample. Therefore the choice of the freeze-dried samples is a conservative (health protective) decision. For example, for Aroclor-1254, using the freeze-dried result, the maximum concentration among the soil samples is 3.583 mg/kg. If the wet result were used, the maximum detected concentration among the soil samples would be 0.637 mg/kg. For sample SD-4407, the risk assessment utilizes pesticide/PCB data from the freeze-dried sample because only those data were reported (results for the wet preparation were not reported).

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4,4,-DDD (0.00193 mg/kg to 0.02658 mg/kg), 4,4-DDE (0.00129 mg/kg to 0.04236 mg/kg), and gamma chlordane (0.00208 to 0.00694 mg/kg) were detected in all four samples analyzed. Several other pesticides were detected at lower frequency. Seventeen inorganics and metals were detected in at least three of the four soil samples. Of note, lead concentrations in soil samples ranged from 44.4 mg/kg to 1,835 mg/kg. However, the lead concentrations were not consistent (174 mg/kg at LPX-SD-4401, 453 mg/kg in the duplicate of LPX-SD-4401, 44.4 mg/kg at LPX-SD4402, and 1,835 at LPX-SD-4404). Among the soil samples, sample LPX-SD-4404 had the highest concentration of thirteen of the seventeen inorganics and metals reported. Concentrations of copper, lead, silver and zinc in sample LPX-SD-4404 seem particularly high relative to the other samples collected. Interestingly, this sample had the lowest 2,3,7,8-TCDD and TEQ concentrations.

The 2004 Oxbow Area investigation results are consistent with the results of historical investigations, the reported releases at the CMRPSS, and the nature of contamination in the sediments of the Woonasquatucket River as well as with the information in the more recent investigation reports from 2003 and 2004: *Task 22H Chemistry Data Report, YR2002 Tree Swallow Study, Centredale Manor Restoration Project Superfund Site, North Providence, Rhode Island* (Battelle, 2003a); *Data Summary Report, Interim Data Collection, Remedial Investigation and Feasibility Study, Centredale Manor Restoration Project Superfund Site, North Providence, Rhode Island* (Battelle, 2003b); *Task RI-8, Petroleum Hydrocarbon Assessment of Centredale Sediment Cores, Centredale Manor Restoration Project Superfund Site, North Providence, Rhode Island* (Battelle, 2003c); and *Task 22I Chemistry Data Report, YR2003 Tree Swallow Study, Centredale Manor Restoration Project Superfund Site, North Providence, Rhode Island* (Battelle, 2004).

Summaries of analytical data for floodplain soils in the Oxbow Area and in the background area (Greystone Mill Pond Area) are presented in Tables 2.1 and 2.2 respectively, which document the selection of COPCs. The upstream background area (Greystone Mill Pond) Greystone Mill Pond is upstream of the Site on the Woonasquatucket River (an upstream location). Soil samples were collected just north of the source area (north of Route 44). These sample locations are considered to be part of the upstream (Greystone Mill Pond) data set. The selection of COPCs for the risk

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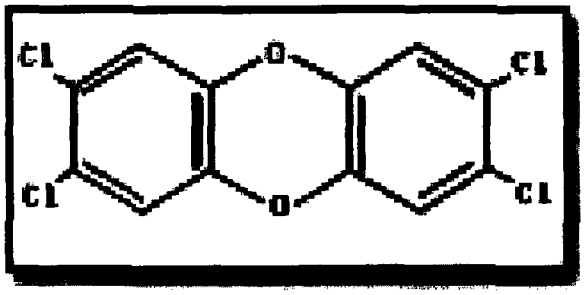
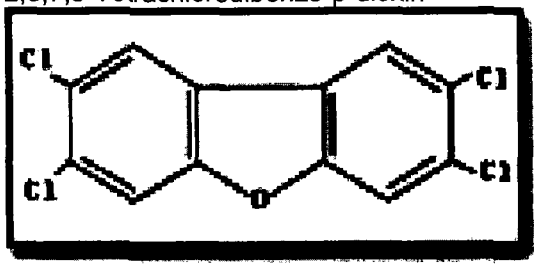
assessment is based on all of the available environmental data that are representative of current and future conditions.

One of the analytical parameters shown in Tables 2.1 and 2.2 is the TEQ for dioxins and furans. The TEQs are media-specific concentrations that are normalized to the toxicity of the 2,3,7,8-TCDD congener, generally considered to be the most toxic of the dioxin furan compounds. The TEQs are calculated by multiplying the medium-specific concentration of each congener or congener group by a Toxicity Equivalence Factor (TEF) and summing those products. The TEF is a measure of the toxicity of a particular congener or congener group relative to toxicity of 2,3,7,8-TCDD. In simple terms, the dioxins/furans TEQ indicates the concentration of 2,3,7,8-TCDD that would have the same toxicity as the mixture of dioxins and furans being evaluated.



2,3,7,8-Tetrachlorodibenzo-p-dioxin



2,3,7,8-Tetrachlorodibenzofuran

Biphenyl is a dual-ring structure comprised of two six-carbon benzene rings joined by a single carbon-carbon bond. Up to ten chlorine atoms can be substituted for hydrogen atoms in the biphenyl molecule. Each of the carbon atoms in the benzene rings is assigned a location number between 1 and 6. The carbon atoms assigned the location 1 are bonded to each other and are not available for chlorine substitution. Each unique chemical compound within the PCB category is referred to a congener. Therefore, the biphenyl molecule containing two chlorine atoms (each located at the "4" position of one of the benzene rings), would be a PCB congener referred to as

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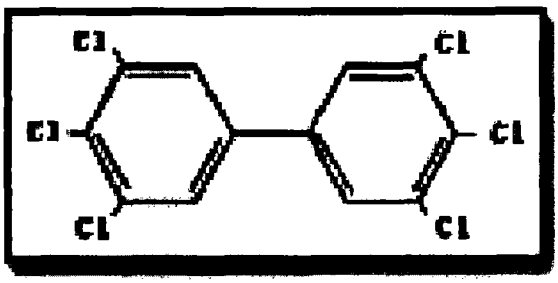
4,4'-Dichlorobiphenyl. A total of 209 PCB congeners have been identified. A biphenyl with one chlorine atom is referred to as a monochlorobiphenyl and a biphenyl with ten chlorine atom is referred to as a decachlorobiphenyl. Homologs are subcategories of PCB congeners having equal numbers of chlorine atoms. For example, there are 12 PCB congeners that have two chlorine atoms. These 12 congeners are included in the dichlorobiphenyl homolog.



3,3',4,4',5,5'-Hexachlorobiphenyl

Commercially produced PCB mixtures were sold under many names. However, the most common naming convention for commercial PCB mixtures was reference to the Aroclor series. Aroclors are mixtures of various chlorinated biphenyls. The last two digits in the Aroclor identifier indicates the percentage of the mixture represented by chlorine. Aroclor-1242 is a mixture of chlorobiphenyls with a chlorine content of 42%. Aroclor-1254 is a mixture of chlorobiphenyls with a chlorine content of approximately 54%. Typically, the higher the chlorine content, the greater the abundance of the heavier chlorinated biphenyls (such as pentachlorobiphenyls and hexabiphenyls).

During investigations of the CMRPSS, analysis of PCBs has been completed by two different analytical approaches. The first, and most frequently applied approach (for the large majority of samples) at the Site is the analysis for Aroclors via Method 8082. In this analysis, the following analytical parameters are typically reported: Aroclor-1016; Aroclor-1221; Aroclor-1232; Aroclor-1242; Aroclor-1248; Aroclor-1254; Aroclor-1260; and Aroclor-1268. The second approach, identification and quantification of individual PCB congeners, was used less frequently, with only a few representative samples per area, at the Site. The identification of individual PCB congeners was accomplished by a modified Method 1668A. Although each of the 209 PCB congeners has a unique chemical name (such as 4,4'-Dichlorobiphenyl), a shorthand means of identifying the individual congeners has been developed. Each of the congeners has been assigned a unique number from 1 to 209 (Ballschmiter, 1992). The numbering scheme

assigns lower numbers to lower chlorine content congeners and higher numbers to higher chlorine content congeners. As an example, the PCB congener 3,4',5-trichlorobiphenyl is also referred to as PCB-39.

A total of 68 of the PCB congeners, based on their chemical structure, have been identified as "dioxin-like" or co-planar PCB congeners. These co-planar PCB congeners have been assigned 2,3,7,8-TCDD TEFs in a manner similar to the dioxin and furan congeners (Van den Berg et. al. 1998). A TEQ for all co-planar PCBs has been calculated for each floodplain soil sample that has been analyzed for PCB congeners. PCB congener analysis was conducted for only 1 floodplain soil sample in Greystone Mill Pond (RWR-FP-5004) and no PCB congener analysis was conducted for floodplain soil samples in the Oxbow Area. The TEFs used in the development of TEQs in this risk assessment are the mammalian TEFs for dioxins, furans, and dioxin-like (coplanar) PCBs as published in Van den Berg et al., 1998.

Dioxin/furan 2,3,7,8-TCDD equivalent concentrations in floodplain soil in the Oxbow Area are substantially higher than in floodplain soil in the Greystone Mill Pond background area. The arithmetic mean TEQs are 0.0018 mg/kg and 0.000055 mg/kg. The Oxbow Area average floodplain soil TEQ is approximately 32.7 times the corresponding background area floodplain soil TEQ. The average Aroclor-1254 floodplain soil concentration at the Oxbow Area is 1.4 mg/kg compared to 0.51998 mg/kg in the background area. This slight difference in means between the two areas is driven primarily by the maximum detected concentration of 3.5833 mg/kg in the Oxbow Area. Average concentrations of arsenic in floodplain soil are very similar between the Oxbow Area (average of 5.4 mg/kg with a maximum of 12.8 mg/kg) and the background area (average of 7.72 mg/kg and maximum of 12.2 mg/kg). In general, it appears that pesticide concentrations in floodplain soils at the Oxbow Area are consistent with background conditions.

In summary, dioxins and furans (particularly 2,3,7,8-TCDD appear to be the primary chemical parameters that are detected in environmental media with frequency of detection and concentrations that are indicative of Site-related impacts. Table 3.1.RME indicates that floodplain soil concentrations of only 2,3,7,8-TCDD are dramatically higher in the Oxbow Area floodplain soil than in the floodplain soil from upstream background area Greystone Mill Pond.

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2.0 HAZARD IDENTIFICATION

The objectives of this section are to present an orderly compilation of the available sampling data on the hazardous substances present at the site, to identify data sets suitable for use in a quantitative risk evaluation, and to identify contaminants of potential concern upon which the quantitative assessment of risk will be based. Summaries of the sampling data have been generated using Risk Assessment Guidance for Superfund (RAGS) Part D standard Table 2s, for each constituent detected in biota, sediment, surface water, and floodplain and bank soils. Table 2s include the minimum and maximum concentrations (including locations of the latter), minimum and maximum data qualifiers, units, frequency of detection, range of detection limits, concentration used for screening, screening toxicity value, potential regulatory criteria (i.e., Food and Drug Administration (FDA) levels, state standards), whether a contaminant is chosen as a COPC, and the rationale for that choice.

When choosing COPCs, USEPA guidance was followed (USEPA, 1989). Consistent with EPA's Guidance for *Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*, September 2002, EPA Region I recommends a baseline risk assessment approach that retains all constituents that exceed risk-based screening concentrations as COPCs for further human health risk evaluation. Per this guidance, background chemical concentrations were not utilized in the selection of COPCs. All chemicals detected during sampling efforts, not just site-related chemicals or those that bioaccumulate, have been considered in the selection of COPCs for the human health evaluation. This will result in a total estimate of risk (including risks associated with background conditions) to the receptors potentially exposed to floodplain soils. Background risks are characterized in this Addendum and the incremental risks above background are identified as part of the risk characterization (Section 5.0).

Chemicals that are infrequently detected may be artifacts in the data due to sampling, analytical, or other problems, and may not be related to site operations or disposal practices. Based on RAGS Part A (USEPA, 1989), a chemical is considered for elimination from the quantitative risk assessment if: 1) it is detected infrequently in one or perhaps two environmental media, 2) it is not detected in any other sampled media or at high concentrations, and 3) there is no reason to believe that the chemical may be present. In addition, chemicals that are considered essential

human nutrients (i.e., copper, iron, magnesium, calcium, potassium, and sodium) will not be considered in the quantitative risk assessment.

2.1 SELECTION OF CHEMICALS OF POTENTIAL CONCERN (COPCS)

This section identifies the chemicals present at the Site and provides rationale for inclusion of analytes as COPCs.

2.1.1 COPC Selection Methods

COPCs are chemicals for which data of sufficient quality are available, and which may pose more than a *de minimus* health risk. The procedure used to select COPCs for the Addendum is summarized as follows, and is consistent with USEPA Region I (USEPA, 1999) methodology:

1) *Comparison to Available Criteria*

- Selected as a COPC in floodplain soils if the maximum detected concentration exceeds the USEPA Region IX Preliminary Remediation Goals (PRGs) for residential soils (USEPA, 2004).

The soil PRGs developed by Region IX are protective for direct contact (ingestion and dermal contact) exposures, as well as for inhalation of particulate and volatile constituents that may be released to air. The PRGs are derived for a $1x10^{-6}$ cancer risk level or a non-cancer hazard quotient (HQ) of 1. Per USEPA Region I guidance (USEPA, 1995), the PRGs based on noncarcinogenic effects have been adjusted to represent a HQ of 0.1 for the purposes of COPC selection. This adjustment of the risk based concentrations (RBCs) and PRGs per the guidance is applied to account for the possible cumulative impacts of having several chemicals that might have similar mechanisms of toxic action.

The use of residential PRGs for selection of COPCs in floodplain soils ensures that analytes present at concentrations that could potentially pose more than a *de minimus* risk for residential land use exposures are identified. The use of these PRGs for selection of COPCs in floodplain soils represents a conservative approach, since potential exposures to these media will not occur at the frequency or intensity that would be associated with residential land use.

2) Essential Nutrients:

- Eliminated as COPCs because they are considered essential human nutrients. The following inorganic analytes are considered essential human nutrients: calcium, copper, magnesium, iron, potassium, and sodium.

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3) Chemicals for which risk-based concentrations were not available were retained as COPCs.

- The results of the COPC selection for floodplain soil at the Oxbow Area and the background area (Greystone Mill Pond Area) are summarized in Tables 2.1 and 2.2. The following notes are used to denote the reasons for selection or exclusion of analytes as COPCs:

  A: The concentration used for COPC screening (the maximum detected concentration) is greater than the risk-based concentration; the analyte is therefore selected as a COPC.

  S: The concentration used for COPC screening (the maximum detected concentration) is less than the risk-based concentration; the analyte is therefore not selected as a COPC.

  E: The analyte is an essential nutrient, and is therefore not selected as a COPC.

Chemicals for which risk-based concentrations were not available were retained as COPCs.

2.1.2 COPC Selection Results

COPCs have been selected for the Oxbow Area floodplain soil and for the background area floodplain soil (Tables 2.1 and 2.2). In general, dioxins and furans, pesticides, Aroclors, and some metals were retained as COPCs in floodplain soil from the Oxbow Area. For the background area (Greystone Mill Pond Area), HCX, coplanar PCBs, and PAH compounds were also retained as COPCs in floodplain soil. Those additional parameters were not included in the analyte list for the Oxbow Area floodplain soil samples.

Table 2.1 presents the selection of COPCs for floodplain soil collected from the Oxbow Area. COPCs include dioxins and furans, Aroclors 1254, seven pesticides, and eight inorganics/metals (including copper, lead, and zinc).

Table 2.2 presents the selection of COPCs for floodplain soil collected from upstream of the source area and just north of Route 44 (Greystone Mill Pond Area). COPCs include dioxin-like compounds (HCX, dioxins and furans, and coplanar PCBs), Aroclors 1254 and 1268, two pesticides, several PAHs, and eleven inorganics/metals (including copper and lead).

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Overall, the number of COPCs for each medium are reasonably consistent between the background area and the Oxbow Area. However, there were more COPCs at the background area because the analyte list was longer at the background area than at the Oxbow Area. As discussed in Section 5.1 (Summary of Calculation of Receptor Risks), calculations were also completed to compare risks between the Site and the background area using similar lists of COPCs (reduced list for the background area) for the two areas.

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3.0 EXPOSURE ASSESSMENT

As defined by the USEPA (USEPA, 1989a), exposure to a chemical is the contact of that chemical with the outer boundary of the body (i.e., skin and openings such as mouth, nostrils, or punctures and lesions). An exposure assessment is the quantitative or qualitative evaluation of that contact. It describes the intensity, frequency, and duration of contact, as well as the rates at which the chemical crosses the boundary (chemical intake or uptake rates), the route by which it crosses the boundary, and the resulting amount of chemical that actually crosses the boundary (a dose) and the amount absorbed (internal dose).

The objective of the exposure assessment is to estimate the type and magnitude of exposures to COPCs at or migrating from the site. The exposure assessment is conducted to: 1) characterize the populations of humans potentially exposed via consumption of biota from the Woonasquatucket River and direct contact with surface water, sediment and bank soil at and adjacent to the river; 2) identify the mechanisms by which receptors may be exposed; and 3) identify the intake, or dose, of COPCs that receptors may receive through the identified exposure pathways. The exposure assessment includes the following components:

- Characterization of the exposure setting (including current and future land use);
- Identification of exposure pathways (including receptor identification and exposure scenarios, and exposure points);
- Identification of EPCs;
- Quantification of exposures; and
- A summary of exposures by receptor and exposure point.

Present and future potential exposures to site contaminants include direct contact with floodplain soil. Narrative descriptions and summary tables of exposure scenarios are provided in this section. The exposure scenarios for current and future potential scenarios are summarized in RAGS Part D Table 4s.

3.1 CHARACTERIZATION OF EXPOSURE SETTING

The exposure setting has previously been described in Section 1.4.

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3.2 IDENTIFICATION OF EXPOSURE PATHWAYS, POTENTIAL RECEPTORS, AND EXPOSURE POINTS

This subsection describes the receptors and activities, exposure pathways, exposure parameters and exposure points for the Passive Recreational Visitor.

This step involves the identification of all relevant exposure pathways through which specific populations may be exposed (current and future) to contaminants at the site. An exposure pathway consists of four necessary elements: 1) a source or mechanism of chemical release; 2) a transport or retention medium; 3) a point of human contact; and 4) a route of exposure at the point of contact (USEPA, 1989a). As discussed in the text below and in Table 1.2 the Passive Recreational Visitor is the receptor population evaluated in this Addendum. The Passive Recreational Visitor is distinguished here from what might be referred to as an Active Recreational Visitor. The distinction is in the nature and intensity of the expected activities that might result in soil exposure. The Passive Recreational activities might include walking, bird watching, and exploring, while Active Recreational activities might include playing baseball, playing in a "tot lot", and other activities with a higher potential for high intensity soil contact.

Exposures were evaluated based on two scenarios, the central tendency (CT) and Reasonable Maximum Exposure (RME) scenarios. The CT exposure is the typical or average exposure that would be expected in a population. The RME is the highest exposure that is reasonably expected to occur at a site. The CT and RME scenarios are characterized by coupling the contaminant concentrations with conservative exposure parameters developed for each exposure scenario. The CT and RME scenarios are summarized in RAGS Part D Table 4s and are discussed in sections 3.2.1 and 3.2.2 below, and results are described in the text. Exposure parameters are obtained from USEPA guidance (USEPA, 1997a) and other USEPA-approved sources. In general, RME parameters represent 95th percentile values and CT parameters represent mean values.

3.2.1 Receptor Exposure Scenarios for Floodplain Soil

Using the information summarized in Table 1.2, receptor exposure scenarios were compiled. The following paragraphs discuss the receptor exposure scenarios.

Exposure parameters for the RME were selected from USEPA guidance documents (USEPA, 1994; 1997; 2001) and were based on professional judgment considering the site-specific

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exposure conditions. This subsection describes the exposure scenarios and RME exposure parameters in detail. Exposure parameters for the CT were based on the RME values, with the following modifications:

- CT values for incidental ingestion of soil were identified as one-half the RME values, based on USEPA Region I guidance (USEPA, 1994) which recommends using one-half the RME value as the CT value for incidental soil ingestion.
- CT values for soil dermal adherence were the recommended CT parameters from USEPA RAGS Part E guidance (USEPA, 2001b).
- The RME values assume that a receptor uses the Site for all of their outdoor activities (e.g., recreational play/exploration, recreational angling, or subsistence angling). The CT parameters accommodate the assumption that a more "typical" or "average" receptor would spend only a portion (roughly 50%) of their outdoor time at the Site (i.e., would access other, non-Site related areas for recreational purposes).

Passive Recreational Visitor

In the previous BHHRA for the CMRPSS, an exposure profile was identified for residents living along the river. A resident who lives at the Centredale Manor Apartments, Brook Village Apartments, or a private residence at one of the residential lots along the eastern shore of the Woonasquatucket River may visit water bodies at the Site for recreational angling, recreational walking, exploring the banks of the river and ponds, and wading and swimming. It is assumed that area residents include young children (ages 1 through 6), older children (ages 7 through 18), and adults (assumed ages 19 through 30). Potential exposures to surface water and aquatic (submerged) sediment by incidental ingestion and dermal contact may occur during angling, wading, or swimming (no swimming in Assapumpset Brook) at Greystone Mill Pond area and Assapumpset Brook and Pond, Allendale Pond, Lyman Mill Pond, Manton Reach, and Dyerville Reach. In addition, possible exposures to bank surface soils at Greystone Mill Pond area, Allendale Pond and Lyman Mill Pond by incidental ingestion and dermal contact may occur when area residents access the water bodies for recreational angling, swimming and wading, or when walking or exploring the edges of the ponds. This exposure profile appears to be an appropriate starting point for evaluating a potential passive recreational visitor for the Oxbow Area. The Oxbow Area is in close proximity to the Woonasquatucket River and to residential properties along the river in the area of the CMRPSS. People who visit the Oxbow Area for hiking, bird-watching, picnicking, and other passive recreational activities would most likely live in the general area of the Woonasquatucket River. This Addendum focuses only on the potential exposures to floodplain soils in the Oxbow Area, since potential exposures to surface water and

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sediment in the river and fish consumption have previously been evaluated in the BHHRA for the CMRPSS.

Cancer and non-cancer risk estimates are calculated separately for floodplain soils at the Oxbow Area. These risks will be used in a floodplain soil-specific evaluation in the future. The risks associated with the Oxbow Area floodplain soils have not been combined with the previously calculated risks associated with potential exposures associated with fish consumption and contact with surface water and sediment in the river.

The RME and CT exposure parameters for floodplain soil are presented in Tables 4.1.RME and 4.1.CT.

Exposure Duration. For the RME scenario, it is assumed that a Passive Recreational Visitor is raised at and remains at the same residence over a 30-year period (USEPA, 1994) in the general area of the river and the Oxbow Area. The 30-year duration is segregated into three age periods: young-child (ages 1 through 6) for 6 years; older child (ages 7 through 18) for 12 years; and adult (ages 19 through 30) for 12 years. The CT exposure duration values are based on the recommended CT parameters for exposure duration published in USEPA RAGS Part E of 9 years. The 9-year exposure duration value was segregated as follows: young child (2 years); older child (3 years); and adult (4 years).

Exposure Frequency. It is assumed that a Passive Recreational Visitor visits the water bodies, banks of the water bodies, or the Oxbow Area for walking/exploring/bird watching May through October. The Oxbow Area is immediately adjacent to the river and therefore, the western bank of the river is included in the Oxbow Area. The exposure frequency associated with these various activities is broken down as follows:

Activity	**RME Frequency / Period**	**RME Total No. Days per Year**	
		Young Child	Older Child / Adult
Walking/Exploring banks and Oxbow Area	2x/week: May, Sept, Oct 4x/week: June – Aug	78	78

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Activity	CT Frequency / Period	CT Total No. Days per Year	
		Young Child	Older Child / Adult
Walking/Exploring banks and Oxbow Area	1x/week: May, Sept, Oct 2x/week: June – Aug	39	39

The exposure frequency during the summer months assumes that walking/exploring/bird watching within the Oxbow Area (including the river bank) assumes a total of four visits to the water bodies occur each week. It is assumed that potential exposures to floodplain soil occur each day that access to the Oxbow Area occurs (78 days per year).

Body Weight. Body weight values for young children and adults are based on values recommended in USEPA guidance (USEPA, 1994). Body weight values for older children are based on the average of 50th percentile body weights for males ages 7 through 18 (USEPA, 1997).

Incidental Ingestion Rate and Fraction Ingested. The incidental ingestion rates for floodplain surface soil are the default ingestion rate values for soil recommended in USEPA (1994) guidance; the ingestion rate for adults is applied to older children who are less likely than young children to place soil-covered hands in the mouth. The fraction ingested parameter for bank surface soil is 100%. The assumed soil ingestion rates (typically applied to residential scenarios) are considered conservative assumptions for a passive recreational scenario. The dermal surface area and adherence factor values for bank surface soil are based on the RAGS Part E (USEPA, 2001c) default values for residential exposures to soil.

3.2.2 Exposure Points

A single exposure point, identified as the entire Oxbow Area, has been identified for evaluation of floodplain soil by the Passive Recreational Visitor. This exposure point is represented by the seven samples (plus two duplicates) that were collected in the area. There is no indication that a hot spot exists that would require a separate evaluation. In addition, a single upstream background exposure point (Greystone Mill Pond Area) has also been identified as an exposure point for use in calculating incremental risks.

Exposure Point Concentrations

A single concentration is selected as representative of the actual concentration for each COPC in a floodplain soil for a given exposure point. This value, called the EPC, is used in the estimates

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of health risks at the site. An EPC is selected for every COPC identified in the screening process described earlier.

For both RME and CT, the 95% Upper Confidence Limit (UCL) on the mean is typically used as the EPC. There are two exceptions to this rule. In the case where the 95% UCL is greater than the maximum detected concentration; and/or if there are fewer than 10 samples in a data set (the UCL is not calculated). When there are fewer than 10 samples in a data set, estimation of a UCL may have a high degree of uncertainty. For these two situations, the maximum detected concentration should be used as the RME EPC and the arithmetic average concentration should be used for the CT EPC. For floodplain soil at the Oxbow Area and at the background area, there are fewer than ten samples available to characterize potential exposures. At the Oxbow Area, seven samples (plus duplicates) were collected and analyzed for dioxins and furans, and four samples were analyzed for metals and pesticides/PCBs. At the background area, four samples were analyzed for dioxins and furans, inorganics and metals, SVOCs, and pesticides and PCBs. One of the background soil samples was analyzed for PCB congeners. Because there were fewer than 10 samples at the Oxbow Area and at the background location, the RME EPC has been identified as the maximum detected concentration for each COPC and for the CT EPC, the arithmetic mean concentration of the samples has been identified. All of the data for the Oxbow Area and the background area are shown in Tables A-1 and A-2 respectively in Appendix A.

Table 3.1.RME and Tables 3.1.CT document the calculation and identification of RME and CT EPCs for floodplain soil. Each table contains all of the EPCs for both the Oxbow Area and the background area.

3.3 QUANTIFICATION OF EXPOSURES

The next step is to calculate COPC intakes via direct contact with floodplain soil for the Passive Recreational Visitor. Population-related variables have been selected that describe the characteristics associated with individual receptors in that population.

3.3.1.1 Estimation of Chemical-Specific Intakes

The chemical-specific intake, or the average daily dose (ADD), is the amount of COPC absorbed into the body. When appropriate, it is the product of the average daily exposure and an

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absorption factor (ABS). Chemical-specific intakes were calculated in a manner consistent with USEPA guidance for risk assessment (USEPA, 1989a; 2001a).

A Lifetime Average Daily Dose (LADD) is calculated in order to estimate carcinogenic risk. The Averaging Time (AT) over which the total intake of COPC is averaged is 70 years for carcinogenic effects (USEPA, 1989a).

For noncarcinogenic effects, depending on the duration of the exposure period, an Average Daily Dose, Chronic (ADD_c) for long-term exposure (seven years or longer) or Average Daily Dose, Subchronic (ADD_s) for exposure periods from a month up to seven years may be calculated.

Soil Direct Contact Exposures

The ADD received by a receptor via direct contact with soil (ADD_{soil}) is the sum of the ADDs for exposure via the routes of dermal contact with the contaminated soil and ingestion of the contaminated soil. Thus,

$$ADD_{soil} = ADD_{dermal} + ADD_{ingestion}$$

Dermal Contact. The ADD due to dermal contact with COPC-contaminated soil ($ADD_{dermal\ absorption}$) may be calculated:

$$ADD_{dermal\ absorption} = \frac{DAevent * SA * EF * ED}{BW * AT}$$

and:

$$DAevent = [COPC]soil * AF * ABS * C$$

Where:

$ADD_{dermal\ absorption}$	=	Average daily dose of COPC received through dermal contact with soil during the period of exposure (dimensions: mass/mass×time, typical units: mg/kg×day)
DAevent	=	Dose of COPC absorbed during each exposure event (dimensions: mg/cm^2)
$[COPC]_{soil}$	=	EPC of COPC in the soil at the exposure point during the period of exposure (dimensions: mg/kg)
SA	=	Skin surface area in contact with the soil on days exposed (dimensions: cm^2/day)
AF	=	Mass of soil adhered to the unit surface area of skin exposed (dimensions: mg/cm^2)
ABS	=	Absorption Factor; represents the fraction of COPC that may be absorbed through the skin from soil (unitless)

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EF	=	Exposure Frequency: the number of exposure events during the exposure period divided by the number of days in the exposure period (dimensions: days/year)
ED	=	Exposure Duration: the period of time over which exposure may occur (dimension: years)
BW	=	Body Weight of the receptor of concern during the exposure duration dimension: kg)
AT	=	Averaging Time (dimension: days)
C	=	Appropriate units conversion factor(s)

Ingestion. The ADD due to the incidental ingestion of COPC contaminated soil ($ADD_{ingestion}$) may be calculated:

$$ADD_{ingestion} = \frac{[COPC]_{soil} * IR * EF * ED * C}{BW * AT}$$

Where:

ADDingestion	=	Average daily dose of COPC received through the ingestion of soil during the period of exposure (dimensions: mass/mass×time, typical units: mg/kg×day)
[COPC]soil	=	EPC of the COPC in soil (dimensions: mass/mass, typical units: mg/kg)
IR	=	Daily soil ingestion rate on days exposed during the exposure period (dimensions: mass/time, typical units: mg/day)
EF	=	Number of exposure events during the exposure period divided by the number of days in the exposure period (dimensions: events/time, typical units: days/year)
ED	=	Duration of the exposure period (dimensions: time, typical units: years)
C	=	Appropriate units conversion factor(s)
BW	=	Body weight of the receptor of concern during the averaging period (dimensions: mass, typical units: kg)
AT	=	Averaging Time (dimension: time, typical units: days)

The daily chemical intakes have been calculated separately for non-cancer and cancer endpoints using the EPCs presented in Table 3.1.RME and Table 3.1.CT, the exposure parameters and intake equations shown in Table 4.1.RME and Tables 4.1.CT. The floodplain soil daily intakes for the Passive Recreational Visitor, all age-groups, are calculated in Tables 7.1.RME through 7.3.RME and Tables 7.1.CT through 7.3.CT for RME and CT exposures respectively for the Oxbow Area. The daily intakes for the background area (Greystone Mill Pond Area) floodplain soil for the Passive Recreational Visitor, all age-groups, are calculated in Tables 7.4.RME through 7.6.RME and Tables 7.4.CT through 7.6.CT for RME and CT scenarios respectively.

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Each of those tables shows all daily intake calculations for floodplain soils for a receptor group/age-group/exposure point combination.

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4.0 TOXICITY ASSESSMENT

4.1 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to characterize the relationship between the dose of COPC administered or received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values (e.g., slope factors (SFs), reference dose (RfD) values, or reference concentrations (RfCs)) are derived that can be used to estimate the likelihood of adverse effects as a function of human exposure to an agent. These toxicity values are used in the risk characterization process to estimate the potential for adverse effects occurring in humans at different exposure levels.

The dose-response relationship(s) for each chemical that has been selected as a COPC is presented in this section. The dose-response information may be divided into two major categories:

- Toxicity information associated with threshold (non-carcinogenic) health effects.
- Toxicity information concerning carcinogenicity, either from human epidemiologic data or from laboratory studies.

All the chemicals selected as COPCs are evaluated for potential *non-carcinogenic* health effects. In addition, any substance considered to be a *known*, *probable*, or *possible* human carcinogen is also evaluated for its potential carcinogenic effects. The classification of a chemical as a carcinogen does not preclude an evaluation of that same chemical for potential non-carcinogenic health risks, as all potentially carcinogenic chemicals may also exert non-carcinogenic health effects.

4.1.1 Dose-Response Assessment for Carcinogenic Effects

It has generally been assumed that carcinogenic effects are non-threshold effects (IRIS, 2003). This means that any dose, no matter how small, is assumed to pose a finite probability of generating a response. Thus, no dose of a carcinogen is thought to be risk-free. For carcinogenic effects, USEPA uses a two-part evaluation in which the substance is first assigned a weight-of-evidence classification, and then a SF or unit risk (UR) is calculated to reflect the carcinogenic potency.

The weight-of-evidence evaluation involves determining the likelihood that the agent is a human carcinogen. USEPA has developed a system for characterizing the overall weight of evidence for a chemical's carcinogenicity based on the availability of animal, human, and other supportive data (USEPA, 1989a). The weight-of-evidence classification rates the likelihood that an agent is a human carcinogen. It qualitatively affects the interpretation of potential health risks. Three major factors are considered in characterizing the overall weight-of-evidence for carcinogenicity: (1) the quality of evidence from human studies, (2) the quality of evidence from animal studies, and (3) other supportive information, such as mutagenicity data and structure-activity data.

USEPA's final classification of the overall weight-of-evidence has the following five categories:

Group A - Human Carcinogen. This category indicates there is sufficient evidence from epidemiological studies to support a causal association between an agent and human cancer.

Group B - Probable Human Carcinogen. This category generally indicates there is at least limited evidence from epidemiologic studies of carcinogenicity to humans (Group B1) or that, in the absence of data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

Group C - Possible Human Carcinogen. This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans.

Group D - Not Classified. This category indicates that the evidence for carcinogenicity in animals is inadequate.

Group E - No Evidence of Carcinogenicity to Humans. This category indicates that there is evidence of noncarcinogenicity in at least two adequate animal tests in different species or in both epidemiologic and animal studies.

USEPA's revised guidelines for cancer risk assessment (USEPA, 2005) have been adopted as agency policy for cancer risk assessment. These guidelines contain a revised classification system for carcinogenic effects with the following classifications.

- Carcinogenic to humans
- Likely to be carcinogenic to humans

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- Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential
- Data inadequate for an assessment of human carcinogenic potential
- Not likely to be carcinogenic in humans

In IRIS, the weight of evidence classification for a given chemical may reflect either of the two classification schemes identified above.

The ability of a chemical to increase the incidence of cancer in a target population is described by one of two values: the carcinogenic SF or the UR. CSFs or URs are typically calculated for chemicals in Groups A, B1, and B2. Cancer dose-response values for chemicals in Group C are calculated on a case-by-case basis.

For some chemicals, human epidemiologic data is the basis of an estimate of the carcinogenic potency, although the most common basis of these values is an animal study. The SF is given in units of $(mg/kg/day)^{-1}$ and is based upon the concept of a LADD. Oral SFs are used to estimate the risks associated with exposure to carcinogens via ingestion. No SFs are available for the dermal route of exposure, but are instead calculated from oral SFs using the methodology described in Section 4.1.3.

The dose-response data used in this Addendum for carcinogenic effects, including SF and UR values, are presented in Table 6.1.

4.1.2 Dose-Response Assessment for Noncarcinogenic Effects

In contrast to carcinogens, noncarcinogens are believed to have threshold exposure levels below which adverse effects are not expected. USEPA has derived standards and guidelines based on acceptable levels of exposure for such compounds. Noncarcinogenic effects of concern on which many of the standards and guidelines are based include liver toxicity, reproductive effects, neurotoxicity, teratogenicity, and other chronic toxicities. Various criteria have been developed from experiments that can be used to estimate the dose-response relationship of noncarcinogens. Some of the same uncertainties involved in deriving cancer risk estimates (namely, selection of an appropriate data set and extrapolation of high-dose animal data to low-dose human exposure) are also involved in deriving noncarcinogenic dose-response criteria. Dose-response values used most often to evaluate noncarcinogenic effects are RfDs.

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The RfD, expressed in units of mg/kg/day, is defined as an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA, 1989). When available, the RfD is the dose-response criterion most appropriate for quantitatively estimating noncarcinogenic effects. The RfD is derived from the following equation:

$$RfD\ (mg/kg/day) = \frac{NOAEL\ or\ LOAEL}{UF\ and/or\ MF}$$

The No Observable Adverse Effect Level (NOAEL) represents the dose of a chemical at which there are no statistically or biologically significant differences in the frequency of an adverse effect between the exposed population and its appropriate control. The Lowest Observable Adverse Effect Level (LOAEL) represents the lowest dose at which a statistically significant difference in the frequency of an effect is noted. Both the NOAEL and the LOAEL are reported in terms of mg/kg/day. An uncertainty factor (UF) of ten per type of uncertainty (e.g., extrapolation from animal sensitivity to human sensitivity, relationship between lowest adverse effect level and no adverse effect level) is used to account for interspecies and interspecies differences, severity of the adverse effect, whether the dose was an NOAEL or an LOAEL, and the adequacy of the data. The magnitude of the UF will therefore vary from chemical to chemical, ranging from 10 to 10,000. A modifying factor (MF), ranging from less than 1 to 10 may also be added to reflect qualitative uncertainties not explicitly addressed in the UFs. The toxicity endpoint upon which the RfD is derived and the UF and/or MF used in the calculation are presented in the dose-response tables. No RfDs are available for the dermal route of exposure but are instead calculated from oral RfDs using the methodology described below (USEPA, 2001b).

The use of chronic RfDs to evaluate the potential for adverse health effects resulting from substantially less-than-lifetime exposures may be overly protective. Subchronic reference doses (RfD_ss) have been developed for many chemicals to evaluate the potential noncarcinogenic effects of limited duration exposures. RfD_ss are similar to chronic RfDs; the distinction is the length of exposure duration. When available, RfD_ss/RfC_ss are used in this risk assessment to evaluate noncarcinogenic effects to a construction worker. When RfD_ss are unavailable, chronic RfDs are used to evaluate noncarcinogenic effects for these receptors.

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The dose-response data for noncarcinogenic effects (RfDs) and their critical toxic effects are presented in Table 5.1, for both chronic and subchronic effects.

4.1.3 Dermal Dose-Response Values

CSFs and non-cancer RfDs were developed to evaluate risk associated with the dermal contact exposure route. In accordance with USEPA guidance (USEPA, 2001a), dermal dose-response values are calculated from oral dose-response values using an oral absorption factor. The oral absorption factor represents the amount of substance that is absorbed from the gastrointestinal tract following oral administration of a substance. The absorbed dose represents the amount of substance that is potentially available for biological interaction. It is this dose-response relationship that the toxicity of a dermally absorbed substance is evaluated. Thus, for potentially carcinogenic substances, the dermal dose-response value is calculated as follows:

$$SF_d = SF_{oral} / Oral\ ABS$$

The dermal dose-response value for evaluating non-carcinogenic effects is calculated as follows:

$$RfD_d = RfD_{oral} \times Oral\ ABS$$

The Oral ABS is the fraction of contaminant absorbed in the gastrointestinal tract (dimensionless) in the critical toxicity study. Chemical-specific Oral ABS values are published by USEPA (USEPA, 2001b). In accordance with USEPA guidance (USEPA, 2001b), oral dose-response values are only adjusted using an Oral ABS value if the COPC has an oral ABS value less than 50%. Otherwise, the oral dose-response value is used as the dermal dose-response value. Dermal SFs and RfDs are presented in Tables 6.1 and 5.1 respectively.

4.1.4 Sources of Dose-Response Values

The following hierarchy of sources for dose-response values has been utilized in identifying dose-response values for this Addendum.

Tier 1- IRIS (http://www.epa.gov/iris/). In accordance with USEPA guidance, the main source of dose-response values is the USEPA Integrated Risk Information System (IRIS), which is a database established by USEPA containing all validated data on many toxic substances found at

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hazardous waste Sites. This database was used to identify the SFs and RfDs applied in this risk assessment (USEPA, 2006).

Tier 2- NCEA's peer reviewed toxicity values (PRTVs). NCEA's PRTVs are developed by the Superfund Technical Support Center (STSC) for the EPA Superfund program. STSC's reassessment of HEAST toxicity values, as well as development of PRTVs in response to Regional or Headquarters Superfund program requests, are consistent with Agency practices on toxicity value development, use the most recent scientific literature, and are supported by both internal and external peer review, providing a high level of confidence in the use of these values in the Superfund Program. USEPA Region I has provided PRTVs and associated documentation prepared by the STSC for aluminum, copper, 2-methylnapthalene, and 4-nitrophenol (USEPA, 2003b).

Tier 3 - Other toxicity values

- Cal EPA's toxicity values. Cal EPA develops toxicity values for both cancer and non-cancer effects. Cal EPA toxicity values are obtained on the Cal EPA website at http://www.oehha.ca.gov/risk/chemicalDB//index.asp.

- ATSDR's MRLs address non-cancer effects only, and are available on the ATSDR website at http://www.atsdr.cdc.gov/mrls.html.

- Toxicity values remaining in current versions of HEAST (1997a).

In this Addendum, the majority of dose-response values used are published in IRIS. For some Site-related COPCs required dose-response data are only available as NCEA provisional values or from CAL-EPA. These dose-response values were used in this Addendum in order to provide a more complete evaluation of potential risks.

Uncertainties related to the absence of dose-response data, particularly for COPCs for which the exposure pathway, which represents the only pathway or most significant exposure pathway, has no toxicity criterion, will be discussed in the risk assessment uncertainty analysis.

Evaluation of Dioxin-Like Compounds in Site Media

Due to the limited toxicological data available for many individual dioxin, furan, coplanar PCB congeners, and HCX, and to simplify the risk assessment process, a methodology has been developed that quantifies the toxicities of various dioxin, furan, and coplanar PCB congeners relative to the toxicity of 2,3,7,8-TCDD (Van den Berg et al., 1998). TCDD is widely accepted to

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be the most toxicological significant chemical among these groups of chemicals, all of whose toxicological properties are assumed to be regulated by their individual abilities to bind to the cytosolic Ah receptor (AhR).

Based on the potency of 2,3,7,8-TCDD, and the greater amount of research that has been devoted to 2,3,7,8-TCDD, a CSF has only been developed for this congener. Other dioxin, furan, and co-planar PCB compounds exert toxicity through the same mechanism of action as 2,3,7,8-TCDD, but the threshold effects levels for the other compounds are directly related to their affinity to interact with the AhR. Therefore, dioxin, furan, and co-planar PCB compounds (dioxin-like compounds) are evaluated using the dose-response data for 2,3,7,8-TCDD, but the concentrations are weighted according to their potency relative to the 2,3,7,8-TCDD using TEFs.

The procedure for weighting the concentrations of dioxin-like compounds is documented in Appendix B. In summary, since 2,3,7,8-TCDD has the greatest affinity for the AhR, it is arbitrarily assigned a TEF of 1. Other congeners are assigned a TCDD TEF relative to 2,3,7,8-TCDD based on experimental evidence concerning their relative binding potential to the AhR. The potency of the congener is then estimated by multiplying the measured media concentration by the TEF for the particular congener to yield a TEQ. Finally, a TEQ for the entire sample can be determined by summing the calculated TEQs for each AhR binding congener; the resulting concentration is a measure of the potency of the entire mixture represented in terms of 2,3,7,8-TCDD, and is expressed as a TCDD-equivalent concentration. This methodology assumes that the combined effects of the different congeners are dose or concentration additive, and this has been generally supported by results of many studies. This approach fails to consider the toxicological significance of effects that are not mediated by the Ah receptor (e.g., neurotoxicity and various hormonal effects). However, current consensus is that the TEF approach is the best methodology for assessing the impacts associated with exposure to dioxin-like compounds (Van den Berg et al., 1998).

The CSF for 2,3,7,8-TCDD of 1.5E+05 per mg/kg/day (USEPA, 1997) is used to evaluate the potential risks associated with dioxin-like compounds. Specifically, this CSF is applied to the calculated intakes for the dioxin-TEQ (sum of TEQs for individual dioxin and furan compounds) and the co-planar PCB TEQ (sum of TEQs for individual co-planar PCB congeners). The TEFs for dioxin-like PCBs, polychlorinated dibenzodioxins (PCDDs) and polychlorinated

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dibenzofurans (PCDFs) identified for mammals (Van den Berg et. al. 1998) are applied to the fish tissue, surface water, and sediment EPCs for each of the congeners to identify a toxic equivalence concentration (TEQ). The TEQ are used in conjunction with the oral CSF for 2,3,7,8-TCDD (available in HEAST, USEPA 1997) to estimate cancer risk for those compounds. The dioxin/furan TEQ has been kept distinct from the co-planar PCB TEQ for purposes of risk calculations.

The dioxin-like PCB congeners evaluated in this manner include congeners 105, 114, 118, 123, 156, 157, 167, 189, 81, 77, 126, and 169. I should be noted that PCB congener analysis was not conducted for Oxbow Area floodplain soil. The remainder of the reported PCB congeners are not evaluated in a quantitative manner. Rather, they are evaluated, by inclusion, with the Aroclor-1254 or Aroclor-1260 using the High Risk and Persistence, Upper Bound CSF for PCBs. Aroclor-1254 and Aroclor-1260 EPCs have not been adjusted (reduced) to account for the twelve co-planar PCB congeners that are evaluated using the dioxin TEF approach. Therefore, there is an overestimation of cancer risk associated with these co-planar PCB congeners. The RfDs (Aroclor 1254) obtained from the IRIS database is used to evaluate non-cancer risks associated with Aroclors.

The compound HCX has been identified as a dioxin-like compound and it was identified at the background area. However, HCX analysis was not conducted for the Oxbow Area floodplain soils. Therefore, HCX risk has not been evaluated for the Oxbow Area.

DIOXIN REASSESSMENT

EPA has reviewed available toxicity studies on 2,3,7,8-TCDD and other dioxin-like compounds. A preliminary draft document, *Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds*, (EPA, 2000) presents EPA's scientific reassessment of the health risks resulting from exposure to these compounds. This draft document has been reviewed by the public and the USEPA's Science Advisory Board (SAB) in its publication, *Dioxin Reassessment – An SAB Review of the Office of Research and Development's Reassessment of Dioxin*, (EPA-SAB, 2001). At this time, the dioxin reassessment document and its contents remain in draft status. The draft reassessment document draws some important conclusions and makes recommendations concerning health risk assessment for dioxins and furans.

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Cancer Effects

In its review of available toxicity studies on 2,3,7,8-TCDD and other dioxin-like compounds (EPA 2000), USEPA recommended a revised CSF of 1E+06 $(mg/kg\text{-}d)^{-1}$ to estimate upper-bound cancer risk for background intakes and incremental intakes above background. This estimate compares well with the published estimates of cancer slope and risk from epidemiological studies by Becher et al., 1998 and Steenland et al., 2001 on the Hamburg and NOISH cohorts. Use of the recommended CSF (EPA 2000) would result in an approximately 7-fold increase in the cancer risk estimates based on the current upper-bound SF (1.56 E+05) associated with 2,3,7,8-TCDD and other dioxin-like compounds.

The epidemiological literature suggests an association with increases in all cancers combined, in respiratory tumors, and possibly in soft tissue sarcoma. EPA found that a weight-of-evidence evaluation suggests that mixtures of 2,3,7,8-TCDD and other dioxin-like PCDDs, PCDFs, and PCBs are strong cancer promoters and weak direct or indirect tumor initiators.

Based on the most sensitive cancer responses in animal and human studies, EPA estimated CSFs ranging from approximately 1E+06 to 9E+06 $(mg/kg\text{-}d)^{-1}$. EPA estimated an upper-bound CSF of 1E+06 $(mg/kg\text{-}d)^{-1}$ based on human data from a meta-analysis of three occupational cohorts, and an upper bound CSF of 1.4E+06 $(mg/kg\text{-}d)^{-1}$ based on animal data. Other analyses of these data have recently been published (Starr, 2001, 99-1301 and Crump, 2003, 99-1300). The shape of the low-dose exposure response relationship could not be determined from available data. Therefore, EPA used a linear dose extrapolation model to derive upper-bound CSF estimates.

Non-cancer Effects

EPA (2000) evaluated the "margin-of-exposure" (MOE), for several toxicology studies on non-cancer effects (DeVito et al., 1995; Gray et al., 1997; Mabley et al., 1992a,b,c; Murray et al., 1979; Narashimhan et al., 1994; Rier et al., 1993; Schantz et al., 1992; Schrenk et al., 1994; Sewall and Lucier, 1995; Smialowicz et al., 1994; Van Birgelen et al., 1995; Vecchi et al., 1983 Vogel et al., 1997; Walker et al., 1999). MOE is defined here as the ratio of the effect level in the comparison species to the current background human body burden. The effect level in the comparison species pertains to the body burden in laboratory species that results in some low level effect, such as a LOAEL, or the ED01 (the effective dose at which 1% of the tested

population shows the effect in question). For the most sensitive endpoints identified, MOEs were found to range from, for example, less than one for enzyme induction in mice and rats, less than four for developmental effects and to four for endometriosis in nonhuman primates. In other words, the body burden in the laboratory species that showed a particular effect was only four times (and less) higher than the current body burden in humans. In evaluating MOEs, consideration should be given to uncertainties in distinguishing between adaptive biochemical changes and adverse effects, both on an individual level and as these changes impact whole populations. Children's non-cancer risks from dioxin and related compounds may be greater than for adults, but more data are needed to fully address this issue.

An RfD, for dioxin-like compounds has not been developed. Further, EPA (2000) concluded that an RfD for dioxin calculated in the manner typical of the way EPA determines RfDs would result in a dose that is significantly lower than current average background doses. RfDs are used primarily to evaluate increments of exposure from specific sources when background exposures are low and insignificant, and background exposures are not insignificant as indicated by the MOE discussion above.

This assessment quantifies non-cancer effects using RfDs to calculate HQs and hazard indices. Because an RfD has not been developed for PCDDs and PCDFs, the potential for non-cancer effects from exposure to dioxin-like compounds is not quantitatively evaluated in this assessment.

Alternative cancer risk estimates for the floodplain soil exposure pathway could be calculated in the same manner as discussed above, but using the 2,3,7,8-TCDD CSF draft value ($1x10^6$/(mg/kg/day) presented in the 2000 Dioxin Reassessment Document (USEPA, 2000c). Using that CSF, the estimated cancer risks associated with dioxin and furan exposure would be approximately 6.4 times higher than calculations presented in this assessment.

Evaluation of Chromium in Site Media

The most common forms of chromium in environmental media are chromium III (trivalent chromium) and chromium VI (hexavalent chromium). Although chromium was detected in Site media, no speciation analyses were performed. To provide a conservative assessment of toxicity and health risks associated with potential exposures to chromium, chromium data was evaluated as hexavalent chromium in this risk assessment.

Exposures to hexavalent chromium have been associated with chronic non-cancer health effects via ingestion, dermal contact, and inhalation, and allergic contact dermatitis via direct dermal contact with hexavalent-chromium containing materials. The chronic oral RfD of 0.003 mg/kg/day (IRIS, 2001d) and the subchronic oral RfD of 0.02 mg/kg/day (HEAST, 1997c) have been applied to the estimated daily doses in order to characterize potential non-cancer risks for ingestion and dermal contact with soil. Hexavalent chromium RfCs are published for chromium particulates and chromic acid mists.

Evaluation of Lead in Site Media

No dose-response values are published for potential exposures to lead. In the absence of dose-response data, USEPA recommends use of lead biokinetic uptake models to evaluate potential lead exposures, and comparison of the lead intake estimated using the models to threshold blood lead levels for children and adults. Lead is screened as a potential COPC by comparing the maximum detected concentration to USEPA's Interim Soil Lead Screening Value of 400 mg/kg (USEPA, 1994), which is considered by USEPA to be protective for residential exposures to lead in soil. The OSWER screening values are used to evaluate potential risks associated with lead exposure at these areas. Lead RME EPCs in floodplain soil were greater than 400 mg/kg in the Oxbow Area (1,835 mg/kg) and at the background area (591 mg/kg) and the lead CT EPCs in floodplain soil were also higher than 400 mg/kg at the Oxbow Area (575 mg/kg) and at the background area (450 mg/kg). The potential soil-related risks have been further evaluated using the OSWER screening values. The lead concentration of 1,835 mg/kg at the Oxbow Area appears to be an anomaly. If the average concentration of lead is calculated for the Oxbow Area without that sample, the average is 201 mg/kg and is clearly below the OSWER screening level for residential soils.

Evaluation of Mercury in Site Media

Mercury may exist as elemental mercury, inorganic mercury salts, and organic mercury. Typically, mercury is present in environmental media as inorganic mercury salts or organic mercury (methyl mercury) that may be produced by bacterial methylation of inorganic mercury. Methyl mercury is known to bioaccumulate. In this Addendum, mercury detected in fish is evaluated using oral dose-response values for organic mercury (methyl mercury), whereas

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mercury detected in other media (e.g., soil) is evaluated using oral dose-response values for inorganic mercury.

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5.0 RISK CHARACTERIZATION

5.1 RISK CHARACTERIZATION

The final step of the risk assessment is the risk characterization. This step involves the integration of the exposure and toxicity assessment into quantitative expressions of potential human health risks associated with COPC exposure. Quantitative estimates of both carcinogenic and noncarcinogenic risks are made for each COPC and each exposure point. Risks associated with RME exposure scenarios and CT exposure scenarios are calculated separately.

Cancer Risks

Carcinogenic risks associated with exposure to individual chemicals are estimated by multiplying the chemical intake for each carcinogen by its CSF. This value represents an upper bound of the probability of an individual developing cancer over a lifetime as the result of exposure to a chemical. For each receptor and each exposure pathway (exposure to a specific medium) such as consumption of a specific fish species, the chemical-specific risks for all carcinogenic compounds will be summed to determine the lifetime cancer risk for that receptor for that medium. The following equations are used to estimate the chemical- and pathway-specific cancer risks.

Chemical-Specific Excess Lifetime Cancer Risk:

$$Risk_i = CDI_i \times CSF_i$$

where:

$Risk_i$	=	unitless probability of an individual developing cancer as the result of exposure to a chemical i
CDI_i	=	chronic daily intake of chemical i averaged over 70 years (mg/kg-day)
CSF_i	=	USEPA CSF for chemical i $(mg/kg\text{-}day)^{-1}$

According to RAGS Part A, p. 8-6 and 8-11, if the estimated risk is equal to or greater than 0.01, an alternative approach (one-hit equation for high carcinogenic risk levels) for calculating cancer risk should be used:

$$Risk_i = 1 - e^{(-CDIi \; X \; CSFi)}$$

where:

$Risk_i$	=	unitless probability of an individual developing cancer as the result of exposure to a chemical i
CDI_i	=	chronic daily intake of chemical i averaged over 70 years (mg/kg-day)
CSF_i	=	USEPA CSF for chemical i $(mg/kg\text{-}day)^{-1}$
e	=	exponent (value of 2.1817)

Pathway-Specific Incremental Lifetime Cancer Risk:

$$Risk_T = \Sigma\ Risk_i$$

where:

$Risk_T$	=	unitless probability of an individual developing cancer as the result of multiple chemical exposures
$Risk_i$	=	unitless cancer risk estimate for a single chemical associated with biota consumption

The results from the carcinogenic risk assessment are compared to acceptable risk ranges established by the USEPA. The USEPA's guidelines, established in the National Hazardous Substances and Pollution Contingency Plan (NCP) identify acceptable exposure levels as those concentration levels "that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response" (USEPA 1990).

Non-cancer Risks

Non-cancer risk estimates are calculated by dividing specific chemical intake by the appropriate RfD. The result is called the HQ. The HQs for individual compounds within an exposure pathway are summed to obtain the hazard index (HI) for that particular pathway.

The following equation is used to determine the HQ:

$$HQ_i = \frac{I_i}{RfD_i}$$

where:

HQ_i	=	HQ of chemical i
I_i	=	intake of chemical i averaged over the exposure period (mg/kg-day)

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RfD_i = RfD for chemical i corresponding to the same exposure duration as the intake (mg/kg-day)

The following equation is used to determine the HI:

$$HI = \Sigma HQ_i$$

where:

HI = potential for noncarcinogenic effects from multiple chemical exposures
HQ_i = HQ for each chemical associated with biota consumption

An HI of less than 1 indicates that noncarcinogenic toxic effects are unlikely. An HI greater than 1 indicates a greater possibility of a noncarcinogenic toxic effect occurring, but the circumstances must be evaluated on a case-by-case basis. Generally, as the HI increases, so does the likelihood that adverse effects might be associated with exposure. However, the relationship between increased risk and larger HI values may not be linear.

Calculation of Non-cancer and Cancer Risks

RAGS Part D Table 7s are used to present the risk calculations. In simplistic terms, for a given receptor/age-group, cancer risks are calculated for each chemical in each medium (e.g., sediment) and exposure route (e.g., ingestion, dermal contact). Risks across exposure routes are summed to yield the risk for that medium. Cancer risks associated with all exposure media for that receptor/age-group are summed to yield the cumulative receptor cancer risk for that receptor/age-group. For a given receptor (by age-group), the non-cancer HI is calculated for each chemical, and exposure route for a given medium. HI values associated with all exposure media for each receptor/age-group are summed to yield the screening cumulative HI for that receptor/age-group. This summing of HI values across chemicals and exposure media is a conservative screening approach; because chemicals can have different target organs, non-cancer risks are not necessarily additive.

The calculated RME and CT cancer risks and HI values for the Passive Recreational Visitor, all age-groups, are calculated in Tables 7.1.RME through 7.3.RME and Tables 7.1.CT through 7.3.CT for RME and CT exposures respectively for the Oxbow Area. The daily intakes for the background area (Greystone Mill Pond Area) floodplain soil for the Passive Recreational Visitor, all age-groups, are calculated in Tables 7.4.RME through 7.6.RME and Tables 7.4.CT through

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7.6.CT for RME and CT scenarios respectively. For each receptor group, each of the age groups is presented in a separate table. The RAGS Part D Table 7s document the risk calculations by identifying the COPCs, EPCs, daily chemical intakes by chemical for both cancer and non-cancer endpoints, the CSFs and RfDs, and the calculated cancer risk and HQ for each chemical in each exposure medium. Further, the Table 7s present summed risks for each medium/exposure route combination and for each medium.

The RME risk calculation spreadsheets are presented in the following order.

OXBOW AREA

- Passive Recreational Visitor at the Oxbow Area – adult, older child, child – floodplain soil. Tables 7.1.RME through 7.3.RME.

GREYSTONE MILL POND

- Passive Recreational Visitor at Greystone Mill Pond (background area) – adult, older child, child – floodplain soil. Tables 7.4.RME through 7.6.RME.

The CT risk calculation spreadsheets are presented in the same order with the same numbering scheme as the RME spreadsheets, but the table numbers contain "CT" rather than "RME (e.g., Table 7.1.CT).

There are no RAGS Part D Table 8s for this Addendum. Table 8s are specifically for the calculation of radiological risks. No radiological COPCs were identified in this assessment. Therefore, no Table 8s are required.

Summary of Non-cancer and Cancer Risks

RAGS Part D Table 9s summarize the information that is documented in the Table 7s. In addition, consistent with USEPA guidance (USEPA, 1989, 2001c), the Table 9s segregate the HI calculations by target organ system, and calculate a HI for each target organ system. This presentation of the HI calculations is an enhancement of the screening HI calculations presented previously in the Table 7s. RAGS Part D Tables 9.1.RME through 9.6.RME and Tables 9.1.CT through 9.6.CT summarize the risk calculations that are documented in the Table 7s that were discussed previously.

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Alternate Cancer Risk Calculation Method

Consistent with USEPA guidance (USEPA, 1989), if the cancer risk calculated by the standard linear dose-response model is greater than 0.01, cancer risks should be recalculated using the one-hit model presented in Section 5.1. None of the calculated cancer risks are greater than 0.01 for any exposure pathways either individually or combined. Therefore, it is not necessary to recalculate cancer risks using the one-hit model.

Identification of Chemicals of Concern

RAGS Part D Table 10s identify, for each of the three age groups for the Passive Recreational Visitor at the Oxbow Area, those chemicals that are considered chemicals of concern (COCs). COCs are those substances that have associated cancer risk greater than one in one-million (1×10^{-6}) and/or a HI greater than one for a given medium/receptor/age-group combination. COCs are those substances that would typically be considered in the Feasibility Study process. Tables 10.1.RME through 10.3.RME and Tables 10.1.CT through 10.3.CT identify the COCs and the risks associated with each of the COCs in floodplain soil at the Oxbow Area for the Passive Recreational Visitor. There are no Table 10s for Greystone Mill Pond, which is the background area. The background area risks were calculated for the purposes of calculating incremental risks. It is not necessary to identify COCs for that area.

For the RME Passive Recreational Visitor scenario, Aroclor-1254, arsenic, and dioxin TEQ were identified as COCs for floodplain soil at the Oxbow Area because the chemical-specific cancer risk is greater than one in one million. No COCs for floodplain soil were identified based on non-cancer HI values for the RME Passive Recreational Visitor scenario because no chemical-specific HI is greater than one.

For the CT Passive Recreational Visitor scenario, only dioxin TEQ was identified as a COC for floodplain soil at the Oxbow Area because the chemical-specific cancer risk is greater than one in one million. No COCs for floodplain soil were identified based on non-cancer HI values for the CT Passive Recreational Visitor scenario because no chemical-specific HI is greater than one.

The identification of a chemical as a COC does not necessarily indicate that the concentrations of the chemical in floodplain soil at the Oxbow Area are elevated above background. For example,

arsenic arithmetic mean and maximum floodplain soil concentrations at the Oxbow Area are 5.4 mg/kg and 12.8 mg/kg. These concentrations are very similar to the arithmetic mean and maximum concentrations in floodplain soil at the Greystone Mill Pond Area (background area) which are 7.72 mg/kg and 12.2 mg/kg respectively. It appears that arsenic concentrations in floodplain soil at the Oxbow Area are consistent with background conditions even though arsenic has been identified as a COC by the Table 10 process. For Aroclor-1254, the mean and maximum concentrations in floodplain soil at the Oxbow Area (1.4 mg/kg and 3.5833 mg/kg) are greater than the corresponding values for the background area (0.51998 mg/kg and 0.83872 mg/kg). However, a single sample at the Oxbow Area (LPX-SD-4402) has the maximum reported value of 3.5833 mg/kg Aroclor-1254. If this single result is removed from the Oxbow Area data set, then the maximum Aroclor-1254 concentration would be 0.687 mg/kg, which would appear to be consistent with background conditions.

Summary of Calculation of Receptor Risks

Tables 11.1.RME and 11.1.CT are risk summary tables. These tables present the floodplain soil route-specific risks for each age-group for the Passive Recreational Visitor. In addition, Tables 12 and 13 present total receptor non-cancer and cancer risks (all age groups combined for cancer risk) for each medium for the passive Recreational Visitor at each exposure point and for all exposure media combined. Tables 12 and 13 also show the incremental risks (the difference between the total calculated risk and the risk at the background location, Greystone Mill Pond). In order to "normalize" calculated risks between the Oxbow Area and the background area for the purposes of calculating incremental risk, in an alternative risk calculation, the risks at the background area were calculated excluding SVOCs and PCB Congener TEQ. Once that was done, the risks for both the Oxbow Area and the background area are based on the same chemical parameter groups: dioxins and furans; inorganics and metals; and pesticides and Aroclors. The Oxbow Area incremental risks were calculated as the difference between calculated Oxbow Area risks and the "normalized" background area risks.

As shown in Table 11.RME, the total (summed across age groups) floodplain soil cancer risk for the Passive Recreational Visitor is 3×10^{-4}, which is above the upper end of the Superfund cancer risk range. The highest non-cancer HI among the age groups is 1, for the child Passive Recreational Receptor. This screening HI is equal to the Superfund HI threshold value. This HI

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does not have a single, dominant chemical contributor. Ingestion of chromium, vanadium, manganese, arsenic, and Aroclor-1254 in floodplain soil is responsible for the majority of the calculated HI. Ingestion of floodplain soil by the child receptor contributes the largest cancer risk among exposure pathways. The largest chemical contributor to RME cancer risk is the dioxin TEQ, which is based on the maximum reported concentration of dioxins and furans in floodplain soil.

As shown in Table 11.CT, the total (summed across age groups) floodplain soil cancer risk for the Passive Recreational Visitor is 9×10^{-6}, which is within the Superfund cancer risk range. The highest non-cancer HI among the age groups is 0.1, for the child Passive Recreational Receptor. This HI is well below the Superfund HI threshold value. Ingestion of floodplain soil by the child receptor contributes the largest cancer risk among exposure pathways. The largest chemical contributor to RME cancer risk is the dioxin TEQ, which is based on the average reported concentration of dioxins and furans in floodplain soil.

Table 12 presents the incremental (above background) non-cancer risk for floodplain soil at the Oxbow Area for the Passive Recreational Visitor. The highest incremental RME HI among the age groups is 0.06 for the older child. This incremental HI value is well below one and it indicates that the incremental HI associated with the Oxbow Area is not significant. The Oxbow Area incremental CT non-cancer risk is reported as zero (the non-cancer risk is not greater at the Oxbow Area than at the background area). To simplify the presentation of risks, negative incremental risks have not been reported as negative values, they have been reported as zero. The calculated floodplain soil CT HI values for the Oxbow Area are actually somewhat lower than the corresponding HI values for floodplain soil at the background area.

Table 13 presents the incremental (above background) cancer risk for floodplain soil at the Oxbow Area for the Passive Recreational Visitor. The incremental RME cancer risk is 3×10^{-4}, which is above the upper end of the Superfund cancer risk range. This incremental cancer risk is essentially equal to the cancer risk presented in Table 11.RME for the Oxbow Area. This indicates that the majority of the calculated RME cancer risk for the Oxbow Area is site-related. The incremental RME cancer risk is contributed almost completely by the dioxin TEQ, which is a function of the maximum reported dioxin TEQ in floodplain soil in the Oxbow Area. The

incremental CT cancer risk is 8 x 10^{-6} which is within the Superfund cancer risk range. This incremental CT cancer risk is very similar in magnitude to the cancer risk presented in Table 11.CT for the Oxbow Area floodplain soils. Therefore, most of the CT cancer risk at the Oxbow Area appears to be site-related (dioxin TEQ in floodplain soil).

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6.0 UNCERTAINTY ANALYSIS

This section includes a discussion of major limitations of the analyses, any sources of uncertainties, and, if possible, any indication as to whether these uncertainties and limitations may have resulted in and over- or under-estimation of risk. The uncertainty section may also include unusual site conditions or extenuating circumstances that may be pertinent to risk management decisions. Other factors such as the inadequacy of toxicity factors to describe all possible COPC-receptor interactions and individual differences within the human population are included in this section. Uncertainties in the quantification of risk associated with the site are identified and their impacts on risk estimates are discussed below.

Hazard Identification

A single, limited environmental investigation event has provided the analytical data that has been utilized in the Addendum. The identification of COPCs has been conducted consistent with USEPA guidance and has been done in a health protective manner. Based on currently available information, it is unlikely that any detected substances that have not been selected as COPCs would have a substantial impact on the Addendum results and conclusions if they had been retained in the Addendum. A full suite of analytical parameters was included in the analysis of most of the floodplain soil samples evaluated in the Addendum. However, given that the dioxin TEQ is such a predominant contributor to site risk, it is unlikely that the inclusion of additional analytical parameters would have substantially changed the results and conclusions of the assessment.

Background conditions have not been specifically considered in the selection or elimination of substances as COPCs. Several of the persistent organic COPCs (such as dioxins, furans, and PCBs), while they are not naturally-occurring substances, are detectable at some concentration almost ubiquitously in environmental samples such as biota and sediments. Therefore, exposure concentrations of those COPCs represent "total" exposure potential from both site-related and non-site-related sources.

There were some analytical parameters (such as PCB congeners and HCX) that were identified and quantified in soil at the background area that were not included in the analyte list for the Oxbow Area floodplain soil. Those analytical were excluded from the calculations of

incremental (above background) for the Oxbow Area. Had those analytical been included in the analyte list, they might have been selected as COPCs for floodplain soils at the Oxbow Area.

Exposure Assessment

The selection of receptors is conservative and health-protective for the conditions identified at the Site. The identification of the Passive Recreational Visitor to be evaluated is conservatively realistic for the current and likely future conditions at the Oxbow Area.

The values for receptor-specific exposure parameters such as soil contact rates and soil ingestion rates have been identified in a conservative manner. Default USEPA residential values have been applied to this passive recreational scenario. Values have been identified based on available guidance and professional judgment. In risk assessment, when values are assigned in lieu of actual measurements, there is some uncertainty in the values, and that uncertainty may have an impact on the results of the risk assessment. In that context, the exposure estimates and associated risk estimates in this assessment would likely be overestimated rather than underestimated. Some factors that were not specifically addressed in the calculations could result in lower risk estimates.

Toxicity Assessment

The toxicity assessment has been conducted consistently with available USEPA guidance. Dose-response information has been obtained from the IRIS database, NCEA, CAL-EPA, and USEPA's Health Effects Assessment Summary Tables. These sources of dose-response values are commonly used for regulatory risk assessment activities and are generally considered to be conservative in nature. The use of surrogate toxicity values for chemicals lacking US EPA recommended values is conservative since it is likely that the chemical specific toxicity would be lower than those exhibited by their surrogate.

Dioxin and Furan Congeners

Dioxin and furan congeners have been evaluated using the 2,3,7,8-TCDD oral CSF of 1.5×10^5 per mg/kg/day (taken from USEPA's HEAST, 1997) and the mammalian TEFs from Van den Berg et al. 1998. This approach represents the most recent risk assessment approach for evaluating dioxins and furans. This approach has been employed because there is not adequate toxicity testing for each of the hundreds of dioxin and furan congeners. Although the TEFs do

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have scientific basis, the use of the TEFs to estimate the cancer potency of each of the congeners does have some uncertainty associated with it. However, the predominant congener in environmental media at the four exposure points is 2,3,7,8-TCDD. Since 2,3,7,8-TCDD is considered to be the most toxic of the dioxin and furan congeners, the use of the TEFs has less impact on the risk assessment than would be the case where 2,3,7,8-TCDD was not the predominant congener and other congeners without published CSFs were the focus of the assessment.

The oral CSF for dioxin that was utilized in this assessment is taken from HEAST, 1997. The USEPA's *Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds, Draft* from September 2000 identifies another potential CSF of 1 x 10^6 per mg/kg/day. Using the alternative CSF, the cancer risk for floodplain soil exposure would increase by a factor of approximately 6.4.

Non-cancer risk was not quantitatively evaluated for potential exposures to dioxins and furans. There is not currently a published USEPA oral RfD available for 2,3,7,8-TCDD, any other dioxin or furan congener. USEPA has concluded that the current average dioxin exposure to the human population is greater than the RfDs that would be calculated based on available data. USEPA, therefore, concluded that RfD values would not be informative for safety assessment (USEPA, 2000). Non-cancer effects such as effects on reproduction and development, suppression of the immune system, and chloracne (USEPA, 2000) have been associated with these compounds in animal studies and it is likely that similar effects might occur with human exposure. Therefore, the non-cancer risk associated with potential exposure to dioxins and furans are understated in this Addendum.

Risk Characterization

The Incremental (above background) risks have been compared to Superfund risk management criteria and benchmarks in order to draw conclusions concerning the Site-related risks. An evaluation has been conducted to confirm that the largest chemical contributors to the Incremental risk are Site-related. As has been discussed previously, more than 99% of the cancer risk for the Passive Recreational Visitor at the Oxbow Area is associated with the dioxin TEQ in floodplain soil. Although the dioxin TEQ is clearly the predominant contributor to cancer risk at

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the Site, it is also clear that the congener 2,3,7,8-TCDD is by far the major risk contributor to the dioxin TEQ.

Overall, the risk characterization provides conservative estimates of non-cancer and cancer risks consistent with USEPA risk assessment guidance (USEPA, 1989).

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7.0 CONCLUSIONS

The potential risks associated with current and future floodplain soil exposure for Passive Recreational Visitors to the Oxbow Area have been characterized. The risk characterization included the evaluation of exposure to floodplain soil at the Oxbow Area. Risks have been calculated using both RME and CT exposure scenarios. The calculated risks have been compared to the Superfund cancer risk range of 10^{-6} to 10^{-4} and to a HI value of 1.

Human health risks have also been characterized for an upstream riverine background area (Greystone Mill Pond). The risks associated with potential exposures at the Oxbow Area have been compared to the calculated risks at the background area. In addition, the incremental risks above those identified for the background area have been identified for floodplain soils at the Oxbow Area.

The following conclusions have been drawn for the Oxbow Area.

- The calculated RME total (all age groups summed) receptor cancer risk for floodplain soil exposure at the Oxbow Area is greater than the Superfund risk range of 10^{-6} to 10^{-4}.
- The calculated CT total (all age groups summed) receptor cancer risk for floodplain soil exposure at the Oxbow Area is within the Superfund risk range of 10^{-6} to 10^{-4}.
- Ingestion of floodplain soil is the pathway that is the largest contributors to cancer risk.
- Dioxins and furans (particularly 2,3,7,8-TCDD) is the largest contributors to cancer risk for the floodplain soil exposure scenario.
- The non-cancer HI is equal to or less than one for each age group for the Passive Recreational Visitor for RME and CT scenarios.
- The incremental (above background) RME total receptor cancer risk for the Oxbow Area floodplain soil Passive Recreational Visitor is also greater than the Superfund risk range of 10^{-6} to 10^{-4}.
- There appears to be no substantial incremental (above background) non-cancer risk for the Oxbow Area floodplain soil Passive Recreational Visitor exposure scenario.

8.0 CALCULATION OF PRELIMINARY REMEDIATION GOALS

The baseline risk assessment has identified the chemicals that most significantly contribute to human health risks for the floodplain soil exposure pathway for the passive recreational Visitor at the Oxbow Area as shown in Tables 10.1.RME through 10.3.RME and Tables 10.1.CT through 10.3.CT. Those chemicals that are associated with an excess lifetime cancer risk greater than one-in-one-million (dioxin TEQ, arsenic, and Aroclor-1254) and/or a non-cancer HQ greater than 1 (no chemicals met that criterion) in any medium have been identified as COCs. PRGs may be established. If derived, risk-based floodplain soil PRGs will be identified for various risk levels (cancer risk of 10^{-6}, 10^{-5}, 10^{-4}, and HQs of 0.1, 1, and 10). PRGs would be developed for dioxin TEQ, arsenic, and Aroclor-1254 in floodplain soil. These floodplain soil concentrations will be risk-based sediment concentrations for consideration in the remedial decision-making process.

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ACRONYMS

ADDs	average daily dose
AhR	Ah Receptor
AT	averaging time
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BW	body weight
CMRPSS	Centredale Manor Restoration Project Superfund Site
COC	chemicals of concern
COPCs	chemicals of potential concern
CSF	cancer slope factor
CSM	conceptual site model
CT	Central Tendency
DER	Data Evaluation Report
DQOs	data quality objectives
EAs	exposure areas
ED	exposure duration
EF	exposure frequency
EPC	exposure point concentrations
FDA	Food and Drug Administration
FI	fraction ingested
FS	Feasibility Study
HCX	hexachloroxanthene
HHBRA	Human Health Baseline Risk Assessment
HI	hazard index
HQ	hazard quotient
IR	Consumption rate
IRIS	Integrated Risk Information System
LADD	lifetime average daily dose
LOAEL	Lowest Observable Adverse Effect Level
mf	modifying factor
mg/kg	milligrams per kilogram
NCP	National Hazardous Substances and Pollution Contingency Plan
NOAEL	No Observable Adverse Effect Level
OCDD	octachlorinated dibenzo-p-**dioxin**
OHM	oil and/or hazardous materials

PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCDDs	polychlorinated dibenzodioxins
PCDFs	polychlorinated dibenzofurans
PRGs	preliminary remediation goals
PRTVs	peer reviewed toxicity values
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk Based Concentration
RfC	Reference Concentration
RfDs	Reference Doses
RfD_ss	Subchronic Reference Doses
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
SA	surface area
SF	Slope Factor
STSC	Superfund Technical Support Center
SVOCs	semivolatile organic compounds
TCDD	tetrachlorodibenzo-p-dioxin
TEF	Toxicity Equivalent Factor
TEQ	toxic equivalent quotient
UCL	upper concentration limit
UF	Uncertainty Factor
UR	Unit Risk
USACE	U.S. Army Corps of Engineers, New England District
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds

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(IPCS), published under the joint sponsorship of the United Nations Environment Programme, the International Labour Organization, and the World Health Organization.

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FIGURES

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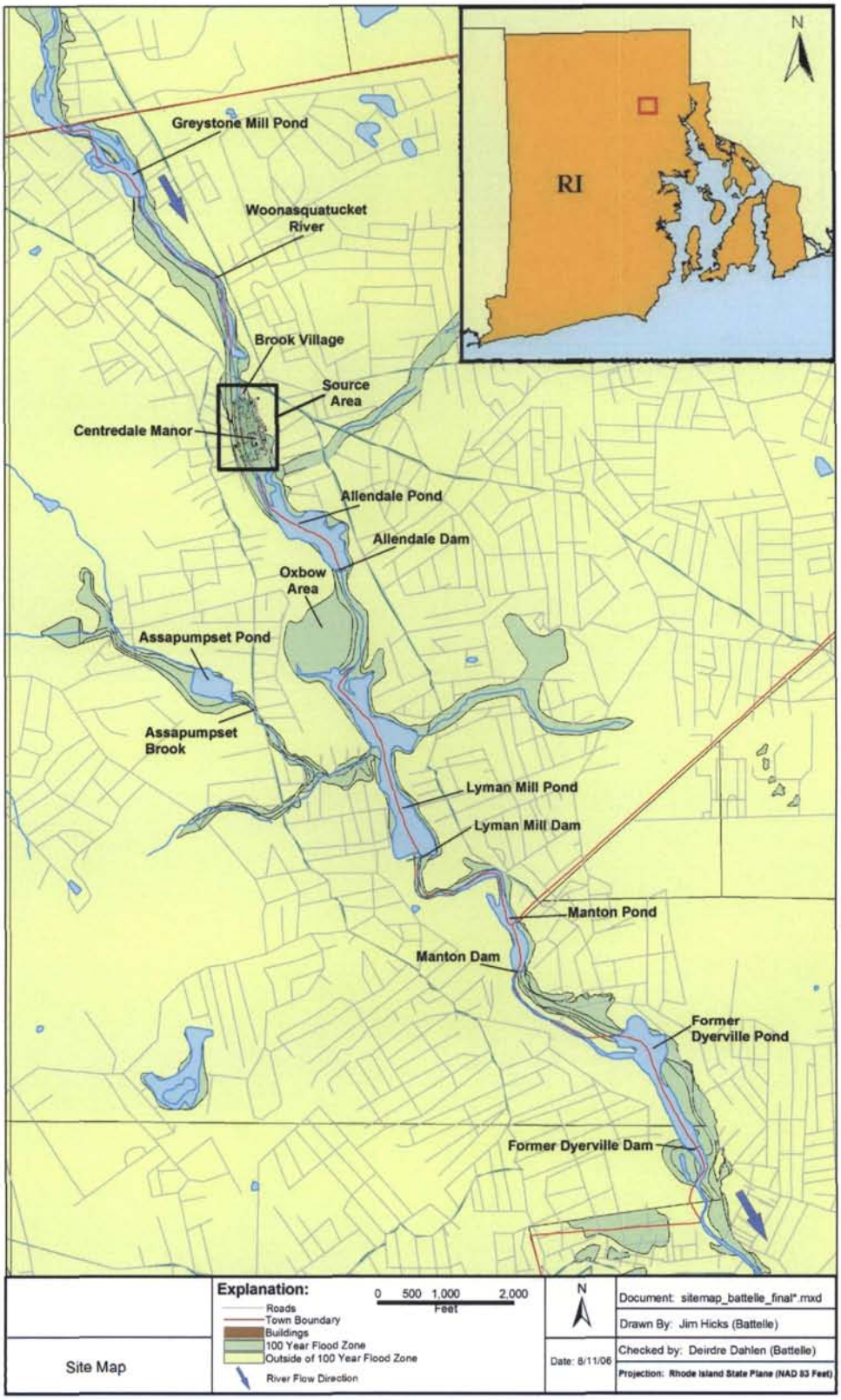

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Figure 1. Site Location Map

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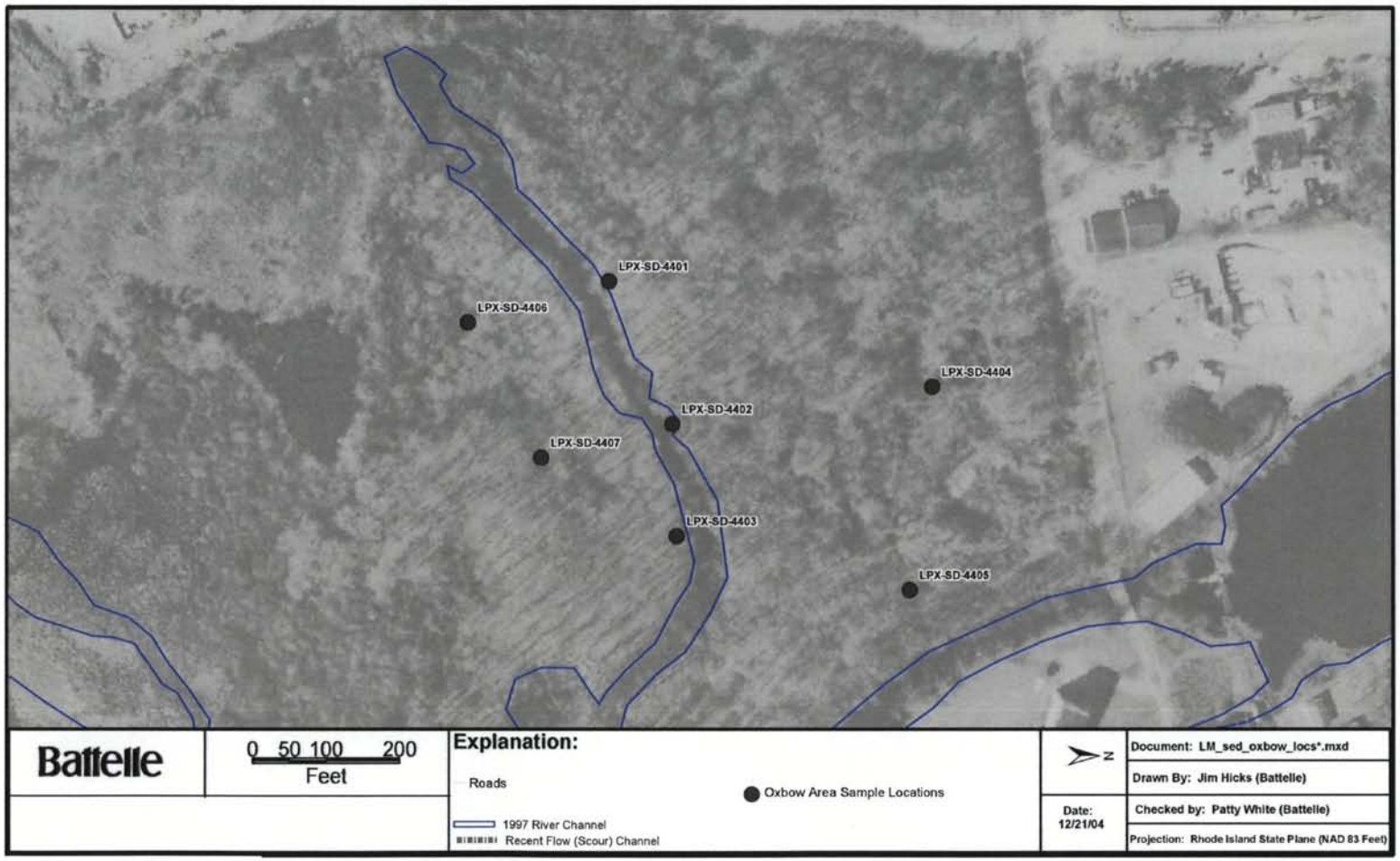

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Figure 2. Oxbow Area Surface Sediment Sample Locations

(Samples from boring locations LPX-SD-4401, LPX-SD-4402 and LPX-SD-4403 do not appear to be within the channel, however, sediment samples from these locations were collected by wading into the channel as far as possible (waist deep). Sample location coordinates are accurate to 4-6m, although the presence of heavy vegetation may have impacted the accuracy of coordinate readings.)

TABLES

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Table 1.1
Baseline Human Health Risk Assessment Approach

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Timeframe	Receptor	Exposure Point	Activity	Exposure Medium	Exposure Route*	Previous Evaluations	RI/FS Approach
Current/Future	Recreational Visitor	Oxbow Area – forested wetland	Passive Recreation	Floodplain Surface Soil	Direct contact (ingestion and dermal contact	None	Will be considered in the FS.
				Surface soil	Inhalation of particulates and vapors	None	Because the area is a forested wetland and soils would typically have high moisture content, evaluation of dust exposure for passive recreational activities is not necessary.

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Table 1.2
Exposure Pathway Summary

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

EXPOSURE POINT AND RECEPTOR POPULATION	RECEPTOR AGE	SCENARIO TIMEFRAME	POTENTIAL EXPOSURE MEDIUM AND RELEVANT PATHWAYS			
			Sediment	Surface Water	Flood Plain Surface Soil	Fish
Greystone Mill Pond (background)						
Passive Recreational Visitor	Child, Adolescent, Adult	C/F	--	--	ING, DERM	--
Oxbow Area (forested wetland)						
Passive Recreational Visitor	Child, Adolescent, Adult	C/F	--	--	ING, DERM	--

Notes:

Timeframe:
C - current land use
F - future land use
Pathways:
DERM - exposure via dermal contact
ING - exposure via incidental ingestion
"--" indicates that the pathway is not evaluated.

Prepared by: MJM
Checked by: KJC

Occurrence, Distribution and Selection of Chemicals of Potential Concern
Floodplain Soil - Oxbow Area

***Addendum* To Baseline Human Health Risk Assessment: Oxbow Area**
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Floodplain Soil
Exposure Medium: Floodplain Soil

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Sample ID of Maximum Concentration	Detection Frequency	Range of Detection Limits Min-Max	Concentration Used for Screening (2)	Background Value	Screening Toxicity Value (3)		Potential ARAR/TBC Value (4)	Potential ARAR/TBC Source	Retain as COPC?	Rationale for Contaminant Deletion or Selection (5)
	Pesticides/PCBs																
72-54-8	4,4'-DDD	0.00442		0.02658		mg/Kg	LPX-SD-4407-0005-01	3 / 3	-	0.02658	N/A	2.4	C	N/A	N/A	No	S
72-55-9	4,4'-DDE	0.00595	J	0.04236		mg/Kg	LPX-SD-4407-0005-01	3 / 3	-	0.04236	N/A	1.7	C	N/A	N/A	No	S
50-29-3	4,4'-DDT	0.00096	J	0.00276	J	mg/Kg	LPX-SD-4407-0005-01	2 / 3	0.00015 - 0.00015	0.00276	N/A	1.7	C	N/A	N/A	No	S
5103-71-9	a-chlordane	0.00119	J	0.00768	J	mg/Kg	LPX-SD-4407-0005-01	2 / 3	0.00014 - 0.00014	0.00768	N/A			N/A	N/A	Yes	A
309-00-2	aldrin	0.00097		0.00164	J	mg/Kg	LPX-SD-4402-0005-01	2 / 3	0.00014 - 0.00014	0.00164	N/A	0.029	C	N/A	N/A	No	S
60-57-1	dieldrin	0.00251		0.06338	J	mg/Kg	LPX-SD-4402-0005-01	3 / 3	-	0.06338	N/A	0.03	C	N/A	N/A	Yes	A
33213-65-9	endosulfan II	0.00337		0.00337		mg/Kg	LPX-SD-4404-0005-01	1 / 3	0.00016 - 0.0002	0.00337	N/A			N/A	N/A	Yes	A
7421-93-4	endrin aldehyde	*0.0019*		0.00951	J	mg/Kg	LPX-SD-4402-0005-01	2 / 3	0.00023 - 0.00023	0.00951	N/A			N/A	N/A	Yes	A
53494-70-5	endrin ketone	0.00173		0.00173		mg/Kg	LPX-SD-4404-0005-01	1 / 3	0.00016 - 0.0002	0.00173	N/A			N/A	N/A	Yes	A
5103-74-2	g-chlordane	*0.00208*	J	0.00694		mg/Kg	LPX-SD-4407-0005-01	3 / 3	-	0.00694	N/A			N/A	N/A	Yes	A
76-44-8	heptachlor	0.00073		0.00073		mg/Kg	LPX-SD-4404-0005-01	1 / 3	0.00015 - 0.00019	0.00073	N/A	*0.11*	C	N/A	N/A	No	S
1024-57-3	heptachlor epoxide	0.00018		0.00018		mg/Kg	LPX-SD-4404-0005-01	1 / 3	0.00014 - 0.00017	0.00018	N/A	0.053	C	N/A	N/A	No	S
58-89-9	Lindane	0.00076	J	0.00076	J	mg/Kg	LPX-SD-4402-0005-01	1 / 3	0.00015 - 0.00018	*0.00076*	N/A	0.44	C	N/A	N/A	No	S
57-74-9	Technical Chlordane	0.03008		0.03008		mg/Kg	LPX-SD-4404-0005-01	1 / 3	0.01626 - 0.02034	0.03008	N/A			N/A	N/A	Yes	A
11097-69-1	Aroclor 1254	0.63783		3.5833	J	mg/Kg	LPX-SD-4402-0005-01	2 / 3	*0.01696 - 0.01696*	3.5833	N/A	0.11	N	N/A	N/A	Yes	A
11100-14-4	*Aroclor 1260*	0.10311		0.10311		mg/Kg	LPX-SD-4404-0005-01	1 / 3	0.01622 - 0.02028	0.10311	N/A	0.11	N	N/A	N/A	No	S
	Inorganics																
7440-36-0	Antimony	0.922		7.01		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	7.01	N/A	3.1	N	N/A	N/A	Yes	A
7440-38-2	Arsenic	2.61		12.8		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	12.8	N/A	0.39	C	N/A	N/A	Yes	A
7440-39-3	Barium	174		514		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	514	N/A	540	N	N/A	N/A	No	S
7440-41-7	Beryllium	3.46		7.9		mg/Kg	LPX-SD-4402-0005-01	4 / 4	-	7.9	N/A	15	N	N/A	N/A	No	S
7440-43-9	Cadmium	1.19		8.25		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	8.25	N/A	3.7	N	N/A	N/A	Yes	A
7440-47-3	Chromium	43.1		*104*		mg/Kg	LPX-SD-4402-0005-01	4 / 4	-	104	N/A	210	C	N/A	N/A	No	S
7440-48-4	Cobalt	8.79		22		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	22	N/A	140	N	N/A	N/A	*No*	*S*
7440-50-8	Copper	*17.2*		357		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	357	N/A	310	N	N/A	N/A	Yes	A
7439-92-1	Lead	44.4		1835		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	1835	N/A	400	N	N/A	N/A	Yes	A
7439-96-5	Manganese	809		859		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	859	N/A	180	N	N/A	N/A	Yes	A
7439-98-7	Molybdenum	4.58		17.3		mg/Kg	LPX-SD-4402-0005-01	4 / 4	-	17.3	N/A	39	N	N/A	N/A	No	S
7440-02-0	Nickel	18.4		32.4		mg/Kg	LPX-SD-4402-0005-01	4 / 4	-	32.4	N/A	160	N	N/A	N/A	No	S
7782-49-2	Selenium	1.52		2.22		mg/Kg	LPX-SD-4404-0005-01	3 / 4	*1.64 - 1.64*	2.22	N/A	39	N	N/A	N/A	No	S
7440-22-4	Silver	0.452		11.1		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	11.1	N/A	39	N	N/A	N/A	No	S
7440-28-0	Thallium	0.401		1.04		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	1.04	N/A	0.52	N	N/A	N/A	Yes	A
7440-62-2	Vanadium	43.6		71.1		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	71.1	N/A	7.8	N	N/A	N/A	Yes	A
7440-66-6	Zinc	109		1867		mg/Kg	LPX-SD-4404-0005-01	4 / 4	-	*1867*	N/A	2300	N	N/A	N/A	No	S
	Dioxins/Furans																
TEM	Toxicity Equivalency - Mammals	0.000347		0.004291		mg/Kg	LPX-SD-4405-0005-01	7 / 7	-	0.004291	N/A	0.0000039		N/A	N/A	Yes	A

(1) Minimum or maximum concentration detected in exposure area. Samples included in data set are identified in Appendix A.
(2) The concentration used for screening is the maximum detected concentration, per USEPA Region I (USEPA, 1995).
(3) Values are the Residential Soil Preliminary Remediation Goals (PRGs) obtained from USEPA Region IX dated October 20, 2004.
Values used for screening are the residential soil PRGs for the lesser of cancer risks equal to 1E-06 or non-cancer risks equal to a hazard index of 0.1, per USEPA Region I (USEPA, 1999).
(4) There are no applicable ARAR values for sediment.
(5) Analyte is selected as a COPC if the concentration used for screening exceeds the PRG.
S = Concentration used for screening is less than the screening toxicity value; the analyte was not selected as a COPC.
A = Concentration used for screening is greater than the screening toxicity value; the analyte was selected as a COPC.
E = The analyte is a human essential nutrient, and is not considered to be toxic at the concentration detected; the analyte was not selected as a COPC (*A.D. Little, 1998; USEPA, 1995*).

mg/KG = milligrams per kilogram
COPC = chemical of potential concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirements / To Be Considered

Basis of screening toxicity value:
N - Based on non-cancer endpoint
C - Based on cancer endpoint
S - Saturated
M - Maximum

N/A = Not applicable
- Background values are not applicable for selection of COPCs. Risks at the Background location will be characterized and compared to the risks characterized in this assessment.
- Potential ARAR/TBC values are not applicable for selection of COPCs. EPA suggests use of risk-based media concentrations for screening COPCs.

Qualifier definitions:
J = Value is estimated.

Prepared by: KJC
Checked by: MJM

Table 2.2
Occurrence, Distribution and Selection of Chemicals of Potential Concern
Floodplain Soil - Background Area

Addendum To Baseline Human Health Risk Assessment : Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Floodplain Soil
Exposure Medium: Floodplain Soil

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Sample ID of Maximum Concentration	Detection Frequency	Range of Detection Limits Min-Max	Concentration Used for Screening (2)	Background Value	Screening Toxicity Value (3)		Potential ARAR/TBC Value (4)	Potential ARAR/TBC Source	Retain as COPC?	Rationale for Contaminant Deletion or Selection (5)
	Semivolatile Organics																
92-52-4	1,1'-Biphenyl	0.02602		0.0617		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.0617	N/A	350	S	N/A	N/A	No	S
91-57-6	2-Methylnaphthalene	0.07282		0.17022	J	MG/KG	RWR-FP-5002-0000-01	4 / 4	-	0.17022	N/A			N/A	N/A	Yes	A
83-32-9	Acenaphthene	0.18626		0.56384	J	MG/KG	RWR-FP-5002-0000-01	4 / 4	-	0.56384	N/A	370	N	N/A	N/A	No	S
208-96-8	Acenaphthylene	0.19667		0.49749		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.49749	N/A			N/A	N/A	Yes	A
120-12-7	Anthracene	0.4802		0.98295		MG/KG	RWR-FP-5002-0000-01	4 / 4	-	0.98295	N/A	2200	N	N/A	N/A	No	S
100-52-7	Benzaldehyde	0.06052		0.17229		MG/KG	RWR-FP-5004-0000-01	4 / 4	-	0.17229	N/A	610	N	N/A	N/A	No	S
56-55-3	Benzo(a)anthracene	2.29265		3.41086		MG/KG	RWR-FP-5004-0000-01	4 / 4	-	3.41086	N/A	0.62	C	N/A	N/A	Yes	A
50-32-8	Benzo(a)pyrene	2.29123		3.41803		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	3.41803	N/A	0.062	C	N/A	N/A	Yes	A
205-99-2	Benzo(b)fluoranthene	2.31549		4.28861		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	4.28861	N/A	0.62	C	N/A	N/A	Yes	A
191-24-2	Benzo(g,h,i)perylene	1.676		2.87139		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	2.87139	N/A			N/A	N/A	Yes	A
207-08-9	Benzo(k)fluoranthene	2.28394		3.86354		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	3.86354	N/A	6.2	C	N/A	N/A	No	S
117-81-7	bis(2-Ethylhexyl)phthalate	0.8	J	1.9	J	MG/KG	RWR-FP-5001-0000-01	4 / 4	-	1.9	N/A	35	C	N/A	N/A	No	S
85-68-7	Butylbenzylphthalate	0.12	J	0.58	J	MG/KG	RWR-FP-5004-0000-01	4 / 4	-	0.58	N/A	1200	N	N/A	N/A	No	S
86-74-8	Carbazole	0.42	J	0.86	J	MG/KG	RWR-FP-5002-0000-01	4 / 4	-	0.86	N/A	24	C	N/A	N/A	No	S
218-01-9	Chrysene	2.74766		4.48851		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	4.48851	N/A	62	C	N/A	N/A	No	S
53-70-3	Dibenzo(a,h)anthracene	0.43544		0.72851		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.72851	N/A	0.062	C	N/A	N/A	Yes	A
132-64-9	Dibenzofuran	0.16055		0.39925		MG/KG	RWR-FP-5002-0000-01	4 / 4	-	0.39925	N/A	29	N	N/A	N/A	No	S
84-74-2	Di-n-Butylphthalate	0.061	J	0.17	J	MG/KG	RWR-FP-5004-0000-01	4 / 4	-	0.17	N/A	610	N	N/A	N/A	No	S
117-84-0	Di-n-octylphthalate	0.083	J	0.083	J	MG/KG	RWR-FP-5002-0000-01	1 / 4	0.58 - 1	0.083	N/A	240	N	N/A	N/A	No	S
206-44-0	Fluoranthene	5.22748		7.73124		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	7.73124	N/A	230	N	N/A	N/A	No	S
86-73-7	Fluorene	0.25625		0.65899	J	MG/KG	RWR-FP-5002-0000-01	4 / 4	-	0.65899	N/A	270	N	N/A	N/A	No	S
193-39-5	Indeno(1,2,3-cd)pyrene	1.76819		3.0929		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	3.0929	N/A	0.62	C	N/A	N/A	Yes	A
91-20-3	Naphthalene	0.10375		0.30218	J	MG/KG	RWR-FP-5002-0000-01	4 / 4	-	0.30218	N/A	5.6	N	N/A	N/A	No	S
85-01-8	Phenanthrene	3.07207		5.30136		MG/KG	RWR-FP-5002-0000-01	4 / 4	-	5.30136	N/A			N/A	N/A	Yes	A
129-00-0	Pyrene	4.33506		6.37272		MG/KG	RWR-FP-5004-0000-01	4 / 4	-	6.37272	N/A	230	N	N/A	N/A	No	S
	Pesticides/PCBs																
72-54-8	4,4'-DDD	0.00464	J	0.01517		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.01517	N/A	2.4	C	N/A	N/A	No	S
72-55-9	4,4'-DDE	0.00519	J	0.02061		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.02061	N/A	1.7	C	N/A	N/A	No	S
50-29-3	4,4'-DDT	0.00269	J	0.01827	J	MG/KG	RWR-FP-5004-0000-01	4 / 4	-	0.01827	N/A	1.7	C	N/A	N/A	No	S
5103-71-9	alpha-Chlordane	0.00781		0.03592		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.03592	N/A			N/A	N/A	Yes	A
11097-69-1	Aroclor-1254	0.20734		0.83872		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.83872	N/A	0.22	C	N/A	N/A	Yes	A
11100-14-4	Aroclor-1268	0.04356		0.13953	J	MG/KG	RWR-FP-5004-0000-01	4 / 4	-	0.13953	N/A			N/A	N/A	Yes	A
60-57-1	Dieldrin	0.00424		0.00941		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.00941	N/A	0.03	C	N/A	N/A	No	S
1031-07-8	Endosulfan Sulfate	0.00409	J	0.01269	J	MG/KG	RWR-FP-5004-0000-01	3 / 4	0.00215 - 0.00215	0.01269	N/A			N/A	N/A	Yes	A
1024-57-3	Heptachlor Epoxide	0.00074	J	0.00074	J	MG/KG	RWR-FP-5004-0000-01	1 / 4	0.00124 - 0.00215	0.00074	N/A	0.053	C	N/A	N/A	No	S
57-74-9	Technical Chlordane	0.2782		0.73538		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.73538	N/A			N/A	N/A	Yes	A
	Inorganics																
7429-90-5	Aluminum	10971	J	21793	J	MG/KG	RWR-FP-5001-0000-01	4 / 4	-	21793	N/A	7600	N	N/A	N/A	Yes	A
7440-36-0	Antimony	0.462	J	0.982	J	MG/KG	RWR-FP-5004-0000-01	4 / 4	-	0.982	N/A	3.1	N	N/A	N/A	No	S
7440-38-2	Arsenic	5.58		12.2		MG/KG	RWR-FP-5004-0000-01	4 / 4	-	12.2	N/A	0.39	C	N/A	N/A	Yes	A
7440-39-3	Barium	181		282		MG/KG	RWR-FP-5002-0000-01	4 / 4	-	282	N/A	540	N	N/A	N/A	No	S
7440-41-7	Beryllium	1.9		4.46		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	4.46	N/A	15	N	N/A	N/A	No	S
7440-43-9	Cadmium	0.711		3.46		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	3.46	N/A	3.7	N	N/A	N/A	No	S
7440-47-3	Chromium	171		291		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	291	N/A	210	C	N/A	N/A	Yes	A
7440-48-4	Cobalt	9.57		20.3		MG/KG	RWR-FP-5004-0000-01	4 / 4	-	20.3	N/A	900	C	N/A	N/A	No	S
7440-50-8	Copper	109		324		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	324	N/A	310	N	N/A	N/A	Yes	A
7439-89-6	Iron	21383		37162		MG/KG	RWR-FP-5004-0000-01	4 / 4	-	37162	N/A	2300	N	N/A	N/A	No	E
7439-92-1	Lead	316		591		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	591	N/A	40	N	N/A	N/A	Yes	A
7439-96-5	Manganese	439		4126		MG/KG	RWR-FP-5004-0000-01	4 / 4	-	4126	N/A	180	N	N/A	N/A	Yes	A

Table 2.2
Occurrence, Distribution and Selection of Chemicals of Potential Concern
Floodplain Soil - Background Area

Addendum To Baseline Human Health Risk Assessment : Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Floodplain Soil
Exposure Medium: Floodplain Soil

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Sample ID of Maximum Concentration	Detection Frequency	Range of Detection Limits Min-Max	Concentration Used for Screening (2)	Background Value	Screening Toxicity Value (3)		Potential ARAR/TBC Value (4)	Potential ARAR/TBC Source	Retain as COPC?	Rationale for Contaminant Deletion or Selection (5)
7439-97-6	Mercury	0.381		0.811		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.811	N/A			N/A	N/A	Yes	A
22967-92-6	Mercury (methyl)	0.000326	J	0.000762	J	MG/KG	RWR-FP-5002-0000-01	4 / 4	-	0.000762	N/A	0.61	N	N/A	N/A	No	S
7439-98-7	Molybdenum	34.8	J	87.7	J	MG/KG	RWR-FP-5003-0000-01	4 / 4	-	87.7	N/A	39	N	N/A	N/A	Yes	A
7440-02-0	Nickel	25.5		387		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	387	N/A	160	N	N/A	N/A	Yes	A
7782-49-2	Selenium	0.687	J	0.963	J	MG/KG	RWR-FP-5004-0000-01	3 / 4	0.611 - 0.611	0.963	N/A	39	N	N/A	N/A	No	S
7440-22-4	Silver	1.23		3.8		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	3.8	N/A	39	N	N/A	N/A	No	S
7440-28-0	Thallium	0.345		0.585		MG/KG	RWR-FP-5004-0000-01	4 / 4	-	0.585	N/A	0.52	N	N/A	N/A	Yes	A
7440-62-2	Vanadium	53.6		103		MG/KG	RWR-FP-5004-0000-01	4 / 4	-	103	N/A	55	N	N/A	N/A	Yes	A
7440-66-6	Zinc	158		497		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	497	N/A	2300	N	N/A	N/A	No	S
	Dioxins/Furans																
38178-99-3	HCX	0.00008577	J	0.00041706	J	MG/KG	RWR-FP-5004-0000-01	4 / 4	-	0.00041706	N/A			N/A	N/A	Yes	A
TEM	Toxicity Equivalency - Mammals	0.0000228		0.000109		MG/KG	RWR-FP-5001-0000-01	4 / 4	-	0.000109	N/A	3.90E-06	C	N/A	N/A	Yes	A
PCBCTEM	Toxicity Equivalency (PCB) - Mammals	0.0000379		0.0000379		MG/KG	RWR-FP-5002-0000-01	1 / 1	-	0.0000379	N/A	3.90E-06	C	N/A	N/A	Yes	A

(1) Minimum or maximum concentration detected in exposure area. Samples included in data set are identified in Appendix A.
(2) The concentration used for screening is the maximum detected concentration, per USEPA Region I (USEPA, 1995).
(3) Values are the Residential Soil Preliminary Remediation Goals (PRGs) obtained from USEPA Region IX dated October 20, 2004.
Values used for screening are the residential soil PRGs for the lesser of cancer risks equal to 1E-06 or non-cancer risks equal to a hazard index of 0.1, per USEPA Region I (USEPA, 1999).
(4) There are no applicable ARAR values for soil.
(5) Analyte is selected as a COPC if the concentration used for screening exceeds the PRG.
S = Concentration used for screening is less than the screening toxicity value; the analyte was not selected as a COPC.
A = Concentration used for screening is greater than the screening toxicity value; the analyte was selected as a COPC.
E = The analyte is a human essential nutrient, and is not considered to be toxic at the concentration detected; the analyte was not selected as a COPC (A.D. Little, 1998; USEPA, 1995).

N/A = Not applicable
- Background values are not applicable for selection of COPCs. Risks at the Background location will be characterized and compared to the risks characterized in this assessment.
- Potential ARAR/TBC values are not applicable for selection of COPCs. EPA suggests use of risk-based media concentrations for screening COPCs.

Qualifier definitions:
J = Value is estimated.

MG/KG = milligrams per kilogram
COPC = chemical of potential concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirements / To Be Considered

Basis of screening toxicity value:
N - Based on non-cancer endpoint
C - Based on cancer endpoint

Prepared by: KJA
Checked by: MJM

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Table 3.1.RME
Medium-Specific Exposure Point Concentration Summary - Reasonable Maximum Exposure
Floodplain Soil

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Floodplain Soil
Exposure Medium: Floodplain Soil

Exposure Point	Chemical of Potential Concern (1)	Units	Arithmetic Mean	95% UCL (distribution)	Maximum Detected Concentration (qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (1)	Rationale
GREYSTONE	**Semivolatile Organics**								
	2-Methylnaphthalene	MG/KG	0.1071	NC	0.17022 J	0.17022	MG/KG	Max	(3)
	Acenaphthylene	MG/KG	0.31765	NC	0.49749	0.49749	MG/KG	Max	(3)
	Benzo(a)anthracene	MG/KG	3.09372	NC	3.41086	3.41086	MG/KG	Max	(3)
	Benzo(a)pyrene	MG/KG	3.07718	NC	3.41803	3.41803	MG/KG	Max	(3)
	Benzo(b)fluoranthene	MG/KG	3.45207	NC	4.28861	4.28861	MG/KG	Max	(3)
	Benzo(g,h,i)perylene	MG/KG	2.336	NC	2.87139	2.87139	MG/KG	Max	(3)
	Dibenzo(a,h)anthracene	MG/KG	0.61485	NC	0.72851	0.72851	MG/KG	Max	(3)
	Indeno(1,2,3-cd)pyrene	MG/KG	2.51886	NC	3.0929	3.0929	MG/KG	Max	(3)
	Phenanthrene	MG/KG	3.95543	NC	5.30136	5.30136	MG/KG	Max	(3)
	Pesticides/PCBs								
	alpha-Chlordane	MG/KG	0.0178	NC	0.03592	0.03592	MG/KG	Max	(3)
	Aroclor-1254	MG/KG	0.51998	NC	0.83872	0.83872	MG/KG	Max	(3)
	Aroclor-1268	MG/KG	0.08389	NC	0.13953 J	0.13953	MG/KG	Max	(3)
	Endosulfan Sulfate	MG/KG	0.00650	NC	0.01269 J	0.01269	MG/KG	Max	(3)
	Technical Chlordane	MG/KG	0.4307	NC	0.73538	0.73538	MG/KG	Max	(3)
	Inorganics								
	Aluminum	MG/KG	15899	NC	21793 J	21793	MG/KG	Max	(3)
	Arsenic	MG/KG	7.72	NC	12.2	12.2	MG/KG	Max	(3)
	Chromium	MG/KG	231	NC	291	291	MG/KG	Max	(3)
	Copper	MG/KG	205	NC	324	324	MG/KG	Max	(3)
	Lead	MG/KG	450	NC	591	591	MG/KG	Max	(3)
	Manganese	MG/KG	1841	NC	4126	4126	MG/KG	Max	(3)
	Mercury	MG/KG	0.582	NC	0.811	0.811	MG/KG	Max	(3)
	Molybdenum	MG/KG	54.0	NC	87.7 J	87.7	MG/KG	Max	(3)
	Nickel	MG/KG	120	NC	387	387	MG/KG	Max	(3)
	Thallium	MG/KG	0.461	NC	0.585	0.585	MG/KG	Max	(3)
	Vanadium	MG/KG	82.3	NC	103	103	MG/KG	Max	(3)
	Dioxins/Furans								
	Toxicity Equivalency (Dioxins/Furans) - Mammals	MG/KG	0.0000550	NC	0.000109	0.000109	MG/KG	Max	(3)

US EPA ARCHIVE DOCUMENT

Table 3.1.RME
Medium-Specific Exposure Point Concentration Summary - Reasonable Maximum Exposure
Floodplain Soil

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Floodplain Soil
Exposure Medium: Floodplain Soil

Exposure Point	Chemical of Potential Concern (1)	Units	Arithmetic Mean	95% UCL (distribution)	Maximum Detected Concentration (qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (1)	Rationale
OXBOW	**Pesticides/PCBs**								
	a-chlordane	MG/KG	0.0030	NC	0.00768 J	0.00768	MG/KG	Max	(2)
	dieldrin	MG/KG	0.023	NC	0.06338 J	0.06338	MG/KG	Max	(2)
	endosulfan II	MG/KG	0.0012	NC	0.00337	0.00337	MG/KG	Max	(2)
	endrin aldehyde	MG/KG	0.0038	NC	0.00951 J	0.00951	MG/KG	Max	(2)
	endrin ketone	MG/KG	0.00064	NC	0.00173	0.00173	MG/KG	Max	(2)
	g-chlordane	MG/KG	0.0040	NC	0.00694	0.00694	MG/KG	Max	(2)
	Technical Chlordane	MG/KG	0.016	NC	0.03008	0.03008	MG/KG	Max	(2)
	Aroclor 1254	MG/KG	1.4	NC	3.5833 J	3.5833	MG/KG	Max	(2)
	Inorganics								
	Antimony	MG/KG	3.0	NC	7.01	7.01	MG/KG	Max	(2)
	Arsenic	MG/KG	5.4	NC	12.8	12.8	MG/KG	Max	(2)
	Cadmium	MG/KG	4.0	NC	8.25	8.25	MG/KG	Max	(2)
	Copper	MG/KG	121	NC	357	357	MG/KG	Max	(2)
	Lead	MG/KG	575	NC	1835	1835	MG/KG	Max	(2)
	Manganese	MG/KG	826	NC	859	859	MG/KG	Max	(2)
	Thallium	MG/KG	0.72	NC	1.04	1.04	MG/KG	Max	(2)
	Vanadium	MG/KG	59.3	NC	71.1	71.1	MG/KG	Max	(2)
	Dioxins/Furans								
	Toxicity Equivalency (Dioxins/Furans) - Mammals	MG/KG	0.0018	NC	0.004291	0.004291	MG/KG	Max	(2)

(1) Chemicals of potential concern are identified in Table 2.1 and Table 2.2 for the site exposure area and background area respectively.
(2) Max: Maximum detected concentration, applied if fewer than 10 samples (95% UCL not calculated), or if the 95% UCL is greater than the maximum concentration.

Qualifier Definitions:
J = Value is estimated.

MG/KG = milligrams per kilogram
NC = Not Calculated
EPC = Exposure Point Concentration
UCL = Upper Confidence Limit on the arithmetic mean

Prepared by:	KJC
Checked by:	MJM

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Table 3.1.CT
Medium-Specific Exposure Point Concentration Summary - Central Tendency
Floodplain Soil

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Floodplain Soil
Exposure Medium: Floodplain Soil

Exposure Point	Chemical of Potential Concern (1)	Units	Arithmetic Mean	95% UCL (distribution)	Maximum Detected Concentration (qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (1)	Rationale
GREYSTONE	**Semivolatile Organics**								
	2-Methylnaphthalene	MG/KG	0.1071	NC	0.17022 J	0.1071	MG/KG	Mean	(3)
	Acenaphthylene	MG/KG	0.31765	NC	0.49749	0.31765	MG/KG	Mean	(3)
	Benzo(a)anthracene	MG/KG	3.09372	NC	3.41086	3.09372	MG/KG	Mean	(3)
	Benzo(a)pyrene	MG/KG	3.07718	NC	3.41803	3.07718	MG/KG	Mean	(3)
	Benzo(b)fluoranthene	MG/KG	3.45207	NC	4.28861	3.45207	MG/KG	Mean	(3)
	Benzo(g,h,i)perylene	MG/KG	2.336	NC	2.87139	2.336	MG/KG	Mean	(3)
	Dibenzo(a,h)anthracene	MG/KG	0.61485	NC	0.72851	0.61485	MG/KG	Mean	(3)
	Indeno(1,2,3-cd)pyrene	MG/KG	2.51886	NC	3.0929	2.51886	MG/KG	Mean	(3)
	Phenanthrene	MG/KG	3.95543	NC	5.30136	3.95543	MG/KG	Mean	(3)
	Pesticides/PCBs								
	alpha-Chlordane	MG/KG	0.0178	NC	0.03592	0.0178	MG/KG	Mean	(3)
	Aroclor-1254	MG/KG	0.51998	NC	0.83872	0.51998	MG/KG	Mean	(3)
	Aroclor-1268	MG/KG	0.08389	NC	0.13953 J	0.08389	MG/KG	Mean	(3)
	Endosulfan Sulfate	MG/KG	0.00650	NC	0.01269 J	0.00650	MG/KG	Mean	(3)
	Technical Chlordane	MG/KG	0.4307	NC	0.73538	0.4307	MG/KG	Mean	(3)
	Inorganics								
	Aluminum	MG/KG	15899	NC	21793 J	15899	MG/KG	Mean	(3)
	Arsenic	MG/KG	7.72	NC	12.2	7.72	MG/KG	Mean	(3)
	Chromium	MG/KG	231	NC	291	231	MG/KG	Mean	(3)
	Copper	MG/KG	205	NC	324	205	MG/KG	Mean	(3)
	Lead	MG/KG	450	NC	591	450	MG/KG	Mean	(3)
	Manganese	MG/KG	1841	NC	4126	1841	MG/KG	Mean	(3)
	Mercury	MG/KG	0.582	NC	0.811	0.582	MG/KG	Mean	(3)
	Molybdenum	MG/KG	54.0	NC	87.7 J	54.0	MG/KG	Mean	(3)
	Nickel	MG/KG	120	NC	387	120	MG/KG	Mean	(3)
	Thallium	MG/KG	0.461	NC	0.585	0.461	MG/KG	Mean	(3)
	Vanadium	MG/KG	82.3	NC	103	82.3	MG/KG	Mean	(3)
	Dioxins/Furans								
	Toxicity Equivalency (Dioxins/Furans) - Mammals	MG/KG	0.0000550	NC	0.000109	0.0000550	MG/KG	Mean	(3)

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Table 3.1.CT
Medium-Specific Exposure Point Concentration Summary - Central Tendency
Floodplain Soil

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Floodplain Soil
Exposure Medium: Floodplain Soil

Exposure Point	Chemical of Potential Concern (1)	Units	Arithmetic Mean	95% UCL (distribution)	Maximum Detected Concentration (qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (1)	Rationale
OXBOW	***Pesticides/PCBs***								
	a-chlordane	MG/KG	0.0030	NC	0.00768 J	0.0030	MG/KG	Mean	(2)
	dieldrin	MG/KG	0.023	NC	0.06338 J	0.023	MG/KG	Mean	(2)
	endosulfan II	MG/KG	0.0012	NC	0.00337	0.0012	MG/KG	Mean	(2)
	endrin aldehyde	MG/KG	0.0038	NC	0.00951 J	0.0038	MG/KG	Mean	(2)
	endrin ketone	MG/KG	0.00064	NC	0.00173	0.00064	MG/KG	Mean	(2)
	g-chlordane	MG/KG	0.0040	NC	0.00694	0.0040	MG/KG	Mean	(2)
	Technical Chlordane	MG/KG	0.016	NC	0.03008	0.016	MG/KG	Mean	(2)
	Aroclor 1254	MG/KG	1.4	NC	3.5833 J	1.4	MG/KG	Mean	(2)
	Inorganics								
	Antimony	MG/KG	3.0	NC	7.01	3.0	MG/KG	Mean	(2)
	Arsenic	MG/KG	5.4	NC	12.8	5.4	MG/KG	Mean	(2)
	Cadmium	MG/KG	4.0	NC	8.25	4.0	MG/KG	Mean	(2)
	Copper	MG/KG	121	NC	357	121	MG/KG	Mean	(2)
	Lead	MG/KG	575	NC	1835	575	MG/KG	Mean	(2)
	Manganese	MG/KG	826	NC	859	826	MG/KG	Mean	(2)
	Thallium	MG/KG	0.72	NC	1.04	0.72	MG/KG	Mean	(2)
	Vanadium	MG/KG	59.3	NC	71.1	59.3	MG/KG	Mean	(2)
	Dioxins/Furans								
	Toxicity Equivalency (Dioxins/Furans) - Mammals	MG/KG	0.0018	NC	0.004291	0.0018	MG/KG	Mean	(2)

(1) Chemicals of potential concern are identified in Table 2.1 and Table 2.2 for the site exposure area and background area respectively.
(2) Mean: Arithmetic Mean, applied if fewer than 10 samples (95% UCL not calculated), or if the 95% UCL is greater than the maximum concentration.
(3) Max: Maximum, applied in the special case where the arithmetic mean has been selected, but because of elevated detection limits in non-detects, it is greater than the maximum detected concentration.

Qualifier Definitions:
J = Value is estimated.

MG/KG = milligrams per kilogram
NC = Not Calculated
EPC = Exposure Point Concentration
UCL = Upper Confidence Limit on the arithmetic mean

Prepared by:	KJC
Checked by:	MJM

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Table 4.1.RME
Values Used For Daily Intake Calculations

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FLOODPLAIN SOIL
EXPOSURE MEDIUM: FLOODPLAIN SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	PASSIVE RECREATIONAL VISITOR	ADULT (ages 19 and above)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION =
				IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994[1]	CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3,4]	
				BW	BODY WEIGHT	70	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		ADOLESCENT (ages 7 - 18)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION =
				IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994[1]	CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4]	
				BW	BODY WEIGHT	45	kg	USEPA, 1997[5]	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		CHILD (ages 1 - 6)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION =
				IR-S	INGESTION RATE OF SOIL	200	mg/day	USEPA, 1994[1]	CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	6	yr	USEPA, 1994[4]	
				BW	BODY WEIGHT	15	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
DERMAL	PASSIVE RECREATIONAL VISITOR	ADULT (ages 19 and above)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
				AF	ADHERENCE FACTOR	0.07	mg/cm2	USEPA, 2001[7]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[8]	
				SA	SKIN SURFACE AREA AVAILABLE FOR C	5700	cm2/day	USEPA, 2001[9]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3,4]	
				BW	BODY WEIGHT	70	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		ADOLESCENT (ages 7 - 18)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
				AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[7]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[8]	
				SA	SKIN SURFACE AREA AVAILABLE FOR C	4800	cm2/day	USEPA, 1997[6]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4]	
				BW	BODY WEIGHT	45	kg	USEPA, 1997[5]	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		

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Table 4.1.RME
Values Used For Daily Intake Calculations

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FLOODPLAIN SOIL
EXPOSURE MEDIUM: FLOODPLAIN SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
DERMAL (cont)	PASSIVE RECREATIONAL VISITOR (cont)	CHILD (ages 1 - 6)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
				AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[7]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[8]	
				SA	SKIN SURFACE AREA AVAILABLE FOR C	2800	cm2/day	USEPA, 2001[9]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	6	yr	USEPA, 1994[4]	
				BW	BODY WEIGHT	15	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C., December.
USEPA, 1994. "Risk Updates No. 2"; USEPA Region I, Waste Management Division; August. Values from "Attachment 2" to Risk Updates No. 2.
USEPA, 1997. "Exposure Factors Handbook, Volume 1"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.
USEPA, 2001. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

1 - Soil ingestion rate used.
2 - Value based on exposure during wading, swimming, and walking/exploring banks (4 days per week June - August), and walking/exploring banks (2 days per week May, Sept, Oct).
3 - Representing ages 19 and above of a 30-year residential exposure duration.
4 - The total RME exposure duration is 30 years, consistent with USEPA, 1994. The allocation of exposure duration for the three age groups is based on professional judgement.
5 - Values are the average of 50th percentile body weights for males and females ages 7 through 18.
6 - Values are the average of 50th percentile body surface areas (sum of areas for face, hands, forearms, lower legs, and feet) for males in the various age groups indicated.
7 - Values for residential exposure to soil used as conservative estimate of potential soil adherence associated with recreational walking/exploring.
8 - Values are provided (Table 3-4 of USEPA, 2001) for arsenic, cadmium, chlordane, 2,4-D, DDT (used for DDD, DDE), TCDD, lindane (used for other BHC isomers), PAHs, PCBs, and pentachlorophenol. A single value is listed for all other SVOCs. No values are listed for VOCs, other pesticides, or other inorganics and, subsequently, no value will be assigned to the ABSd term for COPCs falling into those categories.
9 - Values for residential exposure to soil used as conservative estimate of potential surface area exposed to soil during recreational walking/exploring.

mg - milligrams
cm^2 - square centimeters
kg - kilograms

Prepared by: KJC
Checked by: MJM

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Table 4.1.CT
Values Used For Daily Intake Calculations

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FLOODPLAIN SOIL
EXPOSURE MEDIUM: FLOODPLAIN SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	PASSIVE RECREATIONAL VISITOR	ADULT (ages 19 and above)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION =
				IR-S	INGESTION RATE OF SOIL	50	mg/day	USEPA, 1994[1]	CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	39	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	4	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	70	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	1460	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		ADOLESCENT (ages 7 - 18)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION =
				IR-S	INGESTION RATE OF SOIL	50	mg/day	USEPA, 1994[1]	CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	39	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	3	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	45	kg	USEPA, 1997[4]	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	1095	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		CHILD (ages 1 - 6)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION =
				IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994[1]	CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	39	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	2	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	15	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	730	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
DERMAL	PASSIVE RECREATIONAL VISITOR	ADULT (ages 19 and above)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
				AF	ADHERENCE FACTOR	0.01	mg/cm2	USEPA, 2001[6]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]	
				SA	SKIN SURFACE AREA AVAILABLE FOR CO	5700	cm2/day	USEPA, 2001[8]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	39	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	4	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	70	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	1460	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		ADOLESCENT (ages 7 - 18)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
				AF	ADHERENCE FACTOR	0.04	mg/cm2	USEPA, 2001[6]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]	
				SA	SKIN SURFACE AREA AVAILABLE FOR CO	4800	cm2/day	USEPA, 1997[5]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	39	day/yr	Professional Judgement[2]	
				ED	EXPOSURE DURATION	3	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	45	kg	USEPA, 1997[4]	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	1095	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		

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Table 4.1.CT
Values Used For Daily Intake Calculations

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: FLOODPLAIN SOIL
EXPOSURE MEDIUM: FLOODPLAIN SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
DERMAL (cont)	PASSIVE RECREATIONAL VISITOR (cont)	CHILD (ages 1 - 6)	GREYSTONE MILL POND ALLENDALE POND	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
				AF	ADHERENCE FACTOR	0.04	mg/cm2	USEPA, 2001[6]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]	
				SA	SKIN SURFACE AREA AVAILABLE FOR CC	2800	cm2/day	USEPA, 2001[8]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	*EXPOSURE FREQUENCY*	*39*	*day/yr*	*Professional Judgement*[3]	
				ED	EXPOSURE DURATION	2	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	15	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	730	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C., December.
USEPA, 1994. "Risk Updates No. 2"; USEPA Region I, Waste Management Division; August. Values from "Attachment 2" to Risk Updates No. 2.
USEPA, 1997. "Exposure Factors Handbook, Volume 1"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.
USEPA, 2001. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

1 - CT soil ingestion rate used.
2 - Value based on exposure during wading, swimming, and walking/exploring banks (2 days per week June - August), and walking/exploring banks (1 day per week May, Sept, Oct).
3 - *The total CT exposure duration is 9 years, consistent with* USEPA, 1994. *The allocation of exposure duration for the three age groups is based on professional judgement.*
4 - Values are the average of 50th percentile body weights for males and females ages 7 - 18.
5 - Values are the average of 50th percentile body surface areas (sum of areas for face, hands, forearms, lower legs, and feet) for males in the various age groups indicated.
6 - CT values for residential exposure to soil used as conservative estimate of potential soil adherence associated with recreational walking/exploring.
7 - Values are provided (Table 3-4 of USEPA, 2001) for arsenic, cadmium, chlordane, 2,4-D, DDT (used for DDD, DDE), TCDD, lindane (used for other BHC isomers), PAHs, PCBs, and pentachlorophenol. A single value is listed for all other SVOCs.
No values are listed for VOCs, other pesticides, or other inorganics and, subsequently, no value will be assigned to the ABSd term for COPCs falling into those categories.
8 - Values for residential exposure to soil used as conservative estimate of potential surface area exposed to soil during recreational walking/exploring.

mg - milligrams
cm^2 - *square centimeters*
kg - kilograms

Prepared by: KJC
Checked by: *MJM*

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Table 5.1
Non-Cancer Toxicity Data - Oral/Dermal

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Adjusted Dermal RfD (2)		Primary Target Organ or System / Critical Effect	Combined Uncertainty / Modifying Factors	RfD: Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s)
BASE NEUTRAL COMPOUNDS										
2-Methylnaphthalene	chronic	4.0E-03	mg/kg/day	89%	4.0E-03	mg/kg/day	Lung/pulmonary alveolar proteinosis	1,000/1	IRIS	September, 2004
	subchronic	4.0E-03	mg/kg/day	89%	4.0E-03	mg/kg/day	Lung/pulmonary alveolar proteinosis	1,000/1	Chronic	
Acenaphthylene	chronic	6.0E-02	mg/kg/day	89%	6.0E-02	mg/kg/day	Liver/Hepatoxicity	3,000/1	Surrogate (1)	
	subchronic	6.0E-01	mg/kg/day	89%	6.0E-01	mg/kg/day	Liver/Hepatoxicity	300/1	Surrogate (1)	
Benzo(a)anthracene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney/Renal tubluar pathology	3,000/1	Surrogate (2)	
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney/Renal tubluar pathology	300/1	Surrogate (2)	
Benzo(a)pyrene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney/Renal tubluar pathology	3,000/1	Surrogate (2)	
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney/Renal tubluar pathology	300/1	Surrogate (2)	
Benzo(b)fluoranthene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney/Renal tubluar pathology	3,000/1	Surrogate (2)	
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney/Renal tubluar pathology	300/1	Surrogate (2)	
Benzo(g,h,i)perylene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney/Renal tubluar pathology	3,000/1	Surrogate (2)	
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney/Renal tubluar pathology	300/1	Surrogate (2)	
Dibenzo(a,h)anthracene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney/Renal tubluar pathology	3,000/1	Surrogate (2)	
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney/Renal tubluar pathology	300/1	Surrogate (2)	
Indeno(1,2,3-cd)pyrene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney/Renal tubluar pathology	3,000/1	Surrogate (2)	
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney/Renal tubluar pathology	300/1	Surrogate (2)	
Phenanthrene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney/Renal tubluar pathology	3,000/1	Surrogate (2)	
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney/Renal tubluar pathology	300/1	Surrogate (2)	
PESTICIDES/PCBs										
Chlordane (alpha & gamma isomers)	chronic	5.0E-04	mg/kg/day	80%	5.0E-04	mg/kg/day	Liver/Hepatic necrosis	300	IRIS	September, 2004
	subchronic	5.0E-04	mg/kg/day	80%	5.0E-04	mg/kg/day	Liver/Hepatic necrosis	300	Chronic	
Dieldrin	chronic	5.0E-05	mg/kg/day	100%	5.0E-05	mg/kg/day	Liver/Liver lesions	100	IRIS	September, 2004
	subchronic	5.0E-05	mg/kg/day	100%	5.0E-05	mg/kg/day	Liver/Liver lesions	100	HEAST	FY 1997
Endosulfan II	chronic	6.0E-03	mg/kg/day	100%	6.0E-03	mg/kg/day	Kidney/Kidney lesions		Surrogate	
	subchronic	6.0E-03	mg/kg/day	100%	6.0E-03	mg/kg/day	Kidney/Kidney lesions		Surrogate	
Endosulfan Sulfate	chronic	6.0E-03	mg/kg/day	100%	6.0E-03	mg/kg/day	Kidney/Kidney lesions		Surrogate	
	subchronic	6.0E-03	mg/kg/day	100%	6.0E-03	mg/kg/day	Kidney/Kidney lesions		Surrogate	
Endrin aldehyde	chronic	3.0E-04	mg/kg/day	100%	3.0E-04	mg/kg/day	Nervous system and liver/Convulsions & liver lesions		Surrogate	
	subchronic	3.0E-04	mg/kg/day	100%	3.0E-04	mg/kg/day	Nervous system and liver/Convulsions & liver lesions		Surrogate	
Endrin ketone	chronic	3.0E-04	mg/kg/day	100%	3.0E-04	mg/kg/day	Nervous system and liver/Convulsions & liver lesions		Surrogate	
	subchronic	3.0E-04	mg/kg/day	100%	3.0E-04	mg/kg/day	Nervous system and liver/Convulsions & liver lesions		Surrogate	
Aroclor-1254	chronic	2.0E-05	mg/kg/day	80%	2.0E-05	mg/kg/day	Immune system/Immunotoxicity	300	IRIS	September, 2004
	subchronic	5.0E-05	mg/kg/day	80%	5.0E-05	mg/kg/day	Immune system/Immunotoxicity	300	HEAST	FY 1997
Aroclor 1268	chronic	2.0E-05	mg/kg/day	80%	2.0E-05	mg/kg/day	Immune system/Immunotoxicity	300	Surrogate	
	subchronic	5.0E-05	mg/kg/day	80%	5.0E-05	mg/kg/day	Immune system/Immunotoxicity	300	Surrogate	
INORGANICS/METALS										
Aluminum	chronic	ND			ND					
	subchronic	ND			ND					
Antimony	chronic	4.0E-04	mg/kg/day	15%	6.0E-05	mg/kg/day	Reduced lifespan; Hematological/blood glucose and cholesterol	1,000/1	IRIS	September, 2004
	subchronic	4.0E-04	mg/kg/day	15%	6.0E-05	mg/kg/day	Reduced lifespan; Hematological/blood glucose and cholesterol	1,000/1	IRIS	September, 2004
Arsenic	chronic	3.0E-04	mg/kg/day	95%	3.0E-04	mg/kg/day	Skin/Keratosis and hyperpigmentation	3/1	IRIS	September, 2004
	subchronic	3.0E-04	mg/kg/day	95%	3.0E-04	mg/kg/day	Skin/Keratosis and hyperpigmentation	3/1	HEAST	FY 1997
Chromium VI	chronic	3.0E-03	mg/kg/day	2.5%	7.5E-05	mg/kg/day	No effects observed	300/3	IRIS	September, 2004
	subchronic	2.0E-02	mg/kg/day	2.5%	5.0E-04	mg/kg/day	No effects observed	300/1	HEAST	FY 1997
Copper	chronic	ND			ND				IRIS	September, 2004
	subchronic	ND			ND					
Lead	chronic	ND			ND				IRIS	September, 2004
	subchronic	ND			ND					
Manganese (soil)	chronic	7.1E-02	mg/kg/day	4%	2.8E-03	mg/kg/day	CNS/Impairment of neurobehavioral function	1/1	IRIS	September, 2004
	subchronic	7.1E-02	mg/kg/day	4%	2.8E-03	mg/kg/day	CNS/Impairment of neurobehavioral function	1/1	Chronic	
Mercury (as mercuric chloride)	chronic	3.0E-04	mg/kg/day	7%	2.1E-05	mg/kg/day	Immune system/Autoimmune effects	1,000/1	IRIS	September, 2004
	subchronic	2.0E-03	mg/kg/day	7%	1.4E-04	mg/kg/day	Kidney	100/1	MRL	January, 2004
Molybdenum	chronic	5.0E-03	mg/kg/day	100%	5.0E-03	mg/kg/day	Kidney/Increased uric acid levels	30/1	IRIS	September, 2004
	subchronic	5.0E-03	mg/kg/day	100%	5.0E-03	mg/kg/day	Kidney/Increased uric acid levels	30/1	Chronic	

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Table 5.1
Non-Cancer Toxicity Data - Oral/Dermal

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Adjusted Dermal RfD (2)		Primary Target Organ or System / Critical Effect	Combined Uncertainty / Modifying Factors	RfD: Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s)
Nickel	chronic	2.0E-02	mg/kg/day	4%	8.0E-04	mg/kg/day	Decreased body and organ weights	300/1	IRIS	September, 2004
	subchronic	2.0E-02	mg/kg/day	4%	8.0E-04	mg/kg/day	Decreased body and organ weights	300/1	HEAST	FY 1997
Thallium	chronic	8.0E-05	mg/kg/day	100%	8.0E-05	mg/kg/day	Liver/Increased SGOT and LDH	3,000/1	IRIS	September, 2004
	subchronic	8.0E-04	mg/kg/day	100%	8.0E-04	mg/kg/day	No effects observed	300/1	HEAST	FY 1997
Vanadium	chronic	1.0E-03	mg/kg/day	2.6%	2.6E-05	mg/kg/day			NCEA	April, 2004
	subchronic	3.0E-03	mg/kg/day	2.6%	7.8E-05	mg/kg/day	Kidney	100/1	MRL	January, 2004
DIOXINS/FURANS										
2,3,7,8-tetrachlorobenzo-p-dioxin (TCD	chronic	ND							IRIS	September, 2004
	subchronic	ND								

Notes:

IRIS = Integrated Risk Information System:	September, 2004	mg = milligram
HEAST= Health Effects Assessment Summary Tables:	FY 1997	kg = kilogram
NCEA = National Center for Environmental Assessment:	April, 2004	BW = body weight
NCEA provisional values are obtained from the USEPA Region III RBC Table dated:	*April, 2004*	*chronic - the chronic value is used as the subchronic RfD*
PPRTV = Peer-Reviewed Reference Toxicity Value:	September, 2004	surrogate - a value for a closely related chemical is used as the RfD
MRL = Minimum Risk Level (ATSDR):	January, 2004	

ND = no data available

(1) *Values obtained from RAGS Volume 1 (Part E, Supplemental Guidance for Dermal Risk Assessment, Interim Guidance) (EPA, 1999)*
Per this guidance, a value of 100% is used for analytes without published values.

(2) Adjusted Dermal RfD = Oral RfD x Oral to Dermal Adjustment Factor. Per RAGS Part E (USEPA, 1999), adjustments are only performed for chemicals that have an oral absorption efficiency of less than 50%.

Per USEPA Region I "Risk Updates, No. 5", (August, 1999), Non-carcinogenic PAHs without published RfDs should be evaluated using the published RfD for a structurally similar PAH.
Surrogate (1) - Value for acenaphthene used as a surrogate
Surrogate (2) - Value for pyrene used as a surrogate

RfD for Aroclor 1254 used as surrogate for other PCB congeners with no published RfDs

RfD for Endosulfan used as surrogate for other endosulfan compounds

RfD for Endrin used as surrogate for other endrin compounds

For Manganese in drinking water: As recommended by USEPA Region I Risk Update, a non-dietary RfD is obtained by subtracting typical dietary intake of manganese (5 mg/kday) from critical dose (10 mg/day). Non-dietary RfD is then adjusted with *a modifying factor of 3, as recommended by IRIS for drinking water exposures.*

For manganese in non-drinking water media: As recommended by USEPA Region I Risk Update, a non-dietary RfD is obtained by subtracting typical dietary intake of manganese (5 mg/kday) from critical dose (10 mg/day). A modifying factor of 1 is then applied, per USEPA Region 1.

Value for chlordane used for alpha- and gamma- isomers.

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Table 6.1
Cancer Toxicity Data - Oral/Dermal

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal (2)		Weight of Evidence/ Cancer Guideline Description	Oral Cancer Slope Factor	
	Value	Units		Value	Units		Source(s)	Date(s)
BASE NEUTRAL COMPOUNDS								
2-Methylnaphthalene	NA			NA		Inadequate evidence	IRIS	September, 2004
Acenaphthylene	NA			NA		D	IRIS	September, 2004
Benzo(a)anthracene	7.3E-01	$(mg/kg/day)^{-1}$	89%	7.3E-01	$(mg/kg/day)^{-1}$	B2	IRIS	September, 2004
Benzo(a)pyrene	7.3E+00	$(mg/kg/day)^{-1}$	89%	7.3E+00	$(mg/kg/day)^{-1}$	B2	IRIS	September, 2004
Benzo(b)fluoranthene	7.3E-01	$(mg/kg/day)^{-1}$	89%	7.3E-01	$(mg/kg/day)^{-1}$	B2	IRIS	September, 2004
Benzo(g,h,i)perylene	NA			NA		D	IRIS	September, 2004
Dibenzo(a,h)anthracene	7.3E+00	$(mg/kg/day)^{-1}$	89%	7.3E+00	$(mg/kg/day)^{-1}$	B2	IRIS	September, 2004
Indeno(1,2,3-cd)pyrene	7.3E-01	$(mg/kg/day)^{-1}$	89%	7.3E-01	$(mg/kg/day)^{-1}$	B2	IRIS	September, 2004
Phenanthrene	NA			NA		D	IRIS	September, 2004
PESTICIDES/PCBs								
Chlordane (alpha & gamma isomers)	3.5E-01	$(mg/kg/day)^{-1}$	80%	3.5E-01	$(mg/kg/day)^{-1}$	B2	IRIS	September, 2004
Dieldrin	1.6E+01	$(mg/kg/day)^{-1}$	100%	1.6E+01	$(mg/kg/day)^{-1}$	B2	IRIS	September, 2004
Endosulfan II						ND		
Endosulfan Sulfate						ND		
Endrin aldehyde						ND		
Endrin ketone						ND		
Aroclor-1254	2.0E+00	$(mg/kg/day)^{-1}$	80%	2.0E+00	$(mg/kg/day)^{-1}$	See PCBs		
Aroclor 1268	2.0E+00	$(mg/kg/day)^{-1}$	80%	2.0E+00	$(mg/kg/day)^{-1}$	See PCBs		
Polychlorinated Biphenyls (PCBs)	See Below ***					B2	IRIS	September, 2004
high risk and persistence-upper bound	2.0E+00	$(mg/kg/day)^{-1}$	80%	2.0E+00	$(mg/kg/day)^{-1}$			
INORGANICS/METALS								
Aluminum	ND			ND		ND		
Antimony	ND			ND		ND	IRIS	September, 2004
Arsenic	1.5E+00	$(mg/kg/day)^{-1}$	95%	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	September, 2004
Chromium VI	NA			NA		Inadequate evidence	IRIS	September, 2004
Copper	NA			NA		D	IRIS	September, 2004
Lead	NA			NA		B2	IRIS	September, 2004
Manganese	NA			NA		D	IRIS	September, 2004
Mercury (as mercuric chloride)	NA		7%	NA		C	IRIS	September, 2004
Molybdenum	ND			ND		ND	IRIS	September, 2004
Nickel	ND			ND		ND	IRIS	September, 2004
Thallium	NA			NA		D	IRIS	September, 2004
Vanadium	ND			ND		ND		

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Table 6.1
Cancer Toxicity Data - Oral/Dermal

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal (2)		Weight of Evidence/ Cancer Guideline Description	Oral Cancer Slope Factor	
	Value	Units		Value	Units		Source(s)	Date(s)
DIOXINS/FURANS								
2,3,7,8-tetrachlorobenzo-p-dioxin (TCDD)	1.5E+05	$(mg/kg/day)^{-1}$	70%	1.5E+05	$(mg/kg/day)^{-1}$	B2	HEAST	FY 1997

Notes:
IRIS = Integrated Risk Information System: September, 2004
HEAST= Health Effects Assessment Summary Tab FY 1997
NCEA = National Center for Environmental Assessr Apri, 2004
NCEA provisional values are obtained from the USEPA Region III Apri, 2004
CALEPA - California Environmental Protection Agei September, 2004
ND = no data available
(1) Values obtained from RAGS Volume 1 (Part E, Supplemental Guidance for Dermal Risk Assessment, Interim Guidance) (EPA, 1999) Per this guidance, a value of 100% is used for analytes without published values.
(2) Adjusted Dermal SF = Oral SF / Oral to Dermal Adjustment Factor. Per RAGS Part E (USEPA, 1999), adjustments are only performed for chemicals that have an oral absorption efficiency of less than 50%.
The value for chlordane is used as surrogate for the isomers.
Slope Factor for Benzo(a)Pyrene used for other carcinogenic PAHs, adjusted by Relative Potency Factors of 1.0 [benzo(a)pyrene, dibenz(a,h)anthracene]; 0.1 [benzo(a)anthracene, benzo(b)flouoranthene, indeno(1,2,3-c,d)pyrene]; 0.01 [benzo(k)fluoranthene]; 0.001 [chrysene].
PCB slope factors are applicable to Aroclors 1016, 1248, 1254, and 1260.

Weight of Evidence:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited h
B2 - Probable human carcinogen - indicates sufficient evi inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity
mg = milligram
kg = kilogram
BW = body weight

TABLE 7.1.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT; OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	CSF/UNIT RISK VALUE	CSF/UNIT RISK UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	RfD/RfC (1) VALUE	RfD/RfC (1) UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	OXBOW AREA	INGESTION	a-chlordane	0.00768	mg/kg	4.0E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-10	2.3E-09	mg/kg/day	5.0E-04	mg/kg/day	5.E-06
				dieldrin	0.06338	mg/kg	3.3E-09	mg/kg/day	1.6E+01	(mg/kg/day)-1	5.E-08	1.9E-08	mg/kg/day	5.0E-05	mg/kg/day	4.E-04
				endosulfan II	0.00337	mg/kg	NC		NC			1.0E-09	mg/kg/day	6.0E-03	mg/kg/day	2.E-07
				endrin aldehyde	0.00951	mg/kg	NC		NC			2.9E-09	mg/kg/day	3.0E-04	mg/kg/day	1.E-05
				endrin ketone	0.00173	mg/kg	NC		NC			5.3E-10	mg/kg/day	3.0E-04	mg/kg/day	2.E-06
				g-chlordane	0.00694	mg/kg	3.6E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-10	2.1E-09	mg/kg/day	5.0E-04	mg/kg/day	4.E-06
				Technical Chlordane	0.03008	mg/kg	1.6E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	6.E-10	9.2E-09	mg/kg/day	5.0E-04	mg/kg/day	2.E-05
				Aroclor 1254	3.5833	mg/kg	1.9E-07	mg/kg/day	2.0E+00	(mg/kg/day)-1	4.E-07	1.1E-06	mg/kg/day	2.0E-05	mg/kg/day	5.E-02
				Antimony	7.01	mg/kg	NC		NC			2.1E-06	mg/kg/day	4.0E-04	mg/kg/day	5.E-03
				Arsenic	12.8	mg/kg	6.7E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	1.E-06	3.9E-06	mg/kg/day	3.0E-04	mg/kg/day	1.E-02
				Cadmium	8.25	mg/kg	NC		NC			2.5E-06	mg/kg/day	1.0E-03	mg/kg/day	3.E-03
				Copper	357	mg/kg	NC		NC			1.1E-04	mg/kg/day			
				Lead	1835	mg/kg	9.6E-05	mg/kg/day	--			5.6E-04	mg/kg/day			
				Manganese	859	mg/kg	NC		NC			2.6E-04	mg/kg/day	7.1E-02	mg/kg/day	4.E-03
				Thallium	1.04	mg/kg	NC		NC			3.2E-07	mg/kg/day	8.0E-05	mg/kg/day	4.E-03
				Vanadium	71.1	mg/kg	NC		NC			2.2E-05	mg/kg/day	1.0E-03	mg/kg/day	2.E-02
				Toxicity Equivalency (Dioxins/Furans)	0.004291	mg/kg	2.2E-10	mg/kg/day	1.5E+05	(mg/kg/day)-1	3.E-05	1.3E-09	mg/kg/day			
			EXPOSURE ROUTE TOTAL								4.E-05					1.E-01
			DERMAL	a-chlordane	0.00768	mg/kg	6.4E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	2.E-11	3.7E-10	mg/kg/day	5.0E-04	mg/kg/day	7.E-07
				dieldrin	0.06338	mg/kg	0.0E+00	mg/kg/day	1.6E+01	(mg/kg/day)-1	0.E+00			5.0E-05	mg/kg/day	
				endosulfan II	0.00337	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				endrin aldehyde	0.00951	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				endrin ketone	0.00173	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				g-chlordane	0.00694	mg/kg	5.8E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	2.E-11	3.4E-10	mg/kg/day	5.0E-04	mg/kg/day	7.E-07
				Technical Chlordane	0.03008	mg/kg	2.5E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	9.E-11	1.5E-09	mg/kg/day	5.0E-04	mg/kg/day	3.E-06
				Aroclor 1254	3.5833	mg/kg	1.0E-07	mg/kg/day	2.0E+00	(mg/kg/day)-1	2.E-07	6.1E-07	mg/kg/day	2.0E-05	mg/kg/day	3.E-02
				Antimony	7.01	mg/kg	NC		NC					6.0E-05	mg/kg/day	
				Arsenic	12.8	mg/kg	8.0E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	1.E-07	4.7E-07	mg/kg/day	3.0E-04	mg/kg/day	2.E-03
				Cadmium	8.25	mg/kg	NC		NC			1.0E-08	mg/kg/day	2.5E-05	mg/kg/day	4.E-04
				Copper	357	mg/kg	NC		NC							
				Lead	1835	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	859	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Thallium	1.04	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	71.1	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.004291	mg/kg	2.7E-11	mg/kg/day	1.5E+05	(mg/kg/day)-1	4.E-06	1.6E-10	mg/kg/day			
			EXPOSURE ROUTE TOTAL								4.E-06					5.E-02
		EXPOSURE POINT TOTAL									4.E-05					1.E-01
	EXPOSURE MEDIUM TOTAL										4.E-05					1.E-01
SOIL TOTAL											4.E-05					1.E-01
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	4.E-05			TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA		1.4.E-01

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.2.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS -- REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	CSF/UNIT RISK VALUE	CSF/UNIT RISK UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	RfD/RfC (1) VALUE	RfD/RfC (1) UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	OXBOW AREA	INGESTION	a-chlordane	0.00768	mg/kg	6.3E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	2.E-10	3.6E-09	mg/kg/day	5.0E-04	mg/kg/day	7.E-06
				dieldrin	0.06338	mg/kg	5.2E-09	mg/kg/day	1.6E+01	(mg/kg/day)-1	8.E-08	3.0E-08	mg/kg/day	5.0E-05	mg/kg/day	6.E-04
				endosulfan II	0.00337	mg/kg	NC		NC			1.6E-09	mg/kg/day	6.0E-03	mg/kg/day	3.E-07
				endrin aldehyde	0.00951	mg/kg	NC		NC			4.5E-09	mg/kg/day	3.0E-04	mg/kg/day	2.E-05
				endrin ketone	0.00173	mg/kg	NC		NC			8.2E-10	mg/kg/day	3.0E-04	mg/kg/day	3.E-06
				g-chlordane	0.00694	mg/kg	5.6E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	2.E-10	3.3E-09	mg/kg/day	5.0E-04	mg/kg/day	7.E-06
				Technical Chlordane	0.03008	mg/kg	2.4E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	9.E-10	1.4E-08	mg/kg/day	5.0E-04	mg/kg/day	3.E-05
				Aroclor 1254	3.5833	mg/kg	2.9E-07	mg/kg/day	2.0E+00	(mg/kg/day)-1	6.E-07	1.7E-06	mg/kg/day	2.0E-05	mg/kg/day	9.E-02
				Antimony	7.01	mg/kg	NC		NC			3.3E-06	mg/kg/day	4.0E-04	mg/kg/day	8.E-03
				Arsenic	12.8	mg/kg	1.0E-06	mg/kg/day	1.5E+00	(mg/kg/day)-1	2.E-06	6.1E-06	mg/kg/day	3.0E-04	mg/kg/day	2.E-02
				Cadmium	8.25	mg/kg	NC		NC			3.9E-06	mg/kg/day	1.0E-03	mg/kg/day	4.E-03
				Copper	357	mg/kg	NC		NC			1.7E-04	mg/kg/day			
				Lead	1835	mg/kg	1.5E-04	mg/kg/day	--			8.7E-04	mg/kg/day			
				Manganese	859	mg/kg	NC		NC			4.1E-04	mg/kg/day	7.1E-02	mg/kg/day	6.E-03
				Thallium	1.04	mg/kg	NC		NC			4.9E-07	mg/kg/day	8.0E-05	mg/kg/day	6.E-03
				Vanadium	71.1	mg/kg	NC		NC			3.4E-05	mg/kg/day	1.0E-03	mg/kg/day	3.E-02
				Toxicity Equivalency (Dioxins/Furans)	0.004291	mg/kg	3.5E-10	mg/kg/day	1.5E+05	(mg/kg/day)-1	5.E-05	2.0E-09	mg/kg/day			
			EXPOSURE ROUTE TOTAL								5.E-05					2.E-01
			DERMAL	a-chlordane	0.00768	mg/kg	2.4E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	8.E-11	1.4E-09	mg/kg/day	5.0E-04	mg/kg/day	3.E-06
				dieldrin	0.06338	mg/kg	0.0E+00	mg/kg/day	1.6E+01	(mg/kg/day)-1	0.E+00			5.0E-05	mg/kg/day	
				endosulfan II	0.00337	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				endrin aldehyde	0.00951	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				endrin ketone	0.00173	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				g-chlordane	0.00694	mg/kg	2.2E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	8.E-11	1.3E-09	mg/kg/day	5.0E-04	mg/kg/day	3.E-06
				Technical Chlordane	0.03008	mg/kg	9.4E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-10	5.5E-09	mg/kg/day	5.0E-04	mg/kg/day	1.E-05
				Aroclor 1254	3.5833	mg/kg	3.9E-07	mg/kg/day	2.0E+00	(mg/kg/day)-1	8.E-07	2.3E-06	mg/kg/day	2.0E-05	mg/kg/day	1.E-01
				Antimony	7.01	mg/kg	NC		NC					6.0E-05	mg/kg/day	
				Arsenic	12.8	mg/kg	3.0E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	5.E-07	1.8E-06	mg/kg/day	3.0E-04	mg/kg/day	6.E-03
				Cadmium	8.25	mg/kg	NC		NC			3.8E-08	mg/kg/day	2.5E-05	mg/kg/day	2.E-03
				Copper	357	mg/kg	NC		NC							
				Lead	1835	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	859	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Thallium	1.04	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	71.1	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.004291	mg/kg	1.0E-10	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-05	5.9E-10	mg/kg/day			
			EXPOSURE ROUTE TOTAL								2.E-05					1.E-01
		EXPOSURE POINT TOTAL									7.E-05					3.E-01
	EXPOSURE MEDIUM TOTAL										7.E-05					3.E-01
SOIL TOTAL											7.E-05					3.E-01
									TOTAL RECEPTOR RISK ACROSS ALL MEDIA		7.E-05	TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA				2.9.E-01

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.3.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	CSF/UNIT RISK VALUE	CSF/UNIT RISK UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	RfD/RfC (1) VALUE	RfD/RfC (1) UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	OXBOW AREA	INGESTION	a-chlordane	0.00768	mg/kg	1.9E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	7.E-10	2.2E-08	mg/kg/day	5.0E-04	mg/kg/day	4.E-05
				dieldrin	0.06338	mg/kg	1.5E-08	mg/kg/day	1.6E+01	(mg/kg/day)-1	2.E-07	1.8E-07	mg/kg/day	5.0E-05	mg/kg/day	4.E-03
				endosulfan II	0.00337	mg/kg	NC		NC			9.6E-09	mg/kg/day	6.0E-03	mg/kg/day	2.E-06
				endrin aldehyde	0.00951	mg/kg	NC		NC			2.7E-08	mg/kg/day	3.0E-04	mg/kg/day	9.E-05
				endrin ketone	0.00173	mg/kg	NC		NC			4.9E-09	mg/kg/day	3.0E-04	mg/kg/day	2.E-05
				g-chlordane	0.00694	mg/kg	1.7E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	6.E-10	2.0E-08	mg/kg/day	5.0E-04	mg/kg/day	4.E-05
				Technical Chlordane	0.03008	mg/kg	7.3E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-09	8.6E-08	mg/kg/day	5.0E-04	mg/kg/day	2.E-04
				Aroclor 1254	3.5833	mg/kg	8.8E-07	mg/kg/day	2.0E+00	(mg/kg/day)-1	2.E-06	1.0E-05	mg/kg/day	2.0E-05	mg/kg/day	5.E-01
				Antimony	7.01	mg/kg	NC		NC			2.0E-05	mg/kg/day	4.0E-04	mg/kg/day	5.E-02
				Arsenic	12.8	mg/kg	3.1E-06	mg/kg/day	1.5E+00	(mg/kg/day)-1	5.E-06	3.6E-05	mg/kg/day	3.0E-04	mg/kg/day	1.E-01
				Cadmium	8.25	mg/kg	NC		NC			2.4E-05	mg/kg/day	1.0E-03	mg/kg/day	2.E-02
				Copper	357	mg/kg	NC		NC			1.0E-03	mg/kg/day			
				Lead	1835	mg/kg	4.5E-04	mg/kg/day	--			5.2E-03	mg/kg/day			
				Manganese	859	mg/kg	NC		NC			2.4E-03	mg/kg/day	7.1E-02	mg/kg/day	3.E-02
				Thallium	1.04	mg/kg	NC		NC			3.0E-06	mg/kg/day	8.0E-05	mg/kg/day	4.E-02
				Vanadium	71.1	mg/kg	NC		NC			2.0E-04	mg/kg/day	1.0E-03	mg/kg/day	2.E-01
				Toxicity Equivalency (Dioxins/Furans)	0.004291	mg/kg	1.0E-09	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-04	1.2E-08	mg/kg/day			
			EXPOSURE ROUTE TOTAL								2.E-04					1.E+00
			DERMAL	a-chlordane	0.00768	mg/kg	2.1E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	7.E-11	2.5E-09	mg/kg/day	5.0E-04	mg/kg/day	5.E-06
				dieldrin	0.06338	mg/kg	0.0E+00	mg/kg/day	1.6E+01	(mg/kg/day)-1	0.E+00			5.0E-05	mg/kg/day	
				endosulfan II	0.00337	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				endrin aldehyde	0.00951	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				endrin ketone	0.00173	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				g-chlordane	0.00694	mg/kg	1.9E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	7.E-11	2.2E-09	mg/kg/day	5.0E-04	mg/kg/day	4.E-06
				Technical Chlordane	0.03008	mg/kg	8.2E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-10	9.6E-09	mg/kg/day	5.0E-04	mg/kg/day	2.E-05
				Aroclor 1254	3.5833	mg/kg	3.4E-07	mg/kg/day	2.0E+00	(mg/kg/day)-1	7.E-07	4.0E-06	mg/kg/day	2.0E-05	mg/kg/day	2.E-01
				Antimony	7.01	mg/kg	NC		NC					6.0E-05	mg/kg/day	
				Arsenic	12.8	mg/kg	2.6E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	4.E-07	3.1E-06	mg/kg/day	3.0E-04	mg/kg/day	1.E-02
				Cadmium	8.25	mg/kg	NC		NC			6.6E-08	mg/kg/day	2.5E-05	mg/kg/day	3.E-03
				Copper	357	mg/kg	NC		NC							
				Lead	1835	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	859	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Thallium	1.04	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	71.1	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.004291	mg/kg	8.8E-11	mg/kg/day	1.5E+05	(mg/kg/day)-1	1.E-05	1.0E-09	mg/kg/day			
			EXPOSURE ROUTE TOTAL								1.E-05					2.E-01
		EXPOSURE POINT TOTAL									2.E-04					1.E+00
	EXPOSURE MEDIUM TOTAL										2.E-04					1.E+00
SOIL TOTAL											2.E-04					1.E+00
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	2.E-04			TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA		1.2.E+00

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.4.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE UNITS	CSF/UNIT RISK VALUE	CSF UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE UNITS	RfD/RfC (1) VALUE	RfD/RfC UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	INGESTION	2-Methylnaphthalene	0.17022	mg/kg	NC		NC			5.2E-08	mg/kg/day	4.0E-03	mg/kg/day	1.E-05
				Acenaphthylene	0.49749	mg/kg	NC		NC			1.5E-07	mg/kg/day	6.0E-02	mg/kg/day	3.E-06
				Benzo(a)anthracene	3.41086	mg/kg	1.8E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-07	1.0E-06	mg/kg/day	3.0E-02	mg/kg/day	3.E-05
				Benzo(a)pyrene	3.41803	mg/kg	1.8E-07	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-06	1.0E-06	mg/kg/day	3.0E-02	mg/kg/day	3.E-05
				Benzo(b)fluoranthene	4.28861	mg/kg	2.2E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-07	1.3E-06	mg/kg/day	3.0E-02	mg/kg/day	4.E-05
				Benzo(g,h,i)perylene	2.87139	mg/kg	NC		NC			8.8E-07	mg/kg/day	3.0E-02	mg/kg/day	3.E-05
				Dibenzo(a,h)anthracene	0.72851	mg/kg	3.8E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	3.E-07	2.2E-07	mg/kg/day	3.0E-02	mg/kg/day	7.E-06
				Indeno(1,2,3-cd)pyrene	*3.0929*	mg/kg	*1.6E-07*	mg/kg/day	*7.3E-01*	(mg/kg/day)-1	*1.E-07*	*9.4E-07*	mg/kg/day	*3.0E-02*	mg/kg/day	*3.E-05*
				Phenanthrene	5.30136	mg/kg	NC		NC			1.6E-06	mg/kg/day	3.0E-02	mg/kg/day	5.E-05
				alpha-Chlordane	0.03592	mg/kg	1.9E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	7.E-10	1.1E-08	mg/kg/day	5.0E-04	mg/kg/day	2.E-05
				Aroclor-1254	0.83872	mg/kg	4.4E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	9.E-08	2.6E-07	mg/kg/day	2.0E-05	mg/kg/day	1.E-02
				Aroclor-1268	0.13953	mg/kg	7.3E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	1.E-08	4.3E-08	mg/kg/day	2.0E-05	mg/kg/day	2.E-03
				Endosulfan Sulfate	*0.01269*	mg/kg	NC		NC			3.9E-09	mg/kg/day	6.0E-03	mg/kg/day	6.E-07
				Technical Chlordane	0.73538	mg/kg	3.8E-08	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-08	2.2E-07	mg/kg/day	5.0E-04	mg/kg/day	4.E-04
				Aluminum	21793	mg/kg	NC		NC			6.7E-03	mg/kg/day			
				Arsenic	12.2	mg/kg	6.4E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	1.E-06	3.7E-06	mg/kg/day	*3.0E-04*	mg/kg/day	*1.E-02*
				Chromium	291	mg/kg	NC		NC			8.9E-05	mg/kg/day	3.0E-03	mg/kg/day	3.E-02
				Copper	324	mg/kg	NC		NC			9.9E-05	mg/kg/day			
				Lead	591	mg/kg	3.1E-05	mg/kg/day	--			1.8E-04	mg/kg/day			
				Manganese	4126	mg/kg	NC		NC			1.3E-03	mg/kg/day	7.1E-02	mg/kg/day	2.E-02
				Mercury	*0.811*	mg/kg	NC		NC			2.5E-07	mg/kg/day	3.0E-04	mg/kg/day	8.E-04
				Molybdenum	87.7	mg/kg						2.7E-05	mg/kg/day	5.0E-03	mg/kg/day	5.E-03
				Nickel	387	mg/kg	NC		NC			1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	6.E-03
				Thallium	0.585	mg/kg	NC		NC			1.8E-07	mg/kg/day	*3.0E-05*	mg/kg/day	2.E-03
				Vanadium	103	mg/kg	NC		NC			3.1E-05	mg/kg/day	1.0E-03	mg/kg/day	3.E-02
				Toxicity Equivalency (Dioxins/Furans)	0.000109	mg/kg	5.7E-12	mg/kg/day	1.5E+05	(mg/kg/day)-1	9.E-07	3.3E-11	mg/kg/day			
			EXPOSURE ROUTE TOTAL								4.E-06					1.E-01
			DERMAL	2-Methylnaphthalene	0.17022	mg/kg	NC		NC			2.7E-08	mg/kg/day	4.0E-03	mg/kg/day	7.E-06
				Acenaphthylene	0.49749	mg/kg	NC		NC			7.9E-08	mg/kg/day	6.0E-02	mg/kg/day	1.E-06
				Benzo(a)anthracene	3.41086	mg/kg	9.3E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	7.E-08	5.4E-07	mg/kg/day	*3.0E-02*	mg/kg/day	*2.E-05*
				Benzo(a)pyrene	3.41803	mg/kg	9.3E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	7.E-07	5.4E-07	mg/kg/day	3.0E-02	mg/kg/day	2.E-05
				Benzo(b)fluoranthene	4.28861	mg/kg	1.2E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	8.E-08	6.8E-07	mg/kg/day	3.0E-02	mg/kg/day	2.E-05
				Benzo(g,h,i)perylene	2.87139	mg/kg	NC		NC			4.5E-07	mg/kg/day	3.0E-02	mg/kg/day	2.E-05
				Dibenzo(a,h)anthracene	0.72851	mg/kg	2.0E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-07	1.2E-07	mg/kg/day	3.0E-02	mg/kg/day	4.E-06
				Indeno(1,2,3-cd)pyrene	3.0929	mg/kg	8.4E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	6.E-08	4.9E-07	mg/kg/day	3.0E-02	mg/kg/day	2.E-05
				Phenanthrene	5.30136	mg/kg	NC		NC			8.4E-07	mg/kg/day	3.0E-02	mg/kg/day	3.E-05
				alpha-Chlordane	0.03592	mg/kg	3.0E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-10	1.8E-09	mg/kg/day	5.0E-04	mg/kg/day	4.E-06
				Aroclor-1254	*0.83872*	mg/kg	*2.5E-08*	mg/kg/day	*2.0E+00*	(mg/kg/day)-1	*5.E-08*	1.4E-07	mg/kg/day	2.0E-05	mg/kg/day	7.E-03
				Aroclor-1268	0.13953	mg/kg	4.1E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	8.E-09	2.4E-08	mg/kg/day	2.0E-05	mg/kg/day	1.E-03
				Endosulfan Sulfate	0.01269	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				Technical Chlordane	0.73538	mg/kg	6.1E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	2.E-09	3.6E-08	mg/kg/day	5.0E-04	mg/kg/day	7.E-05
				Aluminum	21793	mg/kg	NC		NC							
				Arsenic	12.2	mg/kg	7.6E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	1.E-07	4.5E-07	mg/kg/day	3.0E-04	mg/kg/day	1.E-03
				Chromium	291	mg/kg	NC		NC					7.5E-05	mg/kg/day	
				Copper	324	mg/kg	NC		NC							
				Lead	591	mg/kg	*0.0E+00*	mg/kg/day	--							
				Manganese	4126	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Mercury	0.811	mg/kg	NC		NC					2.1E-05	mg/kg/day	
				Molybdenum	87.7	mg/kg								*5.0E-03*	mg/kg/day	
				Nickel	387	mg/kg	NC		NC					8.0E-04	mg/kg/day	
				Thallium	0.585	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	103	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	*0.000109*	mg/kg	2.3E-14	mg/kg/day	1.5E+05	(mg/kg/day)-1	3.E-09	1.3E-13	mg/kg/day			
			EXPOSURE ROUTE TOTAL								1.E-06					1.E-02
		EXPOSURE POINT TOTAL									*5.E-06*					*1.E-01*
	EXPOSURE MEDIUM TOTAL										5.E-06					1.E-01
SOIL TOTAL											*5.E-06*					*1.E-01*
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	5.E-06			TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA		1.3.E-01

TABLE 7.4.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.5.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS – REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	CSF/UNIT RISK VALUE	CSF/UNIT RISK UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	RfD/RfC (1) VALUE	RfD/RfC (1) UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	INGESTION	2-Methylnaphthalene	0.17022	mg/kg	NC		NC			8.1E-08	mg/kg/day	4.0E-03	mg/kg/day	2.E-05
				Acenaphthylene	0.49749	mg/kg	NC		NC			2.4E-07	mg/kg/day	6.0E-02	mg/kg/day	4.E-06
				Benzo(a)anthracene	3.41086	mg/kg	2.8E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-07	1.6E-06	mg/kg/day	3.0E-02	mg/kg/day	5.E-05
				Benzo(a)pyrene	3.41803	mg/kg	2.8E-07	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-06	1.6E-06	mg/kg/day	3.0E-02	mg/kg/day	5.E-05
				Benzo(b)fluoranthene	4.28861	mg/kg	3.5E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	3.E-07	2.0E-06	mg/kg/day	3.0E-02	mg/kg/day	7.E-05
				Benzo(g,h,i)perylene	2.87139	mg/kg	NC		NC			1.4E-06	mg/kg/day	3.0E-02	mg/kg/day	5.E-05
				Dibenzo(a,h)anthracene	0.72851	mg/kg	5.9E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	4.E-07	3.5E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Indeno(1,2,3-cd)pyrene	3.0929	mg/kg	2.5E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-07	1.5E-06	mg/kg/day	3.0E-02	mg/kg/day	5.E-05
				Phenanthrene	5.30136	mg/kg	NC		NC			2.5E-06	mg/kg/day	3.0E-02	mg/kg/day	8.E-05
				alpha-Chlordane	0.03592	mg/kg	2.9E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-09	1.7E-08	mg/kg/day	5.0E-04	mg/kg/day	3.E-05
				Aroclor-1254	0.83872	mg/kg	6.8E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	1.E-07	4.0E-07	mg/kg/day	2.0E-05	mg/kg/day	2.E-02
				Aroclor-1268	0.13953	mg/kg	1.1E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	2.E-08	6.6E-08	mg/kg/day	2.0E-05	mg/kg/day	3.E-03
				Endosulfan Sulfate	0.01269	mg/kg	NC		NC			6.0E-09	mg/kg/day	6.0E-03	mg/kg/day	1.E-06
				Technical Chlordane	0.73538	mg/kg	6.0E-08	mg/kg/day	3.5E-01	(mg/kg/day)-1	2.E-08	3.5E-07	mg/kg/day	5.0E-04	mg/kg/day	7.E-04
				Aluminum	21793	mg/kg	NC		NC			1.0E-02	mg/kg/day			
				Arsenic	12.2	mg/kg	9.9E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	1.E-06	5.8E-06	mg/kg/day	3.0E-04	mg/kg/day	2.E-02
				Chromium	291	mg/kg	NC		NC			1.4E-04	mg/kg/day	3.0E-03	mg/kg/day	5.E-02
				Copper	324	mg/kg	NC		NC			1.5E-04	mg/kg/day			
				Lead	591	mg/kg	4.8E-05	mg/kg/day	--			2.8E-04	mg/kg/day			
				Manganese	4126	mg/kg	NC		NC			2.0E-03	mg/kg/day	7.1E-02	mg/kg/day	3.E-02
				Mercury	0.811	mg/kg	NC		NC			3.9E-07	mg/kg/day	3.0E-04	mg/kg/day	1.E-03
				Molybdenum	87.7	mg/kg						4.2E-05	mg/kg/day	5.0E-03	mg/kg/day	8.E-03
				Nickel	387	mg/kg	NC		NC			1.8E-04	mg/kg/day	2.0E-02	mg/kg/day	9.E-03
				Thallium	0.585	mg/kg	NC		NC			2.8E-07	mg/kg/day	8.0E-05	mg/kg/day	3.E-03
				Vanadium	103	mg/kg	NC		NC			4.9E-05	mg/kg/day	1.0E-03	mg/kg/day	5.E-02
				Toxicity Equivalency (Dioxins/Furans)	0.000109	mg/kg	8.9E-12	mg/kg/day	1.5E+05	(mg/kg/day)-1	1.E-06	5.2E-11	mg/kg/day			
			EXPOSURE ROUTE TOTAL								6.E-06					2.E-01
			DERMAL	2-Methylnaphthalene	0.17022	mg/kg	NC		NC			1.0E-07	mg/kg/day	4.0E-03	mg/kg/day	3.E-05
				Acenaphthylene	0.49749	mg/kg	NC		NC			2.9E-07	mg/kg/day	6.0E-02	mg/kg/day	5.E-06
				Benzo(a)anthracene	3.41086	mg/kg	3.5E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	3.E-07	2.0E-06	mg/kg/day	3.0E-02	mg/kg/day	7.E-05
				Benzo(a)pyrene	3.41803	mg/kg	3.5E-07	mg/kg/day	7.3E+00	(mg/kg/day)-1	3.E-06	2.0E-06	mg/kg/day	3.0E-02	mg/kg/day	7.E-05
				Benzo(b)fluoranthene	4.28861	mg/kg	4.4E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	3.E-07	2.5E-06	mg/kg/day	3.0E-02	mg/kg/day	8.E-05
				Benzo(g,h,i)perylene	2.87139	mg/kg	NC		NC			1.7E-06	mg/kg/day	3.0E-02	mg/kg/day	6.E-05
				Dibenzo(a,h)anthracene	0.72851	mg/kg	7.4E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	5.E-07	4.3E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Indeno(1,2,3-cd)pyrene	3.0929	mg/kg	3.1E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-07	1.8E-06	mg/kg/day	3.0E-02	mg/kg/day	6.E-05
				Phenanthrene	5.30136	mg/kg	NC		NC			3.1E-06	mg/kg/day	3.0E-02	mg/kg/day	1.E-04
				alpha-Chlordane	0.03592	mg/kg	1.1E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	4.E-10	6.6E-09	mg/kg/day	5.0E-04	mg/kg/day	1.E-05
				Aroclor-1254	0.83872	mg/kg	9.2E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	2.E-07	5.4E-07	mg/kg/day	2.0E-05	mg/kg/day	3.E-02
				Aroclor-1268	0.13953	mg/kg	1.5E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	3.E-08	8.9E-08	mg/kg/day	2.0E-05	mg/kg/day	4.E-03
				Endosulfan Sulfate	0.01269	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				Technical Chlordane	0.73538	mg/kg	2.3E-08	mg/kg/day	3.5E-01	(mg/kg/day)-1	8.E-09	1.3E-07	mg/kg/day	5.0E-04	mg/kg/day	3.E-04
				Aluminum	21793	mg/kg	NC		NC							
				Arsenic	12.2	mg/kg	2.9E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	4.E-07	1.7E-06	mg/kg/day	3.0E-04	mg/kg/day	6.E-03
				Chromium	291	mg/kg	NC		NC					7.5E-05	mg/kg/day	
				Copper	324	mg/kg	NC		NC							
				Lead	591	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	4126	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Mercury	0.811	mg/kg	NC		NC					2.1E-05	mg/kg/day	
				Molybdenum	87.7	mg/kg								5.0E-03	mg/kg/day	
				Nickel	387	mg/kg	NC		NC					8.0E-04	mg/kg/day	
				Thallium	0.585	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	103	mg/kg	NC		NC					2.6E-03	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.000109	mg/kg	8.5E-14	mg/kg/day	1.5E+05	(mg/kg/day)-1	1.E-08	5.0E-13	mg/kg/day			
			EXPOSURE ROUTE TOTAL								5.E-06					4.E-02
		EXPOSURE POINT TOTAL									1.E-05					2.E-01
	EXPOSURE MEDIUM TOTAL										1.E-05					2.E-01
SOIL TOTAL											1.E-05					2.E-01
											TOTAL RECEPTOR RISK ACROSS ALL MEDIA	1.E-05		TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA		2.3.E-01

TABLE 7.5.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS -- REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS				NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

US EPA ARCHIVE DOCUMENT

TABLE 7.6.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE UNITS	CSF/UNIT RISK VALUE	CSF UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE UNITS	RfD/RfC (1) VALUE	RfD/RfC UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	INGESTION	2-Methylnaphthalene	0.17022	mg/kg	NC		NC			4.9E-07	mg/kg/day	4.0E-01	mg/kg/day	1.E-04
				Acenaphthylene	0.49749	mg/kg	NC		NC			1.4E-06	mg/kg/day	6.0E-02	mg/kg/day	2.E-05
				Benzo(a)anthracene	3.41086	mg/kg	8.3E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	6.E-07	9.7E-06	mg/kg/day	3.0E-02	mg/kg/day	3.E-04
				Benzo(a)pyrene	3.41803	mg/kg	8.3E-07	mg/kg/day	7.3E+00	(mg/kg/day)-1	6.E-06	9.7E-06	mg/kg/day	3.0E-02	mg/kg/day	3.E-04
				Benzo(b)fluoranthene	4.28861	mg/kg	1.0E-06	mg/kg/day	7.3E-01	(mg/kg/day)-1	8.E-07	1.2E-05	mg/kg/day	3.0E-02	mg/kg/day	4.E-04
				Benzo(g,h,i)perylene	2.87139	mg/kg	NC		NC			8.2E-06	mg/kg/day	3.0E-02	mg/kg/day	3.E-04
				Dibenzo(a,h)anthracene	0.72851	mg/kg	1.8E-07	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-06	2.1E-06	mg/kg/day	3.0E-02	mg/kg/day	7.E-05
				Indeno(1,2,3-cd)pyrene	3.0929	mg/kg	7.6E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	6.E-07	8.8E-06	mg/kg/day	3.0E-02	mg/kg/day	3.E-04
				Phenanthrene	5.30136	mg/kg	NC		NC			1.5E-05	mg/kg/day	3.0E-02	mg/kg/day	5.E-04
				alpha-Chlordane	0.03592	mg/kg	8.8E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-09	1.0E-07	mg/kg/day	5.0E-04	mg/kg/day	2.E-04
				Aroclor-1254	0.83872	mg/kg	2.0E-07	mg/kg/day	2.0E+00	(mg/kg/day)-1	4.E-07	2.4E-06	mg/kg/day	2.0E-05	mg/kg/day	1.E-01
				Aroclor-1268	0.13953	mg/kg	3.4E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	7.E-08	4.0E-07	mg/kg/day	2.0E-05	mg/kg/day	2.E-02
				Endosulfan Sulfate	0.01269	mg/kg	NC		NC			3.6E-08	mg/kg/day	6.0E-03	mg/kg/day	6.E-06
				Technical Chlordane	0.73538	mg/kg	1.8E-07	mg/kg/day	3.5E-01	(mg/kg/day)-1	6.E-08	2.1E-06	mg/kg/day	5.0E-04	mg/kg/day	4.E-03
				Aluminum	21793	mg/kg	NC		NC			6.2E-02	mg/kg/day			
				Arsenic	12.2	mg/kg	3.0E-06	mg/kg/day	1.5E+00	(mg/kg/day)-1	4.E-06	3.5E-05	mg/kg/day	3.0E-04	mg/kg/day	1.E-01
				Chromium	291	mg/kg	NC		NC			8.3E-04	mg/kg/day	3.0E-03	mg/kg/day	3.E-01
				Copper	324	mg/kg	NC		NC			9.2E-04	mg/kg/day			
				Lead	591	mg/kg	1.4E-04	mg/kg/day	-			1.7E-03	mg/kg/day			
				Manganese	4126	mg/kg	NC		NC			1.2E-02	mg/kg/day	7.1E-02	mg/kg/day	2.E-01
				Mercury	0.811	mg/kg	NC		NC			2.3E-06	mg/kg/day	3.0E-04	mg/kg/day	8.E-03
				Molybdenum	87.7	mg/kg						2.5E-04	mg/kg/day	5.0E-03	mg/kg/day	5.E-02
				Nickel	387	mg/kg	NC		NC			1.1E-03	mg/kg/day	2.0E-02	mg/kg/day	6.E-02
				Thallium	0.585	mg/kg	NC		NC			1.7E-06	mg/kg/day	8.0E-05	mg/kg/day	2.E-02
				Vanadium	103	mg/kg	NC		NC			2.9E-04	mg/kg/day	1.0E-03	mg/kg/day	3.E-01
				Toxicity Equivalency (Dioxins/Furans)	0.000109	mg/kg	2.7E-11	mg/kg/day	1.5E+05	(mg/kg/day)-1	4.E-06	3.1E-10	mg/kg/day			
			EXPOSURE ROUTE TOTAL								2.E-05					1.E+00
			DERMAL	2-Methylnaphthalene	0.17022	mg/kg	NC		NC			1.8E-07	mg/kg/day	4.0E-03	mg/kg/day	4.E-05
				Acenaphthylene	0.49749	mg/kg	NC		NC			5.2E-07	mg/kg/day	6.0E-02	mg/kg/day	9.E-06
				Benzo(a)anthracene	3.41086	mg/kg	3.0E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-07	3.5E-06	mg/kg/day	3.0E-02	mg/kg/day	1.E-04
				Benzo(a)pyrene	3.41803	mg/kg	3.0E-07	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-06	3.5E-06	mg/kg/day	3.0E-02	mg/kg/day	1.E-04
				Benzo(b)fluoranthene	4.28861	mg/kg	3.8E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	3.E-07	4.4E-06	mg/kg/day	3.0E-02	mg/kg/day	1.E-04
				Benzo(g,h,i)perylene	2.87139	mg/kg	NC		NC			3.0E-06	mg/kg/day	3.0E-02	mg/kg/day	1.E-04
				Dibenzo(a,h)anthracene	0.72851	mg/kg	6.5E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	5.E-07	7.6E-07	mg/kg/day	3.0E-02	mg/kg/day	3.E-05
				Indeno(1,2,3-cd)pyrene	3.0929	mg/kg	2.7E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-07	3.2E-06	mg/kg/day	3.0E-02	mg/kg/day	1.E-04
				Phenanthrene	5.30136	mg/kg	NC		NC			5.5E-06	mg/kg/day	3.0E-02	mg/kg/day	2.E-04
				alpha-Chlordane	0.03592	mg/kg	9.8E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-10	1.1E-08	mg/kg/day	5.0E-04	mg/kg/day	2.E-05
				Aroclor-1254	0.83872	mg/kg	8.0E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	2.E-07	9.4E-07	mg/kg/day	2.0E-05	mg/kg/day	5.E-02
				Aroclor-1268	0.13953	mg/kg	1.3E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	3.E-08	1.6E-07	mg/kg/day	2.0E-05	mg/kg/day	8.E-03
				Endosulfan Sulfate	0.01269	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				Technical Chlordane	0.73538	mg/kg	2.0E-08	mg/kg/day	3.5E-01	(mg/kg/day)-1	7.E-09	2.3E-07	mg/kg/day	5.0E-04	mg/kg/day	5.E-04
				Aluminum	21793	mg/kg	NC		NC							
				Arsenic	12.2	mg/kg	2.5E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	4.E-07	2.9E-06	mg/kg/day	3.0E-04	mg/kg/day	1.E-02
				Chromium	291	mg/kg	NC		NC					7.5E-05	mg/kg/day	
				Copper	324	mg/kg	NC		NC							
				Lead	591	mg/kg	0.0E+00	mg/kg/day	-							
				Manganese	4126	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Mercury	0.811	mg/kg	NC		NC					2.1E-05	mg/kg/day	
				Molybdenum	87.7	mg/kg								5.0E-03	mg/kg/day	
				Nickel	387	mg/kg	NC		NC					8.0E-04	mg/kg/day	
				Thallium	0.585	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	103	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.000109	mg/kg	7.5E-14	mg/kg/day	1.5E+05	(mg/kg/day)-1	1.E-08	8.7E-13	mg/kg/day			
			EXPOSURE ROUTE TOTAL								4.E-06					7.E-02
		EXPOSURE POINT TOTAL									2.E-05					1.E+00
	EXPOSURE MEDIUM TOTAL										2.E-05					1.E+00
SOIL TOTAL											2.E-05					1.E+00
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	2.E-05			TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA		1.2.E+00

TABLE 7.6.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.1.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	CSF/UNIT RISK VALUE	CSF/UNIT RISK UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	RfD/RfC (1) VALUE	RfD/RfC (1) UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	OXBOW AREA	INGESTION	a-chlordane	0.00298	mg/kg	1.3E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	5.E-12	2.3E-10	mg/kg/day	5.0E-04	mg/kg/day	5.E-07
				dieldrin	0.023106667	mg/kg	1.0E-10	mg/kg/day	1.6E+01	(mg/kg/day)-1	2.E-09	1.8E-09	mg/kg/day	5.0E-05	mg/kg/day	4.E-05
				endosulfan II	0.001183333	mg/kg	NC		NC			9.0E-11	mg/kg/day	6.0E-03	mg/kg/day	2.E-08
				endrin aldehyde	0.003841667	mg/kg	NC		NC			2.9E-10	mg/kg/day	3.0E-04	mg/kg/day	1.E-06
				endrin ketone	0.000636667	mg/kg	NC		NC			4.9E-11	mg/kg/day	3.0E-04	mg/kg/day	2.E-07
				g-chlordane	0.003983333	mg/kg	1.7E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	6.E-12	3.0E-10	mg/kg/day	5.0E-04	mg/kg/day	6.E-07
				Technical Chlordane	0.016126667	mg/kg	7.0E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	2.E-11	1.2E-09	mg/kg/day	5.0E-04	mg/kg/day	2.E-06
				Aroclor 1254	1.40987	mg/kg	6.1E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	1.E-08	1.1E-07	mg/kg/day	2.0E-05	mg/kg/day	5.E-03
				Antimony	3.0255	mg/kg	NC		NC			2.3E-07	mg/kg/day	4.0E-04	mg/kg/day	6.E-04
				Arsenic	5.39	mg/kg	2.4E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	4.E-08	4.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.E-03
				Cadmium	4.02	mg/kg	NC		NC			3.1E-07	mg/kg/day	1.0E-03	mg/kg/day	3.E-04
				Copper	121.025	mg/kg	NC		NC			9.2E-06	mg/kg/day			
				Lead	574.85	mg/kg	2.5E-06	mg/kg/day	--			4.4E-05	mg/kg/day			
				Manganese	826	mg/kg	NC		NC			6.3E-05	mg/kg/day	7.1E-02	mg/kg/day	9.E-04
				Thallium	0.71575	mg/kg	NC		NC			5.5E-08	mg/kg/day	8.0E-05	mg/kg/day	7.E-04
				Vanadium	59.3	mg/kg	NC		NC			4.5E-06	mg/kg/day	1.0E-03	mg/kg/day	5.E-03
				Toxicity Equivalency (Dioxins/Furans)	0.001808571	mg/kg	7.9E-12	mg/kg/day	1.5E+05	(mg/kg/day)-1	1.E-06	1.4E-10	mg/kg/day			
			EXPOSURE ROUTE TOTAL								1.E-06					1.E-02
			DERMAL	a-chlordane	0.00298	mg/kg	5.9E-13	mg/kg/day	3.5E-01	(mg/kg/day)-1	2.E-13	1.0E-11	mg/kg/day	5.0E-04	mg/kg/day	2.E-08
				dieldrin	0.023106667	mg/kg	0.0E+00	mg/kg/day	1.6E+01	(mg/kg/day)-1	0.E+00			5.0E-05	mg/kg/day	
				endosulfan II	0.001183333	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				endrin aldehyde	0.003841667	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				endrin ketone	0.000636667	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				g-chlordane	0.003983333	mg/kg	7.9E-13	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-13	1.4E-11	mg/kg/day	5.0E-04	mg/kg/day	3.E-08
				Technical Chlordane	0.016126667	mg/kg	3.2E-12	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-12	5.6E-11	mg/kg/day	5.0E-04	mg/kg/day	1.E-07
				Aroclor 1254	1.40987	mg/kg	9.8E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	2.E-09	1.7E-08	mg/kg/day	2.0E-05	mg/kg/day	9.E-04
				Antimony	3.0255	mg/kg	NC		NC					6.0E-05	mg/kg/day	
				Arsenic	5.39	mg/kg	8.0E-10	mg/kg/day	1.5E+00	(mg/kg/day)-1	1.E-09	1.4E-08	mg/kg/day	3.0E-04	mg/kg/day	5.E-05
				Cadmium	4.02	mg/kg	NC		NC			3.5E-10	mg/kg/day	2.5E-05	mg/kg/day	1.E-05
				Copper	121.025	mg/kg	NC		NC							
				Lead	574.85	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	826	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Thallium	0.71575	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	59.3	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.001808571	mg/kg	2.7E-13	mg/kg/day	1.5E+05	(mg/kg/day)-1	4.E-08	4.7E-12	mg/kg/day			
			EXPOSURE ROUTE TOTAL								4.E-08					9.E-04
		EXPOSURE POINT TOTAL									1.E-06					1.E-02
	EXPOSURE MEDIUM TOTAL										1.E-06					1.E-02
SOIL TOTAL											1.E-06					1.E-02
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	1.E-06			TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA		1.5.E-02

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not avalailable from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.2.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS – CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	CSF/UNIT RISK VALUE	CSF/UNIT RISK UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	RfD/RfC (1) VALUE	RfD/RfC (1) UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	OXBOW AREA	INGESTION	a-chlordane	0.00298	mg/kg	1.5E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	5.E-12	3.5E-10	mg/kg/day	5.0E-04	mg/kg/day	7.E-07
				dieldrin	0.023106667	mg/kg	1.2E-10	mg/kg/day	1.6E+01	(mg/kg/day)-1	2.E-09	2.7E-09	mg/kg/day	5.0E-05	mg/kg/day	5.E-05
				endosulfan II	0.001183333	mg/kg	NC		NC			1.4E-10	mg/kg/day	6.0E-03	mg/kg/day	2.E-08
				endrin aldehyde	0.003841667	mg/kg	NC		NC			4.6E-10	mg/kg/day	3.0E-04	mg/kg/day	2.E-06
				endrin ketone	0.000636667	mg/kg	NC		NC			7.6E-11	mg/kg/day	3.0E-04	mg/kg/day	3.E-07
				g-chlordane	0.003983333	mg/kg	2.0E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	7.E-12	4.7E-10	mg/kg/day	5.0E-04	mg/kg/day	9.E-07
				Technical Chlordane	0.016126667	mg/kg	8.2E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-11	1.9E-09	mg/kg/day	5.0E-04	mg/kg/day	4.E-06
				Aroclor 1254	1.40987	mg/kg	7.2E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	1.E-08	1.7E-07	mg/kg/day	2.0E-05	mg/kg/day	8.E-03
				Antimony	3.0255	mg/kg	NC		NC			3.6E-07	mg/kg/day	4.0E-04	mg/kg/day	9.E-04
				Arsenic	5.39	mg/kg	2.7E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	4.E-08	6.4E-07	mg/kg/day	3.0E-04	mg/kg/day	2.E-03
				Cadmium	4.02	mg/kg	NC		NC			4.8E-07	mg/kg/day	1.0E-03	mg/kg/day	5.E-04
				Copper	121.025	mg/kg	NC		NC			1.4E-05	mg/kg/day			
				Lead	574.85	mg/kg	2.9E-06	mg/kg/day	--			6.8E-05	mg/kg/day			
				Manganese	826	mg/kg	NC		NC			9.8E-05	mg/kg/day	7.1E-02	mg/kg/day	1.E-03
				Thallium	0.71575	mg/kg	NC		NC			8.5E-08	mg/kg/day	8.0E-05	mg/kg/day	1.E-03
				Vanadium	59.3	mg/kg	NC		NC			7.0E-06	mg/kg/day	1.0E-03	mg/kg/day	7.E-03
				Toxicity Equivalency (Dioxins/Furans)	0.001808571	mg/kg	9.2E-12	mg/kg/day	1.5E+05	(mg/kg/day)-1	1.E-06	2.1E-10	mg/kg/day			
			EXPOSURE ROUTE TOTAL								1.E-06					2.E-02
			DERMAL	a-chlordane	0.00298	mg/kg	2.3E-12	mg/kg/day	3.5E-01	(mg/kg/day)-1	8.E-13	5.4E-11	mg/kg/day	5.0E-04	mg/kg/day	1.E-07
				dieldrin	0.023106667	mg/kg	0.0E+00	mg/kg/day	1.6E+01	(mg/kg/day)-1	0.E+00			5.0E-05	mg/kg/day	
				endosulfan II	0.001183333	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				endrin aldehyde	0.003841667	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				endrin ketone	0.000636667	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				g-chlordane	0.003983333	mg/kg	3.1E-12	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-12	7.3E-11	mg/kg/day	5.0E-04	mg/kg/day	1.E-07
				Technical Chlordane	0.016126667	mg/kg	1.3E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	4.E-12	2.9E-10	mg/kg/day	5.0E-04	mg/kg/day	6.E-07
				Aroclor 1254	1.40987	mg/kg	3.9E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	8.E-09	9.0E-08	mg/kg/day	2.0E-05	mg/kg/day	4.E-03
				Antimony	3.0255	mg/kg	NC		NC					6.0E-05	mg/kg/day	
				Arsenic	5.39	mg/kg	3.2E-09	mg/kg/day	1.5E+00	(mg/kg/day)-1	5.E-09	7.4E-08	mg/kg/day	3.0E-04	mg/kg/day	2.E-04
				Cadmium	4.02	mg/kg	NC		NC			1.8E-09	mg/kg/day	2.5E-05	mg/kg/day	7.E-05
				Copper	121.025	mg/kg	NC		NC							
				Lead	574.85	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	826	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Thallium	0.71575	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	59.3	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.001808571	mg/kg	1.1E-12	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-07	2.5E-11	mg/kg/day			
			EXPOSURE ROUTE TOTAL								2.E-07					5.E-03
		EXPOSURE POINT TOTAL									2.E-06					3.E-02
	EXPOSURE MEDIUM TOTAL										2.E-06					3.E-02
SOIL TOTAL											2.E-06					3.E-02
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	2.E-06			TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA		2.6.E-02

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not avalailable from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.3.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	CSF/UNIT RISK VALUE	CSF/UNIT RISK UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	RfD/RfC (1) VALUE	RfD/RfC (1) UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	OXBOW AREA	INGESTION	a-chlordane	0.00298	mg/kg	6.1E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	2.E-11	2.1E-09	mg/kg/day	5.0E-04	mg/kg/day	4.E-06
				dieldrin	0.023106667	mg/kg	4.7E-10	mg/kg/day	1.6E+01	(mg/kg/day)-1	8.E-09	1.6E-08	mg/kg/day	5.0E-05	mg/kg/day	3.E-04
				endosulfan II	0.001183333	mg/kg	NC		NC			8.4E-10	mg/kg/day	6.0E-03	mg/kg/day	1.E-07
				endrin aldehyde	0.003841667	mg/kg	NC		NC			2.7E-09	mg/kg/day	3.0E-04	mg/kg/day	9.E-06
				endrin ketone	0.000636667	mg/kg	NC		NC			4.5E-10	mg/kg/day	3.0E-04	mg/kg/day	2.E-06
				g-chlordane	0.003983333	mg/kg	8.1E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-11	2.8E-09	mg/kg/day	5.0E-04	mg/kg/day	6.E-06
				Technical Chlordane	0.016126667	mg/kg	3.3E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-10	1.1E-08	mg/kg/day	5.0E-04	mg/kg/day	2.E-05
				Aroclor 1254	1.40987	mg/kg	2.9E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	6.E-08	1.0E-06	mg/kg/day	2.0E-05	mg/kg/day	5.E-02
				Antimony	3.0255	mg/kg	NC		NC			2.2E-06	mg/kg/day	4.0E-04	mg/kg/day	5.E-03
				Arsenic	5.39	mg/kg	1.1E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	2.E-07	3.8E-06	mg/kg/day	3.0E-04	mg/kg/day	1.E-02
				Cadmium	4.02	mg/kg	NC		NC			2.9E-06	mg/kg/day	1.0E-03	mg/kg/day	3.E-03
				Copper	121.025	mg/kg	NC		NC			8.6E-05	mg/kg/day			
				Lead	574.85	mg/kg	1.2E-05	mg/kg/day	--			4.1E-04	mg/kg/day			
				Manganese	826	mg/kg	NC		NC			5.9E-04	mg/kg/day	7.1E-02	mg/kg/day	8.E-03
				Thallium	0.71575	mg/kg	NC		NC			5.1E-07	mg/kg/day	8.0E-05	mg/kg/day	6.E-03
				Vanadium	59.3	mg/kg	NC		NC			4.2E-05	mg/kg/day	1.0E-03	mg/kg/day	4.E-02
				Toxicity Equivalency (Dioxins/Furans)	0.001808571	mg/kg	3.7E-11	mg/kg/day	1.5E+05	(mg/kg/day)-1	6.E-06	1.3E-09	mg/kg/day			
			EXPOSURE ROUTE TOTAL								6.E-06					1.E-01
			DERMAL	a-chlordane	0.00298	mg/kg	2.7E-12	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-12	9.5E-11	mg/kg/day	5.0E-04	mg/kg/day	2.E-07
				dieldrin	0.023106667	mg/kg	0.0E+00	mg/kg/day	1.6E+01	(mg/kg/day)-1	0.E+00			5.0E-05	mg/kg/day	
				endosulfan II	0.001183333	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				endrin aldehyde	0.003841667	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				endrin ketone	0.000636667	mg/kg	NC		NC					3.0E-04	mg/kg/day	
				g-chlordane	0.003983333	mg/kg	3.6E-12	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-12	1.3E-10	mg/kg/day	5.0E-04	mg/kg/day	3.E-07
				Technical Chlordane	0.016126667	mg/kg	1.5E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	5.E-12	5.1E-10	mg/kg/day	5.0E-04	mg/kg/day	1.E-06
				Aroclor 1254	1.40987	mg/kg	4.5E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	9.E-09	1.6E-07	mg/kg/day	2.0E-05	mg/kg/day	8.E-03
				Antimony	3.0255	mg/kg	NC		NC					6.0E-05	mg/kg/day	
				Arsenic	5.39	mg/kg	3.7E-09	mg/kg/day	1.5E+00	(mg/kg/day)-1	6.E-09	1.3E-07	mg/kg/day	3.0E-04	mg/kg/day	4.E-04
				Cadmium	4.02	mg/kg	NC		NC			3.2E-09	mg/kg/day	2.5E-05	mg/kg/day	1.E-04
				Copper	121.025	mg/kg	NC		NC							
				Lead	574.85	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	826	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Thallium	0.71575	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	59.3	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.001808571	mg/kg	1.2E-12	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-07	4.3E-11	mg/kg/day			
			EXPOSURE ROUTE TOTAL								2.E-07					8.E-03
		EXPOSURE POINT TOTAL									6.E-06					1.E-01
	EXPOSURE MEDIUM TOTAL										6.E-06					1.E-01
SOIL TOTAL											*6.E-06*					*1.E-01*
											TOTAL RECEPTOR RISK ACROSS ALL MEDIA					TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA
											6.E-06					1.4.E-01

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.4.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	CSF/UNIT RISK VALUE	CSF/UNIT RISK UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	RfD/RfC (1) VALUE	RfD/RfC (1) UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	INGESTION	2-Methylnaphthalene	0.1071	mg/kg	NC		NC			8.2E-09	mg/kg/day	4.0E-03	mg/kg/day	2.E-06
				Acenaphthylene	0.31765	mg/kg	NC		NC			2.4E-08	mg/kg/day	6.0E-02	mg/kg/day	4.E-07
				Benzo(a)anthracene	3.0937225	mg/kg	1.3E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-08	2.4E-07	mg/kg/day	3.0E-02	mg/kg/day	8.E-06
				Benzo(a)pyrene	3.0771775	mg/kg	1.3E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-07	2.3E-07	mg/kg/day	3.0E-02	mg/kg/day	8.E-06
				Benzo(b)fluoranthene	3.45207	mg/kg	1.5E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-08	2.6E-07	mg/kg/day	3.0E-02	mg/kg/day	9.E-06
				Benzo(g,h,i)perylene	2.33603	mg/kg	NC		NC			1.8E-07	mg/kg/day	3.0E-02	mg/kg/day	6.E-06
				Dibenzo(a,h)anthracene	0.6148475	mg/kg	2.7E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-08	4.7E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Indeno(1,2,3-cd)pyrene	2.51886	mg/kg	1.1E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	8.E-09	1.9E-07	mg/kg/day	3.0E-02	mg/kg/day	6.E-06
				Phenanthrene	3.955425	mg/kg	NC		NC			3.0E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				alpha-Chlordane	0.0177975	mg/kg	7.8E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-11	1.4E-09	mg/kg/day	5.0E-04	mg/kg/day	3.E-06
				Aroclor-1254	0.5199825	mg/kg	2.3E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	5.E-09	4.0E-08	mg/kg/day	2.0E-05	mg/kg/day	2.E-03
				Aroclor-1268	0.083885	mg/kg	3.7E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	7.E-10	6.4E-09	mg/kg/day	2.0E-05	mg/kg/day	3.E-04
				Endosulfan Sulfate	0.00650125	mg/kg	NC		NC			5.0E-10	mg/kg/day	6.0E-03	mg/kg/day	8.E-08
				Technical Chlordane	0.4307	mg/kg	1.9E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	7.E-10	3.3E-08	mg/kg/day	5.0E-04	mg/kg/day	7.E-05
				Aluminum	15898.75	mg/kg	NC		NC			1.2E-03	mg/kg/day			
				Arsenic	7.715	mg/kg	3.4E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	5.E-08	5.9E-07	mg/kg/day	3.0E-04	mg/kg/day	2.E-03
				Chromium	230.5	mg/kg	NC		NC			1.8E-05	mg/kg/day	3.0E-03	mg/kg/day	6.E-03
				Copper	205	mg/kg	NC		NC			1.6E-05	mg/kg/day			
				Lead	450	mg/kg	2.0E-06	mg/kg/day	--			3.4E-05	mg/kg/day			
				Manganese	1840.5	mg/kg	NC		NC			1.4E-04	mg/kg/day	7.1E-02	mg/kg/day	2.E-03
				Mercury	0.58175	mg/kg	NC		NC			4.4E-08	mg/kg/day	3.0E-04	mg/kg/day	1.E-04
				Molybdenum	54.025	mg/kg						4.1E-06	mg/kg/day	5.0E-03	mg/kg/day	8.E-04
				Nickel	119.725	mg/kg	NC		NC			9.1E-06	mg/kg/day	2.0E-02	mg/kg/day	5.E-04
				Thallium	0.4605	mg/kg	NC		NC			3.5E-08	mg/kg/day	8.0E-05	mg/kg/day	4.E-04
				Vanadium	82.25	mg/kg	NC		NC			6.3E-06	mg/kg/day	1.0E-03	mg/kg/day	6.E-03
				Toxicity Equivalency (Dioxins/Furans)	0.00005495	mg/kg	2.4E-13	mg/kg/day	1.5E+05	(mg/kg/day)-1	4.E-08	4.2E-12	mg/kg/day			
			EXPOSURE ROUTE TOTAL								2.E-07					2.E-02
			DERMAL	2-Methylnaphthalene	0.1071	mg/kg	NC		NC			1.2E-09	mg/kg/day	4.0E-03	mg/kg/day	3.E-07
				Acenaphthylene	0.31765	mg/kg	NC		NC			3.6E-09	mg/kg/day	6.0E-02	mg/kg/day	6.E-08
				Benzo(a)anthracene	3.0937225	mg/kg	2.0E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-09	3.5E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(a)pyrene	3.0771775	mg/kg	2.0E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-08	3.5E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(b)fluoranthene	3.45207	mg/kg	2.2E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-09	3.9E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(g,h,i)perylene	2.33603	mg/kg	NC		NC			2.6E-08	mg/kg/day	3.0E-02	mg/kg/day	9.E-07
				Dibenzo(a,h)anthracene	0.6148475	mg/kg	4.0E-10	mg/kg/day	7.3E+00	(mg/kg/day)-1	3.E-09	7.0E-09	mg/kg/day	3.0E-02	mg/kg/day	2.E-07
				Indeno(1,2,3-cd)pyrene	2.51886	mg/kg	1.6E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-09	2.8E-08	mg/kg/day	3.0E-02	mg/kg/day	9.E-07
				Phenanthrene	3.955425	mg/kg	NC		NC			4.5E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				alpha-Chlordane	0.0177975	mg/kg	3.5E-12	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-12	6.2E-11	mg/kg/day	5.0E-04	mg/kg/day	1.E-07
				Aroclor-1254	0.5199825	mg/kg	3.6E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	7.E-10	6.3E-09	mg/kg/day	2.0E-05	mg/kg/day	3.E-04
				Aroclor-1268	0.083885	mg/kg	5.8E-11	mg/kg/day	2.0E+00	(mg/kg/day)-1	1.E-10	1.0E-09	mg/kg/day	2.0E-05	mg/kg/day	5.E-05
				Endosulfan Sulfate	0.00650125	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				Technical Chlordane	0.4307	mg/kg	8.6E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-11	1.5E-09	mg/kg/day	5.0E-04	mg/kg/day	3.E-06
				Aluminum	15898.75	mg/kg	NC		NC							
				Arsenic	7.715	mg/kg	1.2E-09	mg/kg/day	1.5E+00	(mg/kg/day)-1	2.E-09	2.0E-08	mg/kg/day	3.0E-04	mg/kg/day	7.E-05
				Chromium	230.5	mg/kg	NC		NC					7.5E-05	mg/kg/day	
				Copper	205	mg/kg	NC		NC							
				Lead	450	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	1840.5	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Mercury	0.58175	mg/kg	NC		NC					2.1E-05	mg/kg/day	
				Molybdenum	54.025	mg/kg								5.0E-03	mg/kg/day	
				Nickel	119.725	mg/kg	NC		NC					8.0E-04	mg/kg/day	
				Thallium	0.4605	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	82.25	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.00005495	mg/kg	2.7E-16	mg/kg/day	1.5E+05	(mg/kg/day)-1	4.E-11	4.8E-15	mg/kg/day			
			EXPOSURE ROUTE TOTAL								2.E-08					4.E-04
		EXPOSURE POINT TOTAL									3.E-07					2.E-02
	EXPOSURE MEDIUM TOTAL										3.E-07					2.E-02
SOIL TOTAL											3.E-07					2.E-02
											TOTAL RECEPTOR RISK ACROSS ALL MEDIA	3.E-07		TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA		2.1.E-02	

TABLE 7.4.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS				NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.5.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS -- CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE UNITS	CSF/UNIT RISK VALUE	CSF UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE UNITS	RfD/RfC (1) VALUE	RfD/RfC UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	INGESTION	2-Methylnaphthalene	0.1071	mg/kg	NC		NC			1.3E-08	mg/kg/day	4.0E-03	mg/kg/day	3.E-06
				Acenaphthylene	0.31765	mg/kg	NC		NC			3.8E-08	mg/kg/day	6.0E-02	mg/kg/day	6.E-07
				Benzo(a)anthracene	3.0937225	mg/kg	1.6E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-08	3.7E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Benzo(a)pyrene	3.0771775	mg/kg	1.6E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-07	3.7E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Benzo(b)fluoranthene	3.45207	mg/kg	1.8E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-08	4.1E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Benzo(g,h,i)perylene	2.33603	mg/kg	NC		NC			2.8E-07	mg/kg/day	3.0E-02	mg/kg/day	9.E-06
				Dibenzo(a,h)anthracene	0.6148475	mg/kg	3.1E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-08	7.3E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Indeno(1,2,3-cd)pyrene	2.51886	mg/kg	1.3E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	9.E-09	3.0E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Phenanthrene	3.955425	mg/kg	NC		NC			4.7E-07	mg/kg/day	3.0E-02	mg/kg/day	2.E-05
				alpha-Chlordane	0.0177975	mg/kg	9.1E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-11	2.1E-09	mg/kg/day	5.0E-04	mg/kg/day	4.E-06
				Aroclor-1254	0.5199825	mg/kg	2.6E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	5.E-09	6.2E-08	mg/kg/day	2.0E-05	mg/kg/day	3.E-03
				Aroclor-1268	0.083885	mg/kg	4.3E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	9.E-10	1.0E-08	mg/kg/day	2.0E-05	mg/kg/day	5.E-04
				Endosulfan Sulfate	0.00650125	mg/kg	NC		NC			7.7E-10	mg/kg/day	6.0E-03	mg/kg/day	1.E-07
				Technical Chlordane	0.4307	mg/kg	2.2E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	8.E-10	5.1E-08	mg/kg/day	5.0E-04	mg/kg/day	1.E-04
				Aluminum	15898.75	mg/kg	NC		NC			1.9E-03	mg/kg/day			
				Arsenic	7.715	mg/kg	3.9E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	6.E-08	9.2E-07	mg/kg/day	3.0E-04	mg/kg/day	3.E-03
				Chromium	230.5	mg/kg	NC		NC			2.7E-05	mg/kg/day	3.0E-03	mg/kg/day	9.E-03
				Copper	205	mg/kg	NC		NC			2.4E-05	mg/kg/day			
				Lead	450	mg/kg	2.3E-06	mg/kg/day	--			5.3E-05	mg/kg/day			
				Manganese	1840.5	mg/kg	NC		NC			2.2E-04	mg/kg/day	7.1E-02	mg/kg/day	3.E-03
				Mercury	0.58175	mg/kg	NC		NC			6.9E-08	mg/kg/day	3.0E-04	mg/kg/day	2.E-04
				Molybdenum	54.025	mg/kg						6.4E-06	mg/kg/day	5.0E-03	mg/kg/day	1.E-03
				Nickel	119.725	mg/kg	NC		NC			1.4E-05	mg/kg/day	2.0E-02	mg/kg/day	7.E-04
				Thallium	0.4605	mg/kg	NC		NC			5.5E-08	mg/kg/day	8.0E-05	mg/kg/day	7.E-04
				Vanadium	82.25	mg/kg	NC		NC			9.8E-06	mg/kg/day	1.0E-03	mg/kg/day	1.E-02
				Toxicity Equivalency (Dioxins/Furans)	0.00005495	mg/kg	2.8E-13	mg/kg/day	1.5E+05	(mg/kg/day)-1	4.E-08	6.5E-12	mg/kg/day			
			EXPOSURE ROUTE TOTAL								3.E-07					3.E-02
			DERMAL	2-Methylnaphthalene	0.1071	mg/kg	NC		NC			6.3E-09	mg/kg/day	4.0E-03	mg/kg/day	2.E-06
				Acenaphthylene	0.31765	mg/kg	NC		NC			1.9E-08	mg/kg/day	6.0E-02	mg/kg/day	3.E-07
				Benzo(a)anthracene	3.0937225	mg/kg	7.9E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	6.E-09	1.8E-07	mg/kg/day	3.0E-02	mg/kg/day	6.E-06
				Benzo(a)pyrene	3.0771775	mg/kg	7.8E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	6.E-08	1.8E-07	mg/kg/day	3.0E-02	mg/kg/day	6.E-06
				Benzo(b)fluoranthene	3.45207	mg/kg	8.8E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	6.E-09	2.0E-07	mg/kg/day	3.0E-02	mg/kg/day	7.E-06
				Benzo(g,h,i)perylene	2.33603	mg/kg	NC		NC			1.4E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Dibenzo(a,h)anthracene	0.6148475	mg/kg	1.6E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-08	3.6E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Indeno(1,2,3-cd)pyrene	2.51886	mg/kg	6.4E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-09	1.5E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Phenanthrene	3.955425	mg/kg	NC		NC			2.3E-07	mg/kg/day	3.0E-02	mg/kg/day	8.E-06
				alpha-Chlordane	0.0177975	mg/kg	1.4E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	5.E-12	3.2E-10	mg/kg/day	5.0E-04	mg/kg/day	6.E-07
				Aroclor-1254	0.5199825	mg/kg	1.4E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	3.E-09	3.3E-08	mg/kg/day	2.0E-05	mg/kg/day	2.E-03
				Aroclor-1268	0.083885	mg/kg	2.3E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	5.E-10	5.4E-09	mg/kg/day	2.0E-05	mg/kg/day	3.E-04
				Endosulfan Sulfate	0.00650125	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				Technical Chlordane	0.4307	mg/kg	3.4E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-10	7.9E-09	mg/kg/day	5.0E-04	mg/kg/day	2.E-05
				Aluminum	15898.75	mg/kg	NC		NC							
				Arsenic	7.715	mg/kg	4.5E-09	mg/kg/day	1.5E+00	(mg/kg/day)-1	7.E-09	1.1E-07	mg/kg/day	3.0E-04	mg/kg/day	4.E-04
				Chromium	230.5	mg/kg	NC		NC					7.5E-05	mg/kg/day	
				Copper	205	mg/kg	NC		NC							
				Lead	450	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	1840.5	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Mercury	0.58175	mg/kg	NC		NC					2.1E-05	mg/kg/day	
				Molybdenum	54.025	mg/kg								5.0E-03	mg/kg/day	
				Nickel	119.725	mg/kg	NC		NC					8.0E-04	mg/kg/day	
				Thallium	0.4605	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	82.25	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.00005495	mg/kg	1.1E-15	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-10	2.5E-14	mg/kg/day			
			EXPOSURE ROUTE TOTAL								1.E-07					2.E-03
		EXPOSURE POINT TOTAL									4.E-07					3.E-02
	EXPOSURE MEDIUM TOTAL										4.E-07					3.E-02
SOIL TOTAL											4.E-07					3.E-02
									TOTAL RECEPTOR RISK ACROSS ALL MEDIA		4.E-07	TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA				3.4.E-02

TABLE 7.5.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS -- CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 7.6.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC VALUE	EPC UNITS	CANCER RISK CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	CSF/UNIT RISK VALUE	CSF/UNIT RISK UNITS	CANCER RISK	NON-CANCER HAZARD CALCULATIONS: INTAKE/EXPOSURE CONCENTRATION VALUE	INTAKE/EXPOSURE CONCENTRATION UNITS	RfD/RfC (1) VALUE	RfD/RfC (1) UNITS	HAZARD QUOTIENT
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	INGESTION	2-Methylnaphthalene	0.1071	mg/kg	NC		NC			7.6E-08	mg/kg/day	4.0E-03	mg/kg/day	2.E-05
				Acenaphthylene	0.31765	mg/kg	NC		NC			2.3E-07	mg/kg/day	6.0E-02	mg/kg/day	4.E-06
				Benzo(a)anthracene	3.0937225	mg/kg	6.3E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-08	2.2E-06	mg/kg/day	3.0E-02	mg/kg/day	7.E-05
				Benzo(a)pyrene	3.0771775	mg/kg	6.3E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	5.E-07	2.2E-06	mg/kg/day	3.0E-02	mg/kg/day	7.E-05
				Benzo(b)fluoranthene	3.45207	mg/kg	7.0E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-08	2.5E-06	mg/kg/day	3.0E-02	mg/kg/day	8.E-05
				Benzo(g,h,i)perylene	2.33603	mg/kg	NC		NC			1.7E-06	mg/kg/day	3.0E-02	mg/kg/day	6.E-05
				Dibenzo(a,h)anthracene	0.6148475	mg/kg	1.3E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	9.E-08	4.4E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Indeno(1,2,3-cd)pyrene	2.51886	mg/kg	5.1E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	4.E-08	1.8E-06	mg/kg/day	3.0E-02	mg/kg/day	6.E-05
				Phenanthrene	3.955425	mg/kg	NC		NC			2.8E-06	mg/kg/day	3.0E-02	mg/kg/day	9.E-05
				alpha-Chlordane	0.0177975	mg/kg	3.6E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-10	1.3E-08	mg/kg/day	5.0E-04	mg/kg/day	3.E-05
				Aroclor-1254	0.5199825	mg/kg	1.1E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	2.E-08	3.7E-07	mg/kg/day	2.0E-05	mg/kg/day	2.E-02
				Aroclor-1268	0.083885	mg/kg	1.7E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	3.E-09	6.0E-08	mg/kg/day	2.0E-05	mg/kg/day	3.E-03
				Endosulfan Sulfate	0.00650125	mg/kg	NC		NC			4.6E-09	mg/kg/day	6.0E-03	mg/kg/day	8.E-07
				Technical Chlordane	0.4307	mg/kg	8.8E-09	mg/kg/day	3.5E-01	(mg/kg/day)-1	3.E-09	3.1E-07	mg/kg/day	5.0E-04	mg/kg/day	6.E-04
				Aluminum	*15898.75*	*mg/kg*	*NC*		*NC*			*1.1E-02*	*mg/kg/day*			
				Arsenic	7.715	mg/kg	1.6E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	2.E-07	5.5E-06	mg/kg/day	3.0E-04	mg/kg/day	2.E-02
				Chromium	230.5	mg/kg	NC		NC			1.6E-04	mg/kg/day	3.0E-03	mg/kg/day	5.E-02
				Copper	205	mg/kg	NC		NC			1.5E-04	mg/kg/day			
				Lead	450	mg/kg	9.2E-06	mg/kg/day	--			3.2E-04	mg/kg/day			
				Manganese	*1840.5*	*mg/kg*	NC		NC			1.3E-03	mg/kg/day	7.1E-02	mg/kg/day	2.E-02
				Mercury	0.58175	mg/kg	NC		NC			4.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.E-03
				Molybdenum	*54.025*	*mg/kg*						*3.8E-05*	*mg/kg/day*	*5.0E-03*	*mg/kg/day*	*8.E-03*
				Nickel	119.725	mg/kg	NC		NC			8.5E-05	mg/kg/day	2.0E-02	mg/kg/day	4.E-03
				Thallium	0.4605	mg/kg	NC		NC			3.3E-07	mg/kg/day	8.0E-05	mg/kg/day	4.E-03
				Vanadium	82.25	mg/kg	NC		NC			5.9E-05	mg/kg/day	1.0E-03	mg/kg/day	6.E-02
				Toxicity Equivalency (Dioxins/Furans)	0.00005495	mg/kg	1.1E-12	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-07	3.9E-11	mg/kg/day			
			EXPOSURE ROUTE TOTAL								1.E-06					2.E-01
			DERMAL	2-Methylnaphthalene	0.1071	mg/kg	NC		NC			1.1E-08	mg/kg/day	4.0E-03	mg/kg/day	3.E-06
				Acenaphthylene	0.31765	mg/kg	NC		NC			3.3E-08	mg/kg/day	6.0E-02	mg/kg/day	5.E-07
				Benzo(a)anthracene	3.0937225	mg/kg	9.2E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	7.E-09	3.2E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Benzo(a)pyrene	3.0771775	mg/kg	9.1E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	7.E-08	3.2E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Benzo(b)fluoranthene	3.45207	mg/kg	1.0E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	7.E-09	3.6E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Benzo(g,h,i)perylene	2.33603	mg/kg	NC		NC			2.4E-07	mg/kg/day	3.0E-02	mg/kg/day	8.E-06
				Dibenzo(a,h)anthracene	0.6148475	mg/kg	1.8E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-08	6.4E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Indeno(1,2,3-cd)pyrene	2.51886	mg/kg	7.5E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-09	2.6E-07	mg/kg/day	3.0E-02	mg/kg/day	9.E-06
				Phenanthrene	3.955425	mg/kg	NC		NC			4.1E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				alpha-Chlordane	0.0177975	mg/kg	1.6E-11	mg/kg/day	3.5E-01	(mg/kg/day)-1	6.E-12	5.7E-10	mg/kg/day	5.0E-04	mg/kg/day	1.E-06
				Aroclor-1254	0.5199825	mg/kg	1.7E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	3.E-09	5.8E-08	mg/kg/day	2.0E-05	mg/kg/day	3.E-03
				Aroclor-1268	0.083885	mg/kg	2.7E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	5.E-10	9.4E-09	mg/kg/day	2.0E-05	mg/kg/day	5.E-04
				Endosulfan Sulfate	0.00650125	mg/kg	NC		NC					6.0E-03	mg/kg/day	
				Technical Chlordane	0.4307	mg/kg	3.9E-10	mg/kg/day	3.5E-01	(mg/kg/day)-1	1.E-10	1.4E-08	mg/kg/day	5.0E-04	mg/kg/day	3.E-05
				Aluminum	15898.75	mg/kg	NC		NC							
				Arsenic	7.715	mg/kg	5.3E-09	mg/kg/day	1.5E+00	(mg/kg/day)-1	8.E-09	1.8E-07	mg/kg/day	3.0E-04	mg/kg/day	6.E-04
				Chromium	230.5	mg/kg	NC		NC					7.5E-05	mg/kg/day	
				Copper	205	mg/kg	NC		NC							
				Lead	450	mg/kg	0.0E+00	mg/kg/day	--							
				Manganese	1840.5	mg/kg	NC		NC					2.8E-03	mg/kg/day	
				Mercury	0.58175	mg/kg	NC		NC					2.1E-05	mg/kg/day	
				Molybdenum	54.025	mg/kg								5.0E-03	mg/kg/day	
				Nickel	119.725	mg/kg	NC		NC					8.0E-04	mg/kg/day	
				Thallium	0.4605	mg/kg	NC		NC					8.0E-05	mg/kg/day	
				Vanadium	82.25	mg/kg	NC		NC					2.6E-05	mg/kg/day	
				Toxicity Equivalency (Dioxins/Furans)	0.00005495	mg/kg	1.3E-15	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-10	4.4E-14	mg/kg/day			
			EXPOSURE ROUTE TOTAL								1.E-07					4.E-03
		EXPOSURE POINT TOTAL									1.E-06					2.E-01
	EXPOSURE MEDIUM TOTAL										1.E-06					2.E-01
SOIL TOTAL											1.E-06					2.E-01
									TOTAL RECEPTOR RISK ACROSS ALL MEDIA		1.E-06	TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA				1.9.E-01

NOTES:

TABLE 7.6.CT
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - *CENTRAL TENDENCY* - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT; OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT *SUPERFUND SITE*
***NORTH PROVIDENCE*, RHODE ISLAND**

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: *PASSIVE RECREATIONAL VISITOR*
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE *POINT*	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	

(1) - Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	a-chlordane	1.4E-10	NA	2.2E-11	NA	1.6E-10	Liver	4.7E-06	NA	7.5E-07	5.4E-06
			dieldrin	5.3E-08	NA	0.0E+00	NA	5.3E-08	Liver	3.9E-04	NA		3.9E-04
			endosulfan II	NC	NA	NC	NA		Kidney	1.7E-07	NA		1.7E-07
			endrin aldehyde	NC	NA	NC	NA		Nervous system	9.7E-06	NA		9.7E-06
			endrin ketone	NC	NA	NC	NA		Nervous system	1.8E-06	NA		1.8E-06
			g-chlordane	1.3E-10	NA	2.0E-11	NA	1.5E-10	Liver	4.2E-06	NA	6.8E-07	4.9E-06
			Technical Chlordane	5.5E-10	NA	8.8E-11	NA	6.4E-10	Liver	1.8E-05	NA	2.9E-06	2.1E-05
			Aroclor 1254	3.8E-07	NA	2.1E-07	NA	5.8E-07	Immune system	5.5E-02	NA	3.1E-02	8.5E-02
			Antimony	NC	NA	NC	NA		Adverse clinical signs	5.4E-03	NA		5.4E-03
			Arsenic	1.0E-06	NA	1.2E-07	NA	1.1E-06	Skin	1.3E-02	NA	1.6E-03	1.5E-02
			Cadmium	NC	NA	NC	NA		Kidney	2.5E-03	NA	4.0E-04	2.9E-03
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	3.7E-03	NA		3.7E-03
			Thallium	NC	NA	NC	NA		NOAEL	4.0E-03	NA		4.0E-03
			Vanadium	NC	NA	NC	NA		NOAEL	2.2E-02	NA		2.2E-02
			Toxicity Equivalency (Dioxins/Furans) - Mam	3.4E-05	NA	4.0E-06	NA	3.8E-05		--	NA	--	
			CHEMICAL TOTAL	3.5E-05	--	4.4E-06	--	4E-05		1.1E-01	0.0E+00	3.3E-02	1E-01
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						4E-05					1E-01
	EXPOSURE MEDIUM TOTAL							4E-05					1E-01
SOIL TOTAL								4E-05					1E-01
RECEPTOR TOTAL								4E-05					1.4E-01
							TOTAL RISK ACROSS ALL MEDIA	4E-05	TOTAL HAZARD ACROSS ALL MEDIA				1.4E-01

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TOTAL ADVERSE CLINICAL SIGNS HI =	5.4E-03
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TOTAL IMMUNE SYSTEM HI =	8.5E-02
TOTAL KIDNEY HI =	2.9E-03
TOTAL LIVER HI =	4.2E-04
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TOTAL NERVOUS SYSTEM HI =	1.1E-05
TOTAL NOAEL HI =	2.9E-02
	--
TOTAL SKIN HI =	1.5E-02
	--

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT; OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	a-chlordane	2.2E-10	NA	8.4E-11	NA	3.0E-10	Liver	7.3E-06	NA	2.8E-06	1.0E-05
			dieldrin	8.3E-08	NA	0.0E+00	NA	8.3E-08	Liver	6.0E-04	NA		6.0E-04
			endosulfan II	NC	NA	NC	NA		Kidney	2.7E-07	NA		2.7E-07
			endrin aldehyde	NC	NA	NC	NA		Nervous system	1.5E-05	NA		1.5E-05
			endrin ketone	NC	NA	NC	NA		Nervous system	2.7E-06	NA		2.7E-06
			g-chlordane	2.0E-10	NA	7.6E-11	NA	2.7E-10	Liver	6.6E-06	NA	2.5E-06	9.1E-06
			Technical Chlordane	8.6E-10	NA	3.3E-10	NA	1.2E-09	Liver	2.9E-05	NA	1.1E-05	4.0E-05
			Aroclor 1254	5.8E-07	NA	7.8E-07	NA	1.4E-06	Immune system	8.5E-02	NA	1.1E-01	2.0E-01
			Antimony	NC	NA	NC	NA		Adverse clinical signs	8.3E-03	NA		8.3E-03
			Arsenic	1.6E-06	NA	4.5E-07	NA	2.0E-06	Skin	2.0E-02	NA	5.8E-03	2.6E-02
			Cadmium	NC	NA	NC	NA		Kidney	3.9E-03	NA	1.5E-03	5.4E-03
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	5.7E-03	NA		5.7E-03
			Thallium	NC	NA	NC	NA		NOAEL	6.2E-03	NA		6.2E-03
			Vanadium	NC	NA	NC	NA		NOAEL	3.4E-02	NA		3.4E-02
			Toxicity Equivalency (Dioxins/Furans) - Mam	5.2E-05	NA	1.5E-05	NA	6.7E-05		--	NA	--	
			CHEMICAL TOTAL	5.5E-05	--	1.6E-05	--	7E-05		1.6E-01	0.0E+00	1.2E-01	3E-01
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						7E-05					3E-01
	EXPOSURE MEDIUM TOTAL							7E-05					3E-01
SOIL TOTAL								7E-05					3E-01
RECEPTOR TOTAL								7E-05					2.9E-01
							TOTAL RISK ACROSS ALL MEDIA	7E-05	TOTAL HAZARD ACROSS ALL MEDIA				2.9E-01

NOTES:
NC - *Not carcinogenic by this exposure route.*
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

TOTAL ADVERSE CLINICAL SIGNS HI =	8.3E-03
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	--
TOTAL IMMUNE SYSTEM HI =	2.0E-01
TOTAL KIDNEY HI =	5.4E-03
TOTAL LIVER HI =	6.6E-04
	--
TOTAL NERVOUS SYSTEM HI =	1.8E-05
TOTAL NOAEL HI =	4.6E-02
	--
TOTAL SKIN HI =	2.6E-02
	--

Prepared by: KJC
Checked by: MJM

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO *BASELINE HUMAN HEALTH RISK ASSESSMENT*: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	a-chlordane	6.6E-10	NA	7.4E-11	NA	7.3E-10	Liver	4.4E-05	NA	4.9E-06	4.9E-05
			dieldrin	2.5E-07	NA	0.0E+00	NA	2.5E-07	Liver	3.6E-03	NA		3.6E-03
			endosulfan II	NC	NA	NC	NA		Kidney	1.6E-06	NA		1.6E-06
			endrin aldehyde	NC	NA	NC	NA		Nervous system	9.0E-05	NA		9.0E-05
			endrin ketone	NC	NA	NC	NA		Nervous system	1.6E-05	NA		1.6E-05
			g-chlordane	5.9E-10	NA	6.6E-11	NA	6.6E-10	Liver	4.0E-05	NA	4.4E-06	4.4E-05
			Technical Chlordane	2.6E-09	NA	2.9E-10	NA	2.9E-09	Liver	1.7E-04	NA	1.9E-05	1.9E-04
			Aroclor 1254	1.8E-06	NA	6.9E-07	NA	2.4E-06	Immune system	5.1E-01	NA	2.0E-01	7.1E-01
			Antimony	NC	NA	NC	NA		Adverse clinical signs	5.0E-02	NA		5.0E-02
			Arsenic	4.7E-06	NA	3.9E-07	NA	5.1E-06	Skin	1.2E-01	NA	1.0E-02	1.3E-01
			Cadmium	NC	NA	NC	NA		Kidney	2.4E-02	NA	2.6E-03	2.6E-02
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	3.4E-02	NA		3.4E-02
			Thallium	NC	NA	NC	NA		NOAEL	3.7E-02	NA		3.7E-02
			Vanadium	NC	NA	NC	NA		NOAEL	2.0E-01	NA		2.0E-01
			Toxicity Equivalency (Dioxins/Furans) - Mam	1.6E-04	NA	1.3E-05	NA	1.7E-04		--	NA	--	
			CHEMICAL TOTAL	1.6E-04	--	1.4E-05	--	2E-04		9.8E-01	0.0E+00	2.1E-01	1E+00
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						2E-04					1E+00
	EXPOSURE MEDIUM TOTAL							2E-04					1E+00
SOIL TOTAL								2E-04					1E+00
RECEPTOR TOTAL								2E-04					1.2E+00
							TOTAL RISK ACROSS ALL MEDIA	2E-04	TOTAL HAZARD ACROSS ALL MEDIA				1.2E+00

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

TOTAL ADVERSE CLINICAL SIGNS HI =	5.0E-02
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TOTAL IMMUNE SYSTEM HI =	7.1E-01
TOTAL *KIDNEY* HI =	2.6E-02
TOTAL LIVER HI =	3.9E-03
	--
TOTAL NERVOUS SYSTEM HI =	1.1E-04
TOTAL NOAEL HI =	2.7E-01
	--
TOTAL *SKIN* HI =	1.3E-01
	--

Prepared by: KJC
Checked by: MJM

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	2-Methylnaphthalene	NC	NA	NC	NA		Cardiovascular system	1.3E-05	NA	6.7E-06	2.0E-05
			Acenaphthylene	NC	NA	NC	NA		Liver	2.5E-06	NA	1.3E-06	3.8E-06
			Benzo(a)anthracene	1.3E-07	NA	6.8E-08	NA	2.0E-07	Kidney	3.5E-05	NA	1.8E-05	5.3E-05
			Benzo(a)pyrene	1.3E-06	NA	6.8E-07	NA	2.0E-06	Kidney	3.5E-05	NA	1.8E-05	5.3E-05
			Benzo(b)fluoranthene	1.6E-07	NA	8.5E-08	NA	2.5E-07	Kidney	4.4E-05	NA	2.3E-05	6.6E-05
			Benzo(g,h,i)perylene	NC	NA	NC	NA		Kidney	2.9E-05	NA	1.5E-05	4.4E-05
			Dibenzo(a,h)anthracene	2.8E-07	NA	1.4E-07	NA	4.2E-07	Kidney	7.4E-06	NA	3.8E-06	1.1E-05
			Indeno(1,2,3-cd)pyrene	1.2E-07	NA	6.1E-08	NA	1.8E-07	Kidney	3.1E-05	NA	1.6E-05	4.8E-05
			Phenanthrene	NC	NA	NC	NA		Kidney	5.4E-05	NA	2.8E-05	8.2E-05
			alpha-Chlordane	6.6E-10	NA	1.1E-10	NA	7.6E-10	Liver	2.2E-05	NA	3.5E-06	2.5E-05
			Aroclor-1254	8.8E-08	NA	4.9E-08	NA	1.4E-07	Immune system	1.3E-02	NA	7.2E-03	2.0E-02
			Aroclor-1268	1.5E-08	NA	8.2E-09	NA	2.3E-08	Immune system	2.1E-03	NA	1.2E-03	3.3E-03
			Endosulfan Sulfate	NC	NA	NC	NA		Kidney	6.5E-07	NA		6.5E-07
			Technical Chlordane	1.3E-08	NA	2.1E-09	NA	1.6E-08	Liver	4.5E-04	NA	7.2E-05	5.2E-04
			Aluminum	NC	NA	NC	NA			--	NA		
			Arsenic	9.6E-07	NA	1.1E-07	NA	1.1E-06	Skin	1.2E-02	NA	1.5E-03	1.4E-02
			Chromium	NC	NA	NC	NA		NOAEL	3.0E-02	NA		3.0E-02
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	1.8E-02	NA		1.8E-02
			Mercury	NC	NA	NC	NA		Immune system	8.3E-04	NA		8.3E-04
			Molybdenum				NA		Kidney	5.4E-03	NA		5.4E-03
			Nickel	NC	NA	NC	NA		Developmental toxicity	5.9E-03	NA		5.9E-03
			Thallium	NC	NA	NC	NA		NOAEL	2.2E-03	NA		2.2E-03
			Vanadium	NC	NA	NC	NA		NOAEL	3.1E-02	NA		3.1E-02
			Toxicity Equivalency (Dioxins/Furans) - Mam	8.6E-07	NA	3.4E-09	NA	8.6E-07		--	NA	--	
			CHEMICAL TOTAL	3.9E-06	--	1.2E-06	--	5E-06		1.2E-01	0.0E+00	1.0E-02	1E-01
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						5E-06					1E-01
	EXPOSURE MEDIUM TOTAL							5E-06					1E-01
SOIL TOTAL								5E-06					1E-01
RECEPTOR TOTAL								5E-06					1.3E-01
							TOTAL RISK ACROSS ALL MEDIA	5E-06	TOTAL HAZARD ACROSS ALL MEDIA				1.3E-01

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

	--
TOTAL CARDIOVASCULAR SYSTEM HI =	2.0E-05
TOTAL DEVELOPMENTAL TOXICITY HI =	5.9E-03
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	--
TOTAL IMMUNE SYSTEM HI =	2.4E-02
TOTAL KIDNEY HI =	5.7E-03
TOTAL LIVER HI =	5.5E-04
	--
	--
TOTAL NOAEL HI =	8.1E-02
	--
TOTAL SKIN HI =	1.4E-02
	--

Prepared by: KJC
Checked by: MJM

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	2-Methylnaphthalene	NC	NA	NC	NA		Cardiovascular system	2.0E-05	NA	2.5E-05	4.5E-05
			Acenaphthylene	NC	NA	NC	NA		Liver	3.9E-06	NA	4.9E-06	8.9E-06
			Benzo(a)anthracene	2.0E-07	NA	2.5E-07	NA	4.6E-07	Kidney	5.4E-05	NA	6.7E-05	1.2E-04
			Benzo(a)pyrene	2.0E-06	NA	2.5E-06	NA	4.6E-06	Kidney	5.4E-05	NA	6.8E-05	1.2E-04
			Benzo(b)fluoranthene	2.5E-07	NA	3.2E-07	NA	5.7E-07	Kidney	6.8E-05	NA	8.5E-05	1.5E-04
			Benzo(g,h,i)perylene	NC	NA	NC	NA		Kidney	4.5E-05	NA	5.7E-05	1.0E-04
			Dibenzo(a,h)anthracene	4.3E-07	NA	5.4E-07	NA	9.7E-07	Kidney	1.2E-05	NA	1.4E-05	2.6E-05
			Indeno(1,2,3-cd)pyrene	1.8E-07	NA	2.3E-07	NA	4.1E-07	Kidney	4.9E-05	NA	6.1E-05	1.1E-04
			Phenanthrene	NC	NA	NC	NA		Kidney	8.4E-05	NA	1.0E-04	1.9E-04
			alpha-Chlordane	1.0E-09	NA	3.9E-10	NA	1.4E-09	Liver	3.4E-05	NA	1.3E-05	4.7E-05
			Aroclor-1254	1.4E-07	NA	1.8E-07	NA	3.2E-07	Immune system	2.0E-02	NA	2.7E-02	4.7E-02
			Aroclor-1268	2.3E-08	NA	3.1E-08	NA	5.3E-08	Immune system	3.3E-03	NA	4.5E-03	7.8E-03
			Endosulfan Sulfate	NC	NA	NC	NA		Kidney	1.0E-06	NA		1.0E-06
			Technical Chlordane	2.1E-08	NA	8.0E-09	NA	2.9E-08	Liver	7.0E-04	NA	2.7E-04	9.7E-04
			Aluminum	NC	NA	NC	NA			--	NA		
			Arsenic	1.5E-06	NA	4.3E-07	NA	1.9E-06	Skin	1.9E-02	NA	5.6E-03	2.5E-02
			Chromium	NC	NA	NC	NA		NOAEL	4.6E-02	NA		4.6E-02
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	2.8E-02	NA		2.8E-02
			Mercury	NC	NA	NC	NA		Immune system	1.3E-03	NA		1.3E-03
			Molybdenum				NA		Kidney	8.3E-03	NA		8.3E-03
			Nickel	NC	NA	NC	NA		Developmental toxicity	9.2E-03	NA		9.2E-03
			Thallium	NC	NA	NC	NA		NOAEL	3.5E-03	NA		3.5E-03
			Vanadium	NC	NA	NC	NA		NOAEL	4.9E-02	NA		4.9E-02
			Toxicity Equivalency (Dioxins/Furans) - Mam	1.3E-06	NA	1.3E-08	NA	1.3E-06		--	NA	--	
			CHEMICAL TOTAL	6.1E-06	--	4.5E-06	--	1E-05		1.9E-01	0.0E+00	3.8E-02	2E-01
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						1E-05					2E-01
	EXPOSURE MEDIUM TOTAL							1E-05					2E-01
SOIL TOTAL								1E-05					2E-01
RECEPTOR TOTAL								1E-05					2.3E-01
							TOTAL RISK ACROSS ALL MEDIA	1E-05	TOTAL HAZARD ACROSS ALL MEDIA				2.3E-01

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

	--
TOTAL CARDIOVASCULAR SYSTEM HI =	4.5E-05
TOTAL DEVELOPMENTAL TOXICITY HI =	9.2E-03
	--
	--
	--
	--
TOTAL IMMUNE SYSTEM HI =	5.6E-02
TOTAL KIDNEY HI =	9.2E-03
TOTAL LIVER HI =	1.0E-03
	--
	--
TOTAL NOAEL HI =	1.3E-01
	--
TOTAL SKIN HI =	2.5E-02
	--

Prepared by: KJC
Checked by: MJM

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	*INHALATION*	*DERMAL*	*EXTERNAL (RADIATION)*	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	2-Methylnaphthalene	NC	NA	NC	NA		Cardiovascular system	1.2E-04	NA	4.4E-05	1.7E-04
			Acenaphthylene	NC	NA	NC	NA		Liver	2.4E-05	NA	8.6E-06	3.2E-05
			Benzo(a)anthracene	6.1E-07	NA	2.2E-07	NA	8.3E-07	Kidney	3.2E-04	NA	1.2E-04	4.4E-04
			Benzo(a)pyrene	6.1E-06	NA	2.2E-06	NA	8.3E-06	Kidney	3.2E-04	NA	1.2E-04	4.4E-04
			Benzo(b)fluoranthene	7.6E-07	NA	2.8E-07	NA	1.0E-06	Kidney	4.1E-04	NA	1.5E-04	5.6E-04
			Benzo(g,h,i)perylene	NC	NA	NC	NA		Kidney	2.7E-04	NA	9.9E-05	3.7E-04
			Dibenzo(a,h)anthracene	1.3E-06	NA	4.7E-07	NA	1.8E-06	Kidney	6.9E-05	NA	2.5E-05	9.4E-05
			Indeno(1,2,3-cd)pyrene	5.5E-07	NA	2.0E-07	NA	7.5E-07	Kidney	2.9E-04	NA	1.1E-04	4.0E-04
			Phenanthrene	NC	NA	NC	NA		Kidney	5.0E-04	NA	1.8E-04	6.9E-04
			alpha-Chlordane	3.1E-09	NA	3.4E-10	NA	3.4E-09	Liver	2.0E-04	NA	2.3E-05	2.3E-04
			Aroclor-1254	4.1E-07	NA	1.6E-07	NA	5.7E-07	Immune system	1.2E-01	NA	4.7E-02	1.7E-01
			Aroclor-1268	6.8E-08	NA	2.7E-08	NA	9.5E-08	Immune system	2.0E-02	NA	7.8E-03	2.8E-02
			Endosulfan Sulfate	NC	NA	NC	NA		Kidney	6.0E-06	NA		6.0E-06
			Technical Chlordane	6.3E-08	NA	7.0E-09	NA	7.0E-08	Liver	4.2E-03	NA	4.7E-04	4.7E-03
			Aluminum	NC	NA	NC	NA			--	NA		
			Arsenic	4.5E-06	NA	3.8E-07	NA	4.8E-06	Skin	1.2E-01	NA	9.7E-03	1.3E-01
			Chromium	NC	NA	NC	NA		NOAEL	2.8E-01	NA		2.8E-01
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	1.7E-01	NA		1.7E-01
			Mercury	NC	NA	NC	NA		Immune system	7.7E-03	NA		7.7E-03
			Molybdenum				NA		Kidney	5.0E-02	NA		5.0E-02
			Nickel	NC	NA	NC	NA		Developmental toxicity	5.5E-02	NA		5.5E-02
			Thallium	NC	NA	NC	NA		NOAEL	2.1E-02	NA		2.1E-02
			Vanadium	NC	NA	NC	NA		NOAEL	2.9E-01	NA		2.9E-01
			Toxicity Equivalency (Dioxins/Furans) - Mam	4.0E-06	NA	1.1E-08	NA	4.0E-06		--	NA	--	
			CHEMICAL TOTAL	1.8E-05	--	4.0E-06	--	2E-05		1.1E+00	0.0E+00	6.6E-02	1E+00
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						2E-05					1E+00
	EXPOSURE MEDIUM TOTAL							2E-05					1E+00
SOIL TOTAL								2E-05					1E+00
RECEPTOR TOTAL								2E-05					1.2E+00
							TOTAL RISK ACROSS ALL MEDIA	2E-05	TOTAL HAZARD ACROSS ALL MEDIA				1.2E+00

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

	--
TOTAL CARDIOVASCULAR SYSTEM HI =	1.7E-04
TOTAL DEVELOPMENTAL TOXICITY HI =	5.5E-02
	--
	--
	--
	--
TOTAL IMMUNE SYSTEM HI =	2.0E-01
TOTAL KIDNEY HI =	5.3E-02
TOTAL LIVER HI =	4.9E-03
	--
	--
TOTAL NOAEL HI =	7.6E-01
	--
TOTAL SKIN HI =	1.3E-01
	--

Prepared by: KJC
Checked by: MJM

TABLE 9.1.CT
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - CENTRAL TENDENCY - *CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT*
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	*FLOODPLAIN SOIL*	*OXBOW AREA*	a-chlordane	4.5E-12	NA	2.1E-13	NA	4.8E-12	Liver	4.5E-07	NA	2.1E-08	4.8E-07
			dieldrin	1.6E-09	NA	0.0E+00	NA	1.6E-09	Liver	3.5E-05	NA		3.5E-05
			endosulfan II	NC	NA	NC	NA		Kidney	1.5E-08	NA		1.5E-08
			endrin aldehyde	NC	NA	NC	NA		Nervous system	9.8E-07	NA		9.8E-07
			endrin ketone	NC	NA	NC	NA		Nervous system	1.6E-07	NA		1.6E-07
			g-chlordane	6.1E-12	NA	2.8E-13	NA	6.4E-12	Liver	6.1E-07	NA	2.8E-08	6.4E-07
			Technical Chlordane	2.5E-11	NA	1.1E-12	NA	2.6E-11	Liver	2.5E-06	NA	1.1E-07	2.6E-06
			Aroclor 1254	1.2E-08	NA	2.0E-09	NA	1.4E-08	Immune system	5.4E-03	NA	8.6E-04	6.2E-03
			Antimony	NC	NA	NC	NA		Adverse clinical signs	5.8E-04	NA		5.8E-04
			Arsenic	3.5E-08	NA	1.2E-09	NA	3.6E-08	Skin	1.4E-03	NA	4.7E-05	1.4E-03
			Cadmium	NC	NA	NC	NA		Kidney	3.1E-04	NA	1.4E-05	3.2E-04
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	8.9E-04	NA		8.9E-04
			Thallium	NC	NA	NC	NA		NOAEL	6.8E-04	NA		6.8E-04
			Vanadium	NC	NA	NC	NA		NOAEL	4.5E-03	NA		4.5E-03
			Toxicity Equivalency (Dioxins/Furans) - Mam	1.2E-06	NA	4.0E-08	NA	1.2E-06		--	NA	--	
			CHEMICAL TOTAL	1.2E-06	--	4.4E-08	--	1E-06		1.4E-02	0.0E+00	9.2E-04	1E-02
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						1E-06					1E-02
	EXPOSURE MEDIUM TOTAL							1E-06					1E-02
SOIL TOTAL								1E-06					1E-02
RECEPTOR TOTAL								1E-06					1.5E-02
							TOTAL RISK ACROSS ALL MEDIA	1E-06	TOTAL HAZARD ACROSS ALL MEDIA				1.5E-02

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

TOTAL ADVERSE CLINICAL SIGNS HI =	5.8E-04
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TOTAL IMMUNE SYSTEM HI =	6.2E-03
TOTAL KIDNEY HI =	3.2E-04
TOTAL LIVER HI =	3.9E-05
	--
TOTAL NERVOUS SYSTEM HI =	1.1E-06
TOTAL NOAEL HI =	6.1E-03
	--
TOTAL SKIN HI =	1.4E-03
	--

Prepared by: KJC
Checked by: MJM

TABLE 9.2.CT
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	a-chlordane	5.3E-12	NA	8.2E-13	NA	6.1E-12	Liver	7.1E-07	NA	1.1E-07	8.2E-07
			dieldrin	1.9E-09	NA	0.0E+00	NA	1.9E-09	Liver	5.5E-05	NA		5.5E-05
			endosulfan II	NC	NA	NC	NA		Kidney	2.3E-08	NA		2.3E-08
			endrin aldehyde	NC	NA	NC	NA		Nervous system	1.5E-06	NA		1.5E-06
			endrin ketone	NC	NA	NC	NA		Nervous system	2.5E-07	NA		2.5E-07
			g-chlordane	7.1E-12	NA	1.1E-12	NA	8.2E-12	Liver	9.5E-07	NA	1.5E-07	1.1E-06
			Technical Chlordane	2.9E-11	NA	4.4E-12	NA	3.3E-11	Liver	3.8E-06	NA	5.9E-07	4.4E-06
			Aroclor 1254	1.4E-08	NA	7.7E-09	NA	2.2E-08	Immune system	8.4E-03	NA	4.5E-03	1.3E-02
			Antimony	NC	NA	NC	NA		Adverse clinical signs	9.0E-04	NA		9.0E-04
			Arsenic	4.1E-08	NA	4.7E-09	NA	4.6E-08	Skin	2.1E-03	NA	2.5E-04	2.4E-03
			Cadmium	NC	NA	NC	NA		Kidney	4.8E-04	NA	7.3E-05	5.5E-04
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	1.4E-03	NA		1.4E-03
			Thallium	NC	NA	NC	NA		NOAEL	1.1E-03	NA		1.1E-03
			Vanadium	NC	NA	NC	NA		NOAEL	7.0E-03	NA		7.0E-03
			Toxicity Equivalency (Dioxins/Furans) - Mam	1.4E-06	NA	1.6E-07	NA	1.5E-06		--	NA	--	
			CHEMICAL TOTAL	1.4E-06	--	1.7E-07	--	2E-06		2.1E-02	0.0E+00	4.8E-03	3E-02
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						2E-06					3E-02
	EXPOSURE MEDIUM TOTAL							2E-06					3E-02
SOIL TOTAL								2E-06					3E-02
RECEPTOR TOTAL								2E-06					2.6E-02
							TOTAL RISK ACROSS ALL MEDIA	2E-06	TOTAL HAZARD ACROSS ALL MEDIA				2.6E-02

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

TOTAL ADVERSE CLINICAL SIGNS HI =	9.0E-04
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	--
TOTAL IMMUNE SYSTEM HI =	1.3E-02
TOTAL KIDNEY HI =	5.5E-04
TOTAL LIVER HI =	6.1E-05
	--
TOTAL NERVOUS SYSTEM HI =	1.8E-06
TOTAL NOAEL HI =	9.5E-03
	--
TOTAL SKIN HI =	2.4E-03
	--

Prepared by: KJC
Checked by: MJM

TABLE 9.3.CT
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	a-chlordane	2.1E-11	NA	9.5E-13	NA	2.2E-11	Liver	4.2E-06	NA	1.9E-07	4.4E-06
			dieldrin	7.5E-09	NA	0.0E+00	NA	7.5E-09	Liver	3.3E-04	NA		3.3E-04
			endosulfan II	NC	NA	NC	NA		Kidney	1.4E-07	NA		1.4E-07
			endrin aldehyde	NC	NA	NC	NA		Nervous system	9.1E-06	NA		9.1E-06
			endrin ketone	NC	NA	NC	NA		Nervous system	1.5E-06	NA		1.5E-06
			g-chlordane	2.8E-11	NA	1.3E-12	NA	3.0E-11	Liver	5.7E-06	NA	2.5E-07	5.9E-06
			Technical Chlordane	1.1E-10	NA	5.1E-12	NA	1.2E-10	Liver	2.3E-05	NA	1.0E-06	2.4E-05
			Aroclor 1254	5.7E-08	NA	9.0E-09	NA	6.6E-08	Immune system	5.0E-02	NA	7.9E-03	5.8E-02
			Antimony	NC	NA	NC	NA		Adverse clinical signs	5.4E-03	NA		5.4E-03
			Arsenic	1.6E-07	NA	5.5E-09	NA	1.7E-07	Skin	1.3E-02	NA	4.3E-04	1.3E-02
			Cadmium	NC	NA	NC	NA		Kidney	2.9E-03	NA	1.3E-04	3.0E-03
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	8.3E-03	NA		8.3E-03
			Thallium	NC	NA	NC	NA		NOAEL	6.4E-03	NA		6.4E-03
			Vanadium	NC	NA	NC	NA		NOAEL	4.2E-02	NA		4.2E-02
			Toxicity Equivalency (Dioxins/Furans) - Mam	5.5E-06	NA	1.9E-07	NA	5.7E-06		--	NA	--	
			CHEMICAL TOTAL	5.8E-06	--	2.0E-07	--	6E-06		1.3E-01	0.0E+00	8.4E-03	1E-01
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						6E-06					1E-01
	EXPOSURE MEDIUM TOTAL							6E-06					1E-01
SOIL TOTAL								6E-06					1E-01
RECEPTOR TOTAL								6E-06					1.4E-01
							TOTAL RISK ACROSS ALL MEDIA	6E-06	TOTAL HAZARD ACROSS ALL MEDIA				1.4E-01

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

TOTAL ADVERSE CLINICAL SIGNS HI =	5.4E-03
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	--
TOTAL IMMUNE SYSTEM HI =	5.8E-02
TOTAL KIDNEY HI =	3.0E-03
TOTAL LIVER HI =	3.6E-04
	--
TOTAL NERVOUS SYSTEM HI =	1.1E-05
TOTAL NOAEL HI =	5.7E-02
	--
TOTAL SKIN HI =	1.3E-02
	--

Prepared by: KJC
Checked by: MJM

TABLE 9.4.CT
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	2-Methylnaphthalene	NC	NA	NC	NA		Cardiovascular system	2.0E-06	NA	3.0E-07	2.3E-06
			Acenaphthylene	NC	NA	NC	NA		Liver	4.0E-07	NA	6.0E-08	4.6E-07
			Benzo(a)anthracene	9.8E-09	NA	1.5E-09	NA	1.1E-08	Kidney	7.9E-06	NA	1.2E-06	9.0E-06
			Benzo(a)pyrene	9.8E-08	NA	1.5E-08	NA	1.1E-07	Kidney	7.8E-06	NA	1.2E-06	9.0E-06
			Benzo(b)fluoranthene	1.1E-08	NA	1.6E-09	NA	1.3E-08	Kidney	8.8E-06	NA	1.3E-06	1.0E-05
			Benzo(g,h,i)perylene	NC	NA	NC	NA		Kidney	5.9E-06	NA	8.8E-07	6.8E-06
			Dibenzo(a,h)anthracene	2.0E-08	NA	2.9E-09	NA	2.2E-08	Kidney	1.6E-06	NA	2.3E-07	1.8E-06
			Indeno(1,2,3-cd)pyrene	8.0E-09	NA	1.2E-09	NA	9.2E-09	Kidney	6.4E-06	NA	9.5E-07	7.4E-06
			Phenanthrene	NC	NA	NC	NA		Kidney	1.0E-05	NA	1.5E-06	1.2E-05
			alpha-Chlordane	2.7E-11	NA	1.2E-12	NA	2.8E-11	Liver	2.7E-06	NA	1.2E-07	2.8E-06
			Aroclor-1254	4.5E-09	NA	7.2E-10	NA	5.3E-09	Immune system	2.0E-03	NA	3.2E-04	2.3E-03
			Aroclor-1268	7.3E-10	NA	1.2E-10	NA	8.5E-10	Immune system	3.2E-04	NA	5.1E-05	3.7E-04
			Endosulfan Sulfate	NC	NA	NC	NA		Kidney	8.3E-08	NA		8.3E-08
			Technical Chlordane	6.6E-10	NA	3.0E-11	NA	6.9E-10	Liver	6.6E-05	NA	3.0E-06	6.9E-05
			Aluminum	NC	NA	NC	NA			--	NA		
			Arsenic	5.0E-08	NA	1.7E-09	NA	5.2E-08	Skin	2.0E-03	NA	6.7E-05	2.0E-03
			Chromium	NC	NA	NC	NA		NOAEL	5.9E-03	NA		5.9E-03
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	2.0E-03	NA		2.0E-03
			Mercury	NC	NA	NC	NA		Immune system	1.5E-04	NA		1.5E-04
			Molybdenum				NA		Kidney	8.2E-04	NA		8.2E-04
			Nickel	NC	NA	NC	NA		Developmental toxicity	4.6E-04	NA		4.6E-04
			Thallium	NC	NA	NC	NA		NOAEL	4.4E-04	NA		4.4E-04
			Vanadium	NC	NA	NC	NA		NOAEL	6.3E-03	NA		6.3E-03
			Toxicity Equivalency (Dioxins/Furans) - Mam	3.6E-08	NA	4.1E-11	NA	3.6E-08		--	NA	--	
			CHEMICAL TOTAL	2.4E-07	--	2.4E-08	--	3E-07		2.0E-02	0.0E+00	4.5E-04	2E-02
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						3E-07					2E-02
	EXPOSURE MEDIUM TOTAL							3E-07					2E-02
SOIL TOTAL								3E-07					2E-02
RECEPTOR TOTAL								3E-07					2.1E-02
							TOTAL RISK ACROSS ALL MEDIA	3E-07	TOTAL HAZARD ACROSS ALL MEDIA				2.1E-02

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

	--
TOTAL CARDIOVASCULAR SYSTEM HI =	2.3E-06
TOTAL DEVELOPMENTAL TOXICITY HI =	4.6E-04
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	--
TOTAL IMMUNE SYSTEM HI =	2.8E-03
TOTAL KIDNEY HI =	8.8E-04
TOTAL LIVER HI =	7.2E-05
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	--
TOTAL NOAEL HI =	1.5E-02
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TOTAL SKIN HI =	2.0E-03
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Prepared by: KJC
Checked by: MJM

TABLE 9.5.CT
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	2-Methylnaphthalene	NC	NA	NC	NA		Cardiovascular system	3.2E-06	NA	1.6E-06	4.8E-06
			Acenaphthylene	NC	NA	NC	NA		Liver	6.3E-07	NA	3.1E-07	9.4E-07
			Benzo(a)anthracene	1.1E-08	NA	5.7E-09	NA	1.7E-08	Kidney	1.2E-05	NA	6.1E-06	1.8E-05
			Benzo(a)pyrene	1.1E-07	NA	5.7E-08	NA	1.7E-07	Kidney	1.2E-05	NA	6.1E-06	1.8E-05
			Benzo(b)fluoranthene	1.3E-08	NA	6.4E-09	NA	1.9E-08	Kidney	1.4E-05	NA	6.8E-06	2.0E-05
			Benzo(g,h,i)perylene	NC	NA	NC	NA		Kidney	9.2E-06	NA	4.6E-06	1.4E-05
			Dibenzo(a,h)anthracene	2.3E-08	NA	1.1E-08	NA	3.4E-08	Kidney	2.4E-06	NA	1.2E-06	3.6E-06
			Indeno(1,2,3-cd)pyrene	9.4E-09	NA	4.7E-09	NA	1.4E-08	Kidney	1.0E-05	NA	5.0E-06	1.5E-05
			Phenanthrene	NC	NA	NC	NA		Kidney	1.6E-05	NA	7.8E-06	2.3E-05
			alpha-Chlordane	3.2E-11	NA	4.9E-12	NA	3.7E-11	Liver	4.2E-06	NA	6.5E-07	4.9E-06
			Aroclor-1254	5.3E-09	NA	2.8E-09	NA	8.1E-09	Immune system	3.1E-03	NA	1.7E-03	4.7E-03
			Aroclor-1268	8.5E-10	NA	4.6E-10	NA	1.3E-09	Immune system	5.0E-04	NA	2.7E-04	7.7E-04
			Endosulfan Sulfate	NC	NA	NC	NA		Kidney	1.3E-07	NA		1.3E-07
			Technical Chlordane	7.7E-10	NA	1.2E-10	NA	8.8E-10	Liver	1.0E-04	NA	1.6E-05	1.2E-04
			Aluminum	NC	NA	NC	NA			--	NA		
			Arsenic	5.9E-08	NA	6.8E-09	NA	6.6E-08	Skin	3.1E-03	NA	3.5E-04	3.4E-03
			Chromium	NC	NA	NC	NA		NOAEL	9.1E-03	NA		9.1E-03
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	3.1E-03	NA		3.1E-03
			Mercury	NC	NA	NC	NA		Immune system	2.3E-04	NA		2.3E-04
			Molybdenum				NA		Kidney	1.3E-03	NA		1.3E-03
			Nickel	NC	NA	NC	NA		Developmental toxicity	7.1E-04	NA		7.1E-04
			Thallium	NC	NA	NC	NA		NOAEL	6.8E-04	NA		6.8E-04
			Vanadium	NC	NA	NC	NA		NOAEL	9.8E-03	NA		9.8E-03
			Toxicity Equivalency (Dioxins/Furans) - Mam	4.2E-08	NA	1.6E-10	NA	4.2E-08		--	NA	--	
			CHEMICAL TOTAL	2.8E-07	--	9.6E-08	--	4E-07		3.2E-02	0.0E+00	2.3E-03	3E-02
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						4E-07					3E-02
	EXPOSURE MEDIUM TOTAL							4E-07					3E-02
SOIL TOTAL								4E-07					3E-02
RECEPTOR TOTAL								4E-07					3.4E-02
							TOTAL RISK ACROSS ALL MEDIA	4E-07	TOTAL HAZARD ACROSS ALL MEDIA				3.4E-02

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

	--
TOTAL CARDIOVASCULAR SYSTEM HI =	4.8E-06
TOTAL DEVELOPMENTAL TOXICITY HI =	7.1E-04
	--
	--
	--
	--
TOTAL IMMUNE SYSTEM HI =	5.7E-03
TOTAL KIDNEY HI =	1.4E-03
TOTAL LIVER HI =	1.2E-04
	--
	--
TOTAL NOAEL HI =	2.3E-02
	--
TOTAL SKIN HI =	3.4E-03
	--

Prepared by: KJC
Checked by: MJM

TABLE 9.6.CT
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	GREYSTONE MILL POND	2-Methylnaphthalene	NC	NA	NC	NA		Cardiovascular system	*1.9E-05*	NA	2.8E-06	2.2E-05
			Acenaphthylene	NC	NA	NC	NA		Liver	3.8E-06	NA	5.5E-07	4.3E-06
			Benzo(a)anthracene	4.6E-08	NA	6.7E-09	NA	5.3E-08	Kidney	7.3E-05	NA	1.1E-05	8.4E-05
			Benzo(a)pyrene	4.6E-07	NA	6.7E-08	NA	5.2E-07	Kidney	7.3E-05	NA	1.1E-05	8.4E-05
			Benzo(b)fluoranthene	5.1E-08	NA	7.5E-09	NA	5.9E-08	Kidney	8.2E-05	NA	1.2E-05	9.4E-05
			Benzo(g,h,i)perylene	NC	NA	NC	NA		Kidney	5.5E-05	NA	8.1E-06	6.4E-05
			Dibenzo(a,h)anthracene	9.1E-08	NA	1.3E-08	NA	1.0E-07	Kidney	1.5E-05	NA	2.1E-06	1.7E-05
			Indeno(1,2,3-cd)pyrene	3.7E-08	NA	5.4E-09	NA	4.3E-08	Kidney	6.0E-05	NA	8.7E-06	6.9E-05
			Phenanthrene	NC	NA	NC	NA		Kidney	*9.4E-05*	*NA*	*1.4E-05*	*1.1E-04*
			alpha-Chlordane	1.3E-10	NA	5.7E-12	NA	1.3E-10	Liver	2.5E-05	NA	1.1E-06	2.6E-05
			Aroclor-1254	2.1E-08	NA	3.3E-09	NA	2.4E-08	Immune system	1.9E-02	NA	2.9E-03	2.1E-02
			Aroclor-1268	3.4E-09	NA	5.4E-10	NA	3.9E-09	Immune system	3.0E-03	NA	4.7E-04	3.5E-03
			Endosulfan Sulfate	NC	NA	NC	NA		Kidney	7.7E-07	NA		7.7E-07
			Technical Chlordane	*3.1E-09*	*NA*	*1.4E-10*	*NA*	*3.2E-09*	*Liver*	6.1E-04	NA	2.7E-05	6.4E-04
			Aluminum	NC	NA	NC	NA			--	NA		
			Arsenic	2.4E-07	NA	7.9E-09	NA	2.4E-07	Skin	1.8E-02	NA	6.2E-04	1.9E-02
			Chromium	NC	NA	NC	NA		NOAEL	*5.5E-02*	NA		*5.5E-02*
			Copper	NC	NA	NC	NA			--	NA		
			Lead	--	NA	--	NA			--	NA		
			Manganese	NC	NA	NC	NA		NOAEL	1.8E-02	NA		1.8E-02
			Mercury	NC	NA	NC	NA		Immune system	1.4E-03	NA		1.4E-03
			Molybdenum				*NA*		Kidney	7.7E-03	NA		7.7E-03
			Nickel	NC	NA	NC	NA		Developmental toxicity	4.3E-03	NA		4.3E-03
			Thallium	NC	NA	NC	NA		NOAEL	4.1E-03	NA		4.1E-03
			Vanadium	*NC*	*NA*	*NC*	*NA*		*NOAEL*	*5.9E-02*	*NA*		*5.9E-02*
			Toxicity Equivalency (Dioxins/Furans) - Mam	1.7E-07	NA	1.9E-10	NA	1.7E-07		--	NA	--	
			CHEMICAL TOTAL	1.1E-06	--	1.1E-07	--	1E-06		1.9E-01	0.0E+00	4.1E-03	2E-01
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						1E-06					2E-01
	EXPOSURE MEDIUM TOTAL							1E-06					2E-01
SOIL TOTAL								1E-06					2E-01
RECEPTOR TOTAL								1E-06					1.9E-01
							TOTAL RISK ACROSS ALL MEDIA	1E-06	TOTAL HAZARD ACROSS ALL MEDIA				1.9E-01

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

	--
TOTAL CARDIOVASCULAR SYSTEM HI =	2.2E-05
TOTAL DEVELOPMENTAL TOXICITY HI =	4.3E-03
	--
	--
	--
	--
TOTAL *IMMUNE SYSTEM HI* =	2.6E-02
TOTAL KIDNEY HI =	8.2E-03
TOTAL LIVER HI =	6.7E-04
	--
	--
TOTAL NOAEL HI =	1.4E-01
	--
TOTAL *SKIN HI* =	1.9E-02
	--

Prepared by: KJC
Checked by: MJM

TABLE 10.1.RME
RISK SUMMARY - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	Toxicity Equivalency (Dioxins/Furans) - Mam	3.4E-05	NA	4.0E-06	NA	3.8E-05					
			CHEMICAL TOTAL	3.4E-05	--	4.0E-06	--	4E-05		--	0.0E+00	--	0E+00
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						4E-05					0E+00
	EXPOSURE MEDIUM TOTAL							4E-05					0E+00
SOIL TOTAL								4E-05					0E+00
RECEPTOR TOTAL								4E-05					--
			TOTAL RISK ACROSS ALL MEDIA					4E-05	TOTAL HAZARD ACROSS ALL MEDIA				--

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJA
Checked by: MJM

TABLE 10.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	Arsenic	1.6E-06	NA	4.5E-07	NA	2.0E-06	Skin	--	NA	--	
			Toxicity Equivalency (Dioxins/Furans) - Mam	5.2E-05	NA	1.5E-05	NA	6.7E-05					
			CHEMICAL TOTAL	5.4E-05	--	1.6E-05	--	7E-05		--	0.0E+00	--	0E+00
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						7E-05					0E+00
	EXPOSURE MEDIUM TOTAL							7E-05					0E+00
RECEPTOR TOTAL								7E-05					--
			TOTAL RISK ACROSS ALL MEDIA					7E-05	TOTAL HAZARD ACROSS ALL MEDIA				--

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJC
Checked by: MJM

TABLE 10.2.CT
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - OLDER CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: OLDER CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	Toxicity Equivalency (Dioxins/Furans) - Mam	1.4E-06	NA	1.6E-07	NA	1.5E-06					
			CHEMICAL TOTAL	1.4E-06	--	1.6E-07	--	2E-06		--	0.0E+00	--	0E+00
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						2E-06					0E+00
	EXPOSURE MEDIUM TOTAL							2E-06					0E+00
SOIL TOTAL								2E-06					0E+00
RECEPTOR TOTAL								2E-06					--
			TOTAL RISK ACROSS ALL MEDIA					2E-06	TOTAL HAZARD ACROSS ALL MEDIA				--

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJA
Checked by: MJM

TABLE 10.3.RME
RISK SUMMARY - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	Aroclor 1254	1.8E-06	NA	6.9E-07	NA	2.4E-06	Immune system	--	NA	--	
			Arsenic	4.7E-06	NA	3.9E-07	NA	5.1E-06	Skin	--	NA	--	
			Toxicity Equivalency (Dioxins/Furans) - Mam	1.6E-04	NA	1.3E-05	NA	1.7E-04					
			CHEMICAL TOTAL	1.6E-04	--	1.4E-05	--	2E-04		--	0.0E+00	--	0E+00
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						2E-04					0E+00
	EXPOSURE MEDIUM TOTAL							2E-04					0E+00
SOIL TOTAL								2E-04					0E+00
RECEPTOR TOTAL								2E-04					--
			TOTAL RISK ACROSS ALL MEDIA					2E-04	TOTAL HAZARD ACROSS ALL MEDIA				--

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJA
Checked by: MJM

TABLE 10.3.CT
RISK SUMMARY - CENTRAL TENDENCY - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD
ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK					NON-CARCINOGENIC HAZARD QUOTIENT				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	FLOODPLAIN SOIL	OXBOW AREA	Toxicity Equivalency (Dioxins/Furans) - Mam	5.5E-06	NA	1.9E-07	NA	5.7E-06					
			CHEMICAL TOTAL	5.5E-06	--	1.9E-07	--	6E-06		--	0.0E+00	--	0E+00
			RADIONUCLIDE TOTAL										
		EXPOSURE POINT TOTAL						6E-06					0E+00
	EXPOSURE MEDIUM TOTAL							6E-06					0E+00
SOIL TOTAL								6E-06					0E+00
RECEPTOR TOTAL								6E-06					--
			TOTAL RISK ACROSS ALL MEDIA					6E-06	TOTAL HAZARD ACROSS ALL MEDIA				--

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: KJA
Checked by: MJM

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TABLE 11.1.RME
RISK ASSESSMENT SUMMARY - REASONABLE MAXIMUM EXPOSURE

ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

Exposure Scenario	Receptor	Exposure Point	Exposure Route	Excess Lifetime Cancer Risk	Hazard Quotient
Current/Future - Oxbow Area					
Passive Recreational Visitor	Child (ages 1 through 6)	Floodplain Soil	Incidental ingestion	1.6E-04	1
			Dermal contact	1.4E-05	0.2
			Total Risk:	**1.8E-04**	**1**
	Older Child (ages 7 through 18)	Floodplain Soil	Incidental ingestion	5.5E-05	0.2
			Dermal contact	1.6E-05	0.1
			Total Risk:	**7.1E-05**	**0.3**
	Adult (ages 19 and above)	Floodplain Soil	Incidental ingestion	3.5E-05	0.1
			Dermal contact	4.4E-06	0.03
			Total Risk:	**3.9E-05**	**0.1**
			Total Receptor Risk:	**3E-04**	**NC**

Prepared by: KJC
Checked by: MJM

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TABLE 11.1.CT
RISK ASSESSMENT SUMMARY - CENTRAL TENDENCY

ADDENDUM TO BASELINE HUMAN HEALTH RISK ASSESSMENT: OXBOW AREA
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

Exposure Scenario	Receptor	Exposure Point	Exposure Route	Excess Lifetime Cancer Risk	Hazard Quotient
Current/Future - Oxbow Area					
Passive Recreational Visitor	Child (ages 1 through 6)	Floodplain Soil	Incidental ingestion	5.8E-06	0.1
			Dermal contact	2.0E-07	0.008
			Total Risk:	**6.0E-06**	**0.1**
Passive Recreational Visitor	Older Child (ages 7 through 18)	Floodplain Soil	Incidental ingestion	1.4E-06	0.02
			Dermal contact	1.7E-07	0.005
			Total Risk:	**1.6E-06**	**0.03**
Passive Recreational Visitor	Adult (ages 19 and above)	Floodplain Soil	Incidental ingestion	1.2E-06	0.01
			Dermal contact	4.4E-08	0.0009
			Total Risk:	**1.3E-06**	**0.01**
			Total Receptor Risk:	**9E-06**	**NC**

Prepared by: KJC
Checked by: MJM

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Table 12
Summary of Non-Cancer Risks

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Non-Carcinogenic Risk			Floodplain Soil		Incremental Hazard Index	
			CT	RME	CT	RME
Passive Recreational Visitor						
Current & Future	Greystone					
		Child	0.2	1	--	--
		Older Child	0.03	0.2	--	--
		Adult	0.02	0.1	--	--
	Greystone [a]					
		Child	0.2	1	--	--
		Older Child	0.03	0.2	--	--
		Adult	0.02	0.1	--	--
	Oxbow Area					
		Child	0.1	1	0	0.003
		Older Child	0.03	0.3	0	0.06
		Adult	0.01	0.1	0	0.007

CT = Central Tendency
RME = Reasonable Maximum Exposure

[a] Greystone area hazard index for Pesticides, Metals, and Dioxin only. Calculated for use with Oxbow Area to calculate incremental hazard index.

Incremental Receptor Risk = Difference in risk between the exposure point and the background exposure point.
-- = Incremental risk is not calculated for background on reference areas.
BOLDED incremental risk are above the Superfund Noncancer Hazard Index benchmark of 1.

Prepared by: KJC
Checked by: MJM

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Table 13
Summary of Cancer Risks

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Carcinogenic Risk		Floodplain Soil CT	Floodplain Soil RME	Incremental Receptor Risk CT	Incremental Receptor Risk RME
Passive Recreational Visitor					
Current & Future	Greystone	2E-06	4E-05	--	--
	Greystone [a]	7E-07	2E-05	--	--
	Oxbow Area	9E-06	3E-04	8E-06	**3E-04**

CT = Central Tendency
RME = Reasonable Maximum Exposure

[a] Greystone area risks for Pesticides, Metals, and Dioxin only. Calculated for use with Oxbow Area to calculate incremental risk.

Incremental Receptor Risk = Difference in risk between the exposure point and the background exposure point.
-- = Incremental risk is not calculated for background on reference areas.
BOLDED incremental risk are above the high end of the Superfund Cancer Risk Range (1E-04 to 1E-06).

Prepared by: KJC
Checked by: MJM

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APPENDIX A

APPENDIX A

SAMPLE SELECTION CONSIDERATIONS FOR THE RISK ASSESSMENT

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Table A-1
Analytical Data for Floodplain Soil in the Oxbow Area

Adeendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	LPX-DU-062104A 6/21/2004 0-0.5 ft	LPX-DU-062104B 6/21/2004 0-0.5 ft	LPX-DU-062104B DUP 6/21/2004 0-0.5 ft	LPX-SD-4401-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4402-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4403-0005-01 6/21/2004 0-0.5 ft
Pesticides/PCBs (mg/Kg)						
4,4'-DDD		0.00246			0.00899 J	
4,4'-DDE		0.00251 J			0.00595 J	
4,4'-DDT		0.00015 U			0.00015 U	
a-BHC		0.00015 U			0.00015 U	
a-chlordane		0.00121 J			0.00014 U	
aldrin		0.00014 U			0.00164 J	
b-BHC		0.00013 U			0.00013 U	
d-BHC		0.00016 U			0.00016 U	
dieldrin		0.00016 UJ			0.06338 J	
endosulfan I		0.00017 U			0.00017 U	
endosulfan II		0.00116			0.00016 UJ	
endosulfan sulfate		0.00019 U			0.00019 U	
endrin		0.00016 U			0.00016 U	
endrin aldehyde		0.00021 U			0.00951 J	
endrin ketone		0.00016 U			0.00016 U	
g-chlordane		0.0021 J			0.00208 J	
heptachlor		0.00015 U			0.00015 U	
heptachlor epoxide		0.00014 U			0.00014 U	
Lindane		0.00014 U			0.00076 J	
methoxychlor		0.00022 U			0.00022 U	
Technical Chlordane		0.0162 U			0.01626 U	
Toxaphene		0.0162 U			0.01626 U	
Aroclor 1016		0.01619 U			0.01625 U	
Aroclor 1221		0.01615 U			0.01622 U	
Aroclor 1232		0.01615 U			0.01622 U	
Aroclor 1242		0.01615 U			0.01622 U	
Aroclor 1248		0.01615 U			0.01622 U	
Aroclor 1254		0.18542			3.5833 J	
Aroclor 1260		0.01619 U			0.01625 U	
Aroclor 1268		0.01615 U			0.01622 U	
Inorganics (mg/Kg)						
Antimony	2.63			1.37	0.922	
Arsenic	1.45 U			2.99	3.16	
Barium	163			224	174	
Beryllium	2.69			3.61	7.9	
Cadmium	0.06 U			2.87	1.19	
Chromium	18.1			43.1	104	
Cobalt	4.3			11.9	21.2	

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Table A-1
Analytical Data for Floodplain Soil in the Oxbow Area

Adeendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	LPX-DU-062104A 6/21/2004 0-0.5 ft	LPX-DU-062104B 6/21/2004 0-0.5 ft	LPX-DU-062104B DUP 6/21/2004 0-0.5 ft	LPX-SD-4401-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4402-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4403-0005-01 6/21/2004 0-0.5 ft
Copper	23.9			36.7	17.2	
Lead	453			174	44.4	
Manganese	834			809	827	
Molybdenum	2.1			5.71	17.3	
Nickel	6.91			18.4	32.4	
Selenium	1.64 U			1.52	1.64 U	
Silver	0.399			1.04	0.452	
Thallium	0.492			0.791	0.631	
Vanadium	31.8			59.8	43.6	
Zinc	58.3			149	109	
Total Organic Carbon		0.00473	0.00507		0.01303	
Dioxins/Furans (mg/Kg)						
1234678-HpCDD		0.0000442		0.000175	0.0000379	0.0000206
1234678-HpCDF		0.0000138		0.0000443	0.0000149	0.00000881
1234789-HpCDF		0.000000875 U		0.00000246 J	0.00000121 J	0.000000597 U
123478-HxCDD		0.00000128 J		0.00000393 EMPC	0.00000129 J	0.00000061 EMPC
123478-HxCDF		0.00000251 J		0.0000128	0.00000252 J	0.00000171 J
123678-HxCDD		0.00000267 J		0.00000762	0.00000213 J	0.00000128 EMPC
123678-HxCDF		0.00000169 J		0.00000763	0.00000184 J	0.00000126 J
123789-HxCDD		0.00000206 J		0.00000628	0.00000167 J	0.000000689 U
123789-HxCDF		0.000000852 J		0.00000215 J	0.000000881 J	0.000000281 U
12378-PeCDD		0.00000123 J		*0.00000393 J*	*0.0000015 J*	*0.000000705 J*
12378-PeCDF		0.0000524 EMPC		0.0000318 EMPC	0.00000564 EMPC	0.0000038 EMPC
234678-HxCDF		0.00000132 J		0.0000097	0.00000206 J	0.00000152 J
23478-PeCDF		0.00000101 EMPC		0.0000111	0.00000184 J	0.00000194 J
2378-TCDD		0.000789 J#		0.00314 #	0.0004 J#	0.000521 #
2378-TCDF		0.00000286		0.0000193	0.00000328	0.00000164
OCDD		0.000291 J		0.0013 J	0.00023 J	0.000142 J
OCDF		0.0000192 J		0.0000615 J	0.0000292 J	0.000011 J
Toxicity Equivalency - Mammals		0.000795		0.00316	0.000405	0.000524

J - value is estimated
U - not detected, value is the detection limit
EMPC - Estimated Maximum Possible Concentration
- Value is result from second column confirmation analysis

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Table A-1
Analytical Data for Floodplain Soil in the Oxbow Area

Adeendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	LPX-SD-4404-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4405-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4406-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4407-0005-01 6/21/2004 0-0.5 ft
Pesticides/PCBs (mg/Kg)				
4,4'-DDD	0.00442			0.02658
4,4'-DDE	0.00642			0.04236
4,4'-DDT	0.00096 J			0.00276 J
a-BHC	0.00015 U			0.00019 U
a-chlordane	0.00119 J			0.00768 J
aldrin	0.00014 U			0.00097
b-BHC	0.00014 U			0.00016 U
d-BHC	0.00017 U			0.0002 U
dieldrin	0.00343			0.00251
endosulfan I	0.00017 U			0.00021 U
endosulfan II	0.00337			0.0002 U
endosulfan sulfate	0.0002 U			0.00024 U
endrin	0.00017 U			0.0002 U
endrin aldehyde	0.00023 U			0.0019
endrin ketone	0.00173			0.0002 U
g-chlordane	0.00293			0.00694
heptachlor	0.00073			0.00019 U
heptachlor epoxide	0.00018			0.00017 U
Lindane	0.00015 U			0.00018 U
methoxychlor	0.00023 U			0.00028 U
Technical Chlordane	0.03008			0.02034 U
Toxaphene	0.017 U			0.02033 U
Aroclor 1016	0.01699 U			0.02032 U
Aroclor 1221	0.01696 U			0.02028 U
Aroclor 1232	0.01696 U			0.02028 U
Aroclor 1242	0.01696 U			0.02028 U
Aroclor 1248	0.01696 U			0.02028 U
Aroclor 1254	0.01696 U			0.63783
Aroclor 1260	0.01699 U			0.02032 U
Aroclor 1268	0.10311			0.02028 U
Inorganics (mg/Kg)				
Antimony	7.01			2.8
Arsenic	12.8			2.61
Barium	514			288
Beryllium	4.54			3.46
Cadmium	8.25			3.77
Chromium	101			46.1
Cobalt	22			8.79

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Table A-1
Analytical Data for Floodplain Soil in the Oxbow Area

Adeendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	LPX-SD-4404-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4405-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4406-0005-01 6/21/2004 0-0.5 ft	LPX-SD-4407-0005-01 6/21/2004 0-0.5 ft
Copper	357			73.2
Lead	1835			246
Manganese	859			809
Molybdenum	4.58			5.83
Nickel	30.9			30.7
Selenium	2.22			1.78
Silver	11.1			1.05
Thallium	1.04			0.401
Vanadium	71.1			62.7
Zinc	1867			454
Total Organic Carbon	0.01573			0.03614
Dioxins/Furans (mg/Kg)				
1234678-HpCDD	0.00344	0.000213 J	0.000229	0.000224
1234678-HpCDF	0.00319	0.0000893 J	0.0000723	0.0000752
1234789-HpCDF	0.0000936	0.00000527 J	0.0000049 J	0.00000584
123478-HxCDD	0.0000575	0.00000617 J	0.00000387 J	0.00000624
123478-HxCDF	0.0000982	0.0000117 J	0.00000832	0.000019
123678-HxCDD	0.000504	0.0000128 J	0.00000967	0.0000119
123678-HxCDF	0.000102	0.00000855 J	0.0000143 EMPC	0.0000123
123789-HxCDD	0.000213	0.00000875 J	0.00000836	0.00000909
123789-HxCDF	0.0000623	0.0000027 J	0.00000428 EMPC	0.00000393 J
12378-PeCDD	0.0000521	0.00000691 J	0.00000419 J	0.00000774
12378-PeCDF	0.0000244 J	0.00000944 EMPC	0.000227 EMPC	0.000054 EMPC
234678-HxCDF	0.000212	0.0000118 J	0.00000707	0.0000113
23478-PeCDF	0.000173	0.0000063 J	0.0000118	0.0000174
2378-TCDD	0.0000122	0.00427 J#	0.0018 #	0.00207 #
2378-TCDF	0.0000205	0.00000754 J	0.00000673	0.0000239
OCDD	0.0041	0.00138 J	0.0016 J	0.00148 J
OCDF	0.00177	0.000114 J	0.00011 J	0.000102 J
Toxicity Equivalency - Mammals	0.000347	0.004291	0.001831	0.002102

J - value is estimated
U - not detected, value is the detection limit
EMPC - Estimated Maximum Possible Concentration
- Value is result from second column confirmation analysis

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Table A-2
Analaytical Data for Floodplain Soil in Background Area (Greystone Mill Pond Area)

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	RWR-FP-5001-0000-01 7/17/2001	RWR-FP-5002-0000-01 7/16/2001	RWR-FP-5003-0000-01 7/17/2001	RWR-FP-5004-0000-01 7/19/2001
Semivolatiles (ug/kg)				
1,1'-Biphenyl	61.7	58.57	26.02	36.9
2,4,5-Trichlorophenol	5200 U	3300 U	3000 U	3200 U
2,4-Dinitrophenol	5200 U	R	3000 U	3200 UJ
2-Methylnaphthalene	83.4	170.22 J	72.82	101.96
2-Nitrophenol	1000 U	640 U	580 U	630 U
4-Methylphenol	1000 U	640 U	580 U	630 U
4-Nitrophenol	5200 U	3300 U	3000 U	3200 U
Acenaphthene	186.26	563.84 J	195.04	216.23
Acenaphthylene	497.49	210.65 J	196.67	365.79
Anthracene	699.86	982.95	480.2	666.64
Benzaldehyde	87.69	112.08	60.52	172.29
Benzo(a)anthracene	3359.99	3311.39	2292.65	3410.86
Benzo(a)pyrene	3418.03	3204.84	2291.23	3394.61
Benzo(b)fluoranthene	4288.61	3263.74	2315.49	3940.44
Benzo(g,h,i)perylene	2871.39	2183.89	1676	2612.84
Benzo(k)fluoranthene	3863.54	3098.9	2283.94	3559.19
bis(2-Ethylhexyl)phthalate	1900 J	1600	800 J	1700
Butylbenzylphthalate	540 J	370 J	120 J	580 J
Carbazole	420 J	860 J	830 J	590 J
Chrysene	4488.51	3844.25	2747.66	4298.55
Dibenzo(a,h)anthracene	728.51	590.75 J	435.44	704.69
Dibenzofuran	160.55	399.25	163.56	195.84
Di-n-Butylphthalate	150 J	74 J	61 J	170 J
Di-n-octylphthalate	1000 UJ	83 J	580 UJ	630 UJ
Fluoranthene	7731.24	7686.74 J	5227.48	7547.84
Fluorene	256.25	658.99 J	262.7	316.66
Indeno(1,2,3-cd)pyrene	3092.9	2384.11	1768.19	2830.24
Naphthalene	123.24	302.18 J	103.75	151.65
Pentachlorophenol	5200 U	3300 U	3000 U	3200 U
Phenanthrene	3485.83	5301.36	3072.07	3962.44
Phenol	1000 U	640 U	580 U	630 U
Pyrene	6313.86	6210.02	4335.06	6372.72
Pesticides (ug/kg)				
4,4'-DDD	15.17	4.64 J	6.33	6.78 J
4,4'-DDE	20.61	5.19 J	7.65	19.96 J
4,4'-DDT	6.59	2.69 J	6.6	18.27 J
Aldrin	2.15 U	1.39 U	1.24 U	1.55 U
alpha-BHC	2.15 U	1.39 U	1.24 U	1.55 U
alpha-Chlordane	35.92	16.7 J	7.81	10.76 J
beta-BHC	2.15 U	1.39 U	1.24 U	1.55 U
delta-BHC	2.15 U	1.39 U	1.24 U	1.55 U
Dieldrin	9.41	4.3 J	4.24	7.19 J

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Table A-2
Analaytical Data for Floodplain Soil in Background Area (Greystone Mill Pond Area)

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	RWR-FP-5001-0000-01 7/17/2001	RWR-FP-5002-0000-01 7/16/2001	RWR-FP-5003-0000-01 7/17/2001	RWR-FP-5004-0000-01 7/19/2001
Endosulfan I	2.15 U	1.39 UJ	1.24 U	1.55 U
Endosulfan II	2.15 U	1.39 U	1.24 U	1.55 U
Endosulfan Sulfate	2.15 U	4.09 J	8.15	12.69 J
Endrin	2.15 U	1.39 U	1.24 U	1.55 U
Endrin Aldehyde	2.15 U	1.39 U	1.24 U	1.55 U
Endrin Ketone	2.15 U	1.39 U	1.24 U	1.55 U
gamma-BHC	2.15 U	1.39 U	1.24 U	1.55 U
gamma-Chlordane	2.15 U	1.39 UJ	1.24 U	1.55 U
Heptachlor	2.15 U	1.39 U	1.24 U	1.55 U
Heptachlor Epoxide	2.15 U	1.39 U	1.24 U	0.74 J
Methoxychlor	2.15 U	1.39 U	1.24 U	1.55 U
Technical Chlordane	735.38	347.23	278.2	361.99 J
Toxaphene	53.85 U	34.7 U	31.03 U	38.77 U
Aroclors (ug/kg)				
Aroclor-1016	26.93 U	17.35 U	15.51 U	19.38 U
Aroclor-1221	26.93 U	17.35 U	15.51 U	19.38 U
Aroclor-1232	26.93 U	17.35 U	15.51 U	19.38 U
Aroclor-1242	26.93 U	17.35 U	15.51 U	19.38 U
Aroclor-1248	26.93 U	17.35 U	15.51 U	19.38 U
Aroclor-1254	838.72	207.34	394.64	639.23 J
Aroclor-1260	26.93 U	17.35 U	15.51 U	19.38 U
Aroclor-1268	83.6	43.56	68.85	139.53 J
Aroclor, Total	922.32	250.9	463.49	778.76 J
Inorganics and Metals (mg/kg)				
Aluminum	21793 J	12231 J	10971 J	18600 J
Antimony	0.521 J	0.462 J	0.532 J	0.982 J
Arsenic	5.58	6.34	6.74	12.2
Barium	239	282	181	222
Beryllium	4.46	2.48	1.9	3.47
Cadmium	3.46	1.06	0.711	1.28
Chromium	291	171	214	246
Cobalt	9.57	12.5	10.1	20.3
Copper	324	109	132	255
Iron	24538	25960	21383	37162
Lead	591	319	316	574
Manganese	511	2286	439	4126
Mercury	0.811	0.381	0.423	0.712
Mercury (methyl)	0.000326 J	0.000762 J	0.000535 J	0.000348 J
Molybdenum	34.8 J	37 J	87.7 J	56.6 J
Nickel	387	27.4	25.5	39
Selenium	0.862 J	0.611 U	0.687 J	0.963 J
Silver	3.8	1.38	1.23	2.31
Thallium	0.566	0.345	0.346	0.585

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Table A-2
Analaytical Data for Floodplain Soil in Background Area (Greystone Mill Pond Area)

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	RWR-FP-5001-0000-01 7/17/2001	RWR-FP-5002-0000-01 7/16/2001	RWR-FP-5003-0000-01 7/17/2001	RWR-FP-5004-0000-01 7/19/2001
Vanadium	90.7	53.6	81.7	103
Zinc	497	248	158	249
Dioxins, Furans, HCX (ug/kg)				
HCX	0.08577 J	0.11704 J	0.15346 J	0.41706 J
TCX	R	R	R	R
2,3,7,8-TCDD	0.0567	0.00352 U	0.00457 U	0.01842 U
1,2,3,7,8-PeCDD	0.00672 J	0.00309 J	0.00266 J	0.00805 J
1,2,3,4,7,8-HxCDD	0.01131 J	0.0055 J	0.00424 J	0.01228 J
1,2,3,6,7,8-HxCDD	0.04643	0.02198	0.01811	0.04586 J
1,2,3,7,8,9-HxCDD	0.031	0.0153	0.01394	0.03504 J
1,2,3,4,6,7,8-HpCDD	0.87788	0.38319	0.27936	1.02763
OCDD	5.93093	2.40931	2.19127	8.33815
2,3,7,8-TCDF	0.11028 J	0.01029 J	0.01225 J	0.04057 J
1,2,3,7,8-PeCDF	0.00521 J	0.00294 J	0.00418 J	0.00794 J
2,3,4,7,8-PeCDF	0.01171 J	0.00663 J	0.00758 J	0.02446 U
1,2,3,4,7,8-HxCDF	0.03109	0.0192	0.02044	0.05059 J
1,2,3,6,7,8-HxCDF	0.02362	0.01297 J	0.01357	0.03295 J
2,3,4,6,7,8-HxCDF	0.01554 J	0.01027 J	0.00968 J	0.02481 J
1,2,3,7,8,9-HxCDF	0.00107 J	0.00061 J	0.00041 J	0.00353 U
1,2,3,4,6,7,8-HpCDF	0.3021	0.14191	0.14823	0.48157
1,2,3,4,7,8,9-HpCDF	0.01501 J	0.00693 J	0.0073 J	0.02157 J
OCDF	0.47782	0.13373 J	0.21667	1.25355
Toxicity Equivalency - Mammals				
PCB Congeners (ug/kg)				
2-Monochlorobiphenyl (1)		0.06167 J		
4-Chlorobiphenyl (3)		0.09923 J		
2,2'-Dichlorobiphenyl (4)		0.80503 J		
2,3-Dichlorobiphenyl (5)		0.09878 J		
2,3'-Dichlorobiphenyl (6)		0.73743 J		
2,4-Dichlorobiphenyl (7)		0.11977 J		
2,4'-Dichlorobiphenyl (8)		3.58234 J		
2,5-Dichlorobiphenyl (9)		0.24 J		
2,6-Dichlorobiphenyl (10)		0.03945 J		
3,4-Dichlorobiphenyl (12)		0.24342 J		
2,2',3'-Trichlorobiphenyl (16)		2.31589 J		
2,2',4-Trichlorobiphenyl (17)		2.41576 J		
2,2',5-Trichlorobiphenyl (18)		2.18236 J		
2,2',6-Trichlorobiphenyl (19)		0.58127 J		
2,3,3'-Trichlorobiphenyl (20)		8.99815 J		
2,3,4'-Trichlorobiphenyl (22)		3.25385 J		
2,3,6-Trichlorobiphenyl (24)		0.44674 J		
2,3',4-Trichlorobiphenyl (25)		0.43219 J		
2,3',5-Trichlorobiphenyl (26)		1.09534 J		

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Table A-2
Analaytical Data for Floodplain Soil in Background Area (Greystone Mill Pond Area)

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	RWR-FP-5001-0000-01 7/17/2001	RWR-FP-5002-0000-01 7/16/2001	RWR-FP-5003-0000-01 7/17/2001	RWR-FP-5004-0000-01 7/19/2001
2,4',5-Trichlorobiphenyl (31)		4.0322 J		
2,4',6-Trichlorobiphenyl (32)		0.79627 J		
2,2',3,3'-Tetrachlorobiphenyl (40)		3.29677 J		
2,2',3,4'-Tetrachlorobiphenyl (42)		1.54495 J		
2,2',3,5-Tetrachlorobiphenyl (43)		5.38647 J		
2,2',3,5'-Tetrachlorobiphenyl (44)		4.21199 J		
2,2',3,6-Tetrachlorobiphenyl (45)		1.17033 J		
2,2',3,6'-Tetrachlorobiphenyl (46)		0.45003 J		
2,2',4,5-Tetrachlorobiphenyl (48)		0.92776 J		
2,2',4,5'-Tetrachlorobiphenyl (49)		2.10611 J		
2,2',4,6-Tetrachlorobiphenyl (50)		0.92847 J		
2,3,3',4'-Tetrachlorobiphenyl (56)		0.86104 J		
2,3,3',6-Tetrachlorobiphenyl (59)		0.40694 J		
2,3,4,4'-Tetrachlorobiphenyl (60)		0.24141 J		
2,3,4,5-Tetrachlorobiphenyl (61)		3.10409 J		
2,3,4',5-Tetrachlorobiphenyl (63)		0.03272 J		
2,3,4',6-Tetrachlorobiphenyl (64)		1.57756 J		
2,3',4,4'-Tetrachlorobiphenyl (66)		2.55948 J		
3,3',4,4'-Tetrachlorobiphenyl (77)		0.39357 J		
3,4,4',5-Tetrachlorobiphenyl (81)		0.096 UJ		
2,2',3,3',4-Pentachlorobiphenyl (82)		3.68549 J		
2,2',3,3',5-Pentachlorobiphenyl (83)		6.56009 J		
2,2',3,3',6-Pentachlorobiphenyl (84)		8.05484 J		
2,2',3,4,4'-Pentachlorobiphenyl (85)		3.20073 J		
2,2',3,4,5-Pentachlorobiphenyl (86)		13.20021 J		
2,2',3,4,6-Pentachlorobiphenyl (88)		3.37677 J		
2,2',3,4,6'-Pentachlorobiphenyl (89)		0.11235 J		
2,2',3,4',5-Pentachlorobiphenyl (90)		11.07859 J		
2,2',3,5,5'-Pentachlorobiphenyl (92)		2.7982 J		
2,2',3,5,6-Pentachlorobiphenyl (93)		17.80039 J		
2,3,3',4,4'-Pentachlorobiphenyl (105)		4.41497 J		
2,3,3',4,5-Pentachlorobiphenyl (106)		0.93745 J		
2,3,3',4',5'-Pentachlorobiphenyl (108)		0.73618 J		
2,3,3',4',6-Pentachlorobiphenyl (110)		34.32638 J		
2,3,4,4',5-Pentachlorobiphenyl (114)		0.18779 J		
2,3',4,4',5-Pentachlorobiphenyl (118)		14.77995 J		
3,3',4,4',5-Pentachlorobiphenyl (126)		0.34063 J		
2,2',3,3',4,4'-Hexachlorobiphenyl (128)		8.71691 J		
2,2',3,3',4,5-Hexachlorobiphenyl (129)		29.84594 J		
2,2',3,3',4,5'-Hexachlorobiphenyl (130)		2.33884 J		
2,2',3,3',4,6-Hexachlorobiphenyl (131)		0.48272 J		
2,2',3,3',4,6'-Hexachlorobiphenyl (132)		17.96661 J		
2,2',3,3',5,6-Hexachlorobiphenyl (134)		2.52531 J		

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Table A-2
Analaytical Data for Floodplain Soil in Background Area (Greystone Mill Pond Area)

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	RWR-FP-5001-0000-01 7/17/2001	RWR-FP-5002-0000-01 7/16/2001	RWR-FP-5003-0000-01 7/17/2001	RWR-FP-5004-0000-01 7/19/2001
2,2',3,3',5,6'-Hexachlorobiphenyl (135)		7.49559 J		
2,2',3,3',6,6'-Hexachlorobiphenyl (136)		5.21951 J		
2,2',3,4,4',5-Hexachlorobiphenyl (137)		4.39408 J		
2,2',3,4,5,5'-Hexachlorobiphenyl (141)		3.25807 J		
2,2',3,4,5',6-Hexachlorobiphenyl (144)		0.0963 UJ		
2,2',3,4',5,5'-Hexachlorobiphenyl (146)		1.18174 J		
2,2',3,4',5,6-Hexachlorobiphenyl (147)		21.33722 J		
2,2',4,4',5,5'-Hexachlorobiphenyl (153)		7.67713 J		
2,3,3',4,4',5-Hexachlorobiphenyl (156)		2.52639 J		
2,3,3',4,4',6-Hexachlorobiphenyl (158)		2.38598 J		
2,3',4,4',5,5'-Hexachlorobiphenyl (167)		1.09031 J		
3,3',4,4',5,5'-Hexachlorobiphenyl (169)		0.0963 UJ		
2,2',3,3',4,4',5-Heptachlorobiphenyl (170)		7.80164 J		
2,2',3,3',4,4',6-Heptachlorobiphenyl (171)		1.94133 J		
2,2',3,3',4,5,5'-Heptachlorobiphenyl (172)		0.62098 J		
2,2',3,3',4,5,6'-Heptachlorobiphenyl (174)		8.30421 J		
2,2',3,3',4,5',6-Heptachlorobiphenyl (175)		0.10577 J		
2,2',3,3',4,6,6'-Heptachlorobiphenyl (176)		0.68504 J		
2,2',3,3',4,5',6'-Heptachlorobiphenyl (177)		3.22518 J		
2,2',3,3',5,5',6-Heptachlorobiphenyl (178)		0.77451 J		
2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)		4.95613 J		
2,2',3,4,4',5,6'-Heptachlorobiphenyl (182)		0.19261 UJ		
2,2',3,4,4',5',6-Heptachlorobiphenyl (183)		1.36684 J		
2,2',3,4,4',6,6'-Heptachlorobiphenyl (184)		0.01961 UJ		
2,2',3,4,5,5',6-Heptachlorobiphenyl (185)		0.28095 J		
2,2',3,4',5,5',6-Heptachlorobiphenyl (187)		2.81425 J		
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)		0.14433 J		
2,3,3',4,4',5,6-Heptachlorobiphenyl (190)		0.9734 J		
2,3,3',4,4',5',6-Heptachlorobiphenyl (191)		0.12793 J		
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (194)		1.89239 J		
2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)		0.91833 J		
2,2',3,3',4,4',5,6'-Octachlorobiphenyl (196)		1.24699 J		
2,2',3,3',4,4',6,6'-Octachlorobiphenyl (197)		0.04508 J		
2,2',3,3',4,5,5',6-Octachlorobiphenyl (198)		7.61985 J		
2,2',3,3',4,5,6,6'-Octachlorobiphenyl (200)		0.56363 J		
2,2',3,3',4,5',6,6'-Octachlorobiphenyl (201)		0.41837 J		
2,2',3,4,4',5,5',6-Octachlorobiphenyl (203)		2.27038 J		
2,3,3',4,4',5,5',6-Octachlorobiphenyl (205)		0.10246 J		
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl		11.30434 J		
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl		0.78162 J		
Decachlorobiphenyl (209)		16.45018 J		

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Table A-2
Analaytical Data for Floodplain Soil in Background Area (Greystone Mill Pond Area)

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	RWR-FP-5001-0000-01 7/17/2001	RWR-FP-5002-0000-01 7/16/2001	RWR-FP-5003-0000-01 7/17/2001	RWR-FP-5004-0000-01 7/19/2001
Toxicity Equivalency (PCB) - Mammals		0.0000379		

J - value is estimated
U - not detected, value is the detection limit
R - rejected

mg - milligrams
kg - kilograms
ug - micrograms

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APPENDIX B

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APPENDIX B

TOXICITY ASSESSMENT SUPPORT INFORMATION

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Table B-1
WHO TEFs for Human Health Risk Assessment

Addendum To Baseline Human Health Risk Assessment: Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Congener	TEF Value
Dibenzo-p-dioxins	
2,3,7,8-TCDD	1
1,2,3,7,8-PnCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0001
Dibenzofurans	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PnCDF	0.05
2,3,4,7,8-PnCDF	0.5
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0001
Non-ortho PCBs	
PCB 77	0.0001
PCB 81	0.0001
PCB 126	0.1
PCB 169	0.01
Mono-ortho PCBs	
PCB 105	0.0001
PCB 114	0.0005
PCB 118	0.0001
PCB 123	0.0001
PCB 156	0.0005
PCB 157	0.0005
PCB 167	0.00001
PCB 189	0.0001
Hexachloroxanthene (USEPA, 2002)	
HCX	0.0002

Notes:

[1] TEFs are based on the conclusions of the World Health Organization meeting in Stockholm, Sweden, June 15-18 1997 (Van den Berg et al., 1998).

Van den Berg, M., Birnbaum, L., Bosveld, B.T.C., Brunström, B., Cook, P., Feeley, M., Giesy, J.P., Hanberg, A., Hasegawa, R., Kennedy, S.W., Kubiak, T., Larsen, J.C., van Leeuwen, F.X.R., Liem, A.K.D.,Nolt, C., Peterson, R.E., Poellinger, L., Safe, S., Schrenk, D., Tillitt,D., Tysklind, M., Younes, M., Waern, F.,Zacharewski, 1998. T. Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environmental Health Perspective, 106 (12), 775-792.

USEPA, 2002. Personal communication with Chau Vu, USEPA Region I re: TEF for HCX, May 22.

INTERIM FINAL

Part II

Addendum to the Interim Final Baseline Ecological Risk Assessment: Oxbow Area

Centredale Manor Restoration Project Superfund Site North Providence, Rhode Island

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August 2006

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EXECUTIVE SUMMARY

This Addendum presents an assessment of ecological risks for the Oxbow Area at the Centredale Manor Restoration Project Superfund Site ("Centredale Site"), located in North Providence, Rhode Island. The Oxbow Area is a forested wetland area located to the west of the Woonasquatucket River immediately downstream of the Allendale Dam. A site location map is provided as Figure ES-1. This Addendum supplements the Baseline Ecological Risk Assessment (BERA) that was previously performed at the Centredale Site (MACTEC, 2004).

This Addendum has been conducted in accordance with the United States Environmental Protection Agency (USEPA) *Ecological Risk Assessment Guidance for Superfund, Process Document for Designing and Conducting Ecological Risk Assessments* (ERAGs; USEPA, 1997), as well as USEPA Region I risk assessment guidance contained in Risk Updates (USEPA, 1996; 1999). USEPA (1997) established an eight-step process for assessing ecological risk. The first two steps comprise the Screening Level Ecological Risk Assessment (SLERA), which is conducted to determine whether a site poses no or negligible risk, and if not, which contaminants and exposure pathways may require further evaluation. Components of a BERA are the subject of steps three through seven.

A BERA that evaluated ecological risks to receptors exposed to aquatic and associated floodplain habitat has previously been conducted at the Centredale Site (MACTEC, 2004). The BERA evaluated four separate exposure areas within the river proper including the Allendale Pond reach, the Lyman Mill Pond reach, the Manton Pond reach, and the former Dyerville Pond reach (Figure ES-1); these four areas were designated as APB, LPX, MAP, and DYR, respectively. The BERA evaluated the following assessment endpoints:

1. Protection and maintenance (i.e., survival, growth, and reproduction) of aquatic and floodplain invertebrate communities which are a forage base for fish and wildlife.
2. Protection and maintenance of demersal, omnivorous fish populations as a forage base or sport fishery.
3. Protection and maintenance of pelagic, piscivorous, or semi-piscivorous fish populations as a forage base or sport fishery.
4. Protection and maintenance of piscivorous mammal and bird populations.
5. Protection and maintenance of insectivorous mammal and bird populations.
6. Protection and maintenance of omnivorous mammal and bird populations.

Three of these assessment endpoints (i.e., Assessment Endpoints # 1, 5, and 6) included evaluation of ecological receptors that utilize floodplain habitat and may be exposed to contamination within the study area. The BERA evaluated floodplain exposures in the Allendale Pond and Lyman Mill Pond reaches and also quantified ecological risks in similar habitat within the upgradient background area associated with Greystone Mill Pond (which was referred to as "GMP"). Although the BERA evaluated floodplain habitat associated with Lyman Mill Pond, the possibility that flood stage conditions could periodically result in river water overtopping the western bank of the Woonasquatucket River below the Allendale Pond was not fully appreciated until after the BERA had been developed. Consequently, ecological exposures within the Oxbow Area were not identified in the Conceptual Site Model (CSM) and ecological (and human health) risks in this area were not evaluated as part of that investigation.

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Available information indicates that flooding of the Woonasquatucket River may have deposited site-related contaminants in and on the surficial soils and sediment in the Oxbow Area. Various ecological receptors including wildlife, amphibians, invertebrates, and plants that reside or forage in this relatively undisturbed habitat could be exposed to contaminants as a result of these activities. Floodplain soil sampling and analysis previously performed at the Centredale Site for the BERA had detected elevated (i.e., above typical background conditions) levels of dioxin (particularly 2,3,7,8-tetrachlorodibenzo-*p*-dioxin; TCDD), some pesticides, polychlorinated biphenyls (PCBs) (primarily Aroclor 1254), and selected inorganic analytes (Battelle, 2004a).

This Addendum compared maximum analytical concentrations to conservative screening benchmarks to confirm that the contaminants of potential ecological concern (COPECs) for the Oxbow Area are comparable to those selected in the BERA, and identified complete exposure pathways, and receptors of concern. To the extent feasible, elements of the BERA process (i.e., Steps 3 through 7) developed to evaluate ecological risks in other floodplain habitats at the Centredale Site, were also incorporated into this Addendum for the Oxbow Area. This refined analysis was conducted to provide a more realistic assessment of the likelihood and magnitude of potential risk to wildlife receptors and soil invertebrate receptors. Although additional biological data were not collected to support the Oxbow Area assessment, previous site-specific data (including earthworm tissue uptake and soil invertebrate community studies) were used where applicable. This additional level of analysis was conducted to provide a better understanding of how potential ecological risks in the Oxbow Area compare to other exposure areas at the Centredale Site so that site-wide decision-making can be facilitated.

In accordance with USEPA guidance, this Addendum, which comprises the first two steps of the ERAGs SLERA approach, includes four components: problem formulation, exposure assessment, effects assessment, and risk characterization. Each of these components is described below.

PROBLEM FORMULATION

The problem formulation establishes the goals, breadth, and major issues for consideration and includes a description of the environmental setting and resources potentially at risk; the selection of COPECs and their fate, transport, and ecotoxicity; the selection of receptors of concern and species profiles; a CSM with complete exposure pathways; assessment and measurement endpoints along with the study rationale, and risk hypotheses.

Environmental Setting

The Woonasquatucket River is designated as a Class B1 waterbody, suitable for primary and secondary human contact, recreation, and fish and wildlife habitat. The land-use for the eastern shore of Allendale and Lyman Mill reaches is primarily residential with some commercial and industrial activity. Residential, commercial, and industrial properties are located approximately 200 feet or more from the western shore of Allendale and Lyman Mill. Undeveloped land adjacent to the river includes palustrine forest, scrub-shrub, and emergent marsh. Fish and aquatic invertebrates associated with the Woonasquatucket River are typical of a warm-water fishery in New England; these organisms in turn support a variety of wildlife species that forage on fish, invertebrates, or mixed diets (piscivores, insectivores/vermivores, and omnivores, respectively).

Conceptual Site Model (CSM)

The CSM identifies the source, media, pathway, and route of exposures evaluated, as well as the relationship between the measurement and assessment endpoints (USEPA, 1997). It serves as a communication tool that illustrates the major pathways by which ecological receptors might be exposed to COPECs associated with releases from the Centredale source area. Figure ES-2 presents the ecological CSM for the Oxbow Area; a site-wide ecological CSM is presented in the BERA (MACTEC, 2004).

Source Area. The main area of the Centredale Site, is located in North Providence, Rhode Island, just south of Route 44 on the eastern bank of the Woonasquatucket River (Figure ES-1). The Centredale Site source area consists of two parcels located at 2072 and 2074 Smith Street (Lots 200 & 250) that cover approximately 9.04 acres. The remaining portions of the site consist of reaches, man-made ponds, and wetlands associated with the Woonasquatucket River. The river flows from north to south.

The Centredale Site was used for disposal of wastes containing hazardous substances. Between approximately 1940 and 1970, USEPA has reason to believe that the main area of the site was the location of a chemical manufacturing facility (which produced hexachlorophene, among other chemicals) and an incineration-based drum recycling facility. Evidence suggests that operations at the former chemical company and drum reconditioning facility resulted in waste disposal onto surface soil and beneath the ground surface. Wastes have also been released directly into the Woonasquatucket River, which runs along the western side of the area (Tetra Tech NUS Inc., 2000a).

Currently, two high rise buildings (Centredale Manor and Brook Village, both federally-subsidized, senior housing complexes) are located in the main area of the Centredale Site, which is zoned for residential occupancy. In addition to the buildings, the main area is covered by roadway, paved parking lots, and two capped source areas. The first housing complex was built in approximately 1976. The second high rise was built in 1982. Construction records show that hazardous substances were removed from the Centredale Site during the construction of the second complex. Samples indicate the presence of TCDD and other contaminants in soil and sediment in the main portion of the site and the river sediment and floodplain soils downstream. Dioxins and furans have been detected in soils and sediments as well as in fish tissue collected in 1996 from the Woonasquatucket River. Other contaminants detected in Centredale Site media include PCBs, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), hexachloroxanthene (HCX), phthalates, and metals. Elevated VOCs have been detected in overburden groundwater at the Centredale Site and are discharging to the adjacent reach of the Woonasquatucket River as confirmed by vapor diffusion samplers (Church et al., 2000).

Migration of Contaminants. Downstream sediments have been impacted through the transport and deposition of contaminants from the source area. Dioxins and furans have been detected in sediments in Allendale Pond, Lyman Mill Pond, and areas located further downstream (Figure ES-1). With the partial breaching of Allendale Dam in 1991, and the more recent breach in 2001, further contaminant migration may have occurred.

Contaminants that were discharged from the source area entered the Woonasquatucket River and were transported downstream either dissolved in the water column or adsorbed to resuspended sediments. Overland flow during flooding events resulted in contamination of lateral floodplain habitats associated with the river. Over time, contaminants preferentially accumulated in low energy sediment and floodplain soils, which are characterized by higher organic carbon content.

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Compounds with a propensity to bioaccumulate were taken up by plants, invertebrates, and fish and were transferred through aquatic food webs. Wildlife species that consume these lower trophic level organisms could also be exposed to site-related contaminants. Contaminants that were deposited in floodplain soils could also enter the terrestrial food web by a similar process.

Potential Ecological Receptors. Potential ecological receptor species considered in this Addendum include floodplain invertebrates, amphibians, birds, and terrestrial mammals that may utilize the Oxbow Area habitat. Soil invertebrates and wildlife that prey on these species may be exposed to contaminants in floodplain soil directly or by ingesting contaminated prey. Consistent with the BERA, exposures by floodplain plant species were considered to be of secondary concern and were not evaluated in this Addendum.

Ecological Exposure Pathways. Ecological receptors may be exposed to site-related contaminants via a variety of exposure pathways. A complete exposure pathway involves a potential for contact between a given receptor and contamination either through direct exposure to an abiotic medium or indirectly through prey consumption. Pathways are evaluated by considering information on contaminant fate and transport, ecosystems potentially affected, and the magnitude and extent of contamination (USEPA, 1997).

This Addendum includes evaluation of the following exposure pathways: direct contact with floodplain soils by invertebrate receptors; ingestion of biota by vermivorous (i.e., receptors that include a significant percentage of earthworms in their diet) and omnivorous wildlife receptors; and incidental ingestion of floodplain soil by wildlife receptors.

Species representing various trophic levels were selected as representative receptor species to evaluate the assessment endpoints developed for the BERA for the Centredale Site (MACTEC, 2004) and exposures to the relevant species were also evaluated in this Addendum. The selected species are intended to be representative of other species at the same trophic level that share similar ecological characteristics. These groups of species are generally referred to as guilds. By evaluating a representative member of a guild and by accounting for the predominant guilds, the uncertainty associated with missing an important species group or pathway is reduced. In addition to the general category of floodplain soil invertebrates, the following terrestrial wildlife receptors of concern were evaluated in this Addendum:

- Vermivorous Birds – American woodcock
- Vermivorous Mammals – Short-tailed shrew
- Omnivorous Mammals – Raccoon

Summary of Data

This Addendum is based on data collected from a single investigation at the Centredale Site conducted to support the Remedial Investigation report (Battelle, 2004a). Data were collected from seven locations within the Oxbow Area floodplain, including three from the abandoned river channel. Sampling and analysis within the Oxbow Area detected elevated (i.e., above typical background conditions) levels of dioxin (particularly 2,3,7,8-tetrachlorodibenzo-*p*-dioxin; TCDD), some pesticides, PCBs (primarily Aroclor 1254), and selected inorganic analytes (Battelle, 2004a), which is consistent with the findings from other areas within the Centredale Site, as described in the BERA.

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Contaminants of Potential Ecological Concern (COPEC) Selection

Contaminants of potential ecological concern (COPECs) were identified based on a comparison of maximum detected concentrations floodplain soil samples to risk-based screening concentrations. Although no biological tissue samples were collected specifically to support this Addendum, earthworm tissue concentrations of the floodplain soil COPECs were estimated using site-derived biota-soil accumulation factors (BSAFs) that were developed as part the BERA (MACTEC, 2004). COPECs selected for the environmental media evaluated in this Addendum include the following:

- Floodplain soil: inorganic compounds, pesticides, PCBs (Aroclors), and dioxins and furans.
- Earthworm tissue: inorganic compounds, pesticides, PCBs (Aroclors), and dioxins and furans.

Consistent with the revised CSM, which provides a linkage among the historical source area and contaminated upgradient Woonasquatucket River sediments, and Oxbow Area floodplain soils, the Oxbow Area COPECs are comparable to those identified in the BERA (MACTEC, 2004).

Ecotoxicology of Selected COPECs

The BERA for the Centredale Site (MACTEC, 2004) summarized the available toxicological literature for all classes of compounds identified as COPECs for each receptor category evaluated in this Addendum (i.e., invertebrates, birds, and mammals). Consistent with the BERA, a Toxic Equivalency (TEQ) approach (Van den Berg et al., 1998) was employed in this Addendum to overcome the difficulty in assessing the overall toxicity of dioxin mixtures. Specific Toxicity Equivalency Factors (TEFs) have been developed for human/mammals, birds, and fish. A TEF is a congener-specific weighting term used to express the concentration of a dioxin or furan congener in terms of a toxicologically equivalent concentration of 2,3,7,8-TCDD (considered to be the most toxic congener). TEFs for dioxin and furan congeners range from 0.0001 (e.g., octachlorodibenzodioxin [OCDD]) to 1 (e.g., 2,3,7,8-TCDD) (Van den Berg, et al., 1998). A Toxic Equivalent TEQ concentration was derived by summing the products of the individual congener concentrations and their corresponding TEFs for a given environmental sample. The TEQ values presented in the Addendum are reported as the sum of dioxin and furan congeners.

Analytical data for PCB congeners in floodplain soil are not available and toxic equivalencies were not calculated for this class of compounds. Instead, PCBs were evaluated as Aroclors. In addition, floodplain soil samples were not analyzed for HCX, as was done for the BERA; however this site-related compound has a chemical structure and potential mode of action that is similar to dioxin and furan compounds, which were evaluated. The BERA concluded that HCX and PCB congeners contributed far less than 2,3,7,8-TCDD to the overall risks posed to ecological receptors at the Centredale Site.

Assessment and Measurement Endpoints

The assessment endpoints evaluated in this Addendum consist of the following:

1. Protection and maintenance (i.e., survival, growth, reproduction) of floodplain invertebrate communities which serve as a forage base for wildlife.
2. Protection and maintenance of vermivorous mammal and bird populations.
3. Protection and maintenance of omnivorous mammal populations.

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Risk questions and measurement endpoints were identified for each of these six assessment endpoints:

Assessment Endpoint 1: Protection and maintenance (i.e., survival, growth, reproduction) of floodplain invertebrate communities (as represented by the earthworm), which are a forage base for wildlife.

The following risk questions were established for this assessment endpoint:

- Do measured concentrations of COPECs in floodplain soil exceed appropriate guidelines for the protection of floodplain soil invertebrate populations?
- Do measured and modeled concentrations of COPECs in the tissues of floodplain soil invertebrates (such as earthworms) exceed benchmarks for residue effects on survival, growth, or reproduction?
- Do the available floodplain soil invertebrate data indicate presence/absence of ecological integrity?

The following measurement endpoints were selected to evaluate risk to this endpoint receptor group:

- Comparison of floodplain soil COPEC concentrations to benchmarks/guidelines.
- Comparison of estimated COPEC concentrations in floodplain soil invertebrates to CBRs.
- Site-specific study of floodplain soil invertebrate community structure/function.

Assessment Endpoint 2: Protection and maintenance of vermivorous mammal and bird populations (as represented by the short-tailed shrew and American woodcock, respectively).

The following risk questions were established for this assessment endpoint:

- Do ingestion doses of COPECs in vermivorous wildlife exceed toxicity reference values (TRVs) or TEQs for adverse effects on survival, growth, or reproduction?
- Do residues of COPECs in eggs and/or tissues of vermivorous wildlife exceed benchmarks for adverse effects on survival, growth, reproduction, or embryo development?

The following measurement endpoints were selected to evaluate risk to this endpoint receptor group:

- Comparison of estimated ingestion doses in vermivorous wildlife with TRVs and toxic equivalencies.
- Comparison of estimated vermivorous wildlife tissue and egg residues with site-specific CBR data.

Assessment Endpoint 3: Protection and maintenance of omnivorous mammal populations (as represented by the raccoon).

The following risk questions were established for this assessment endpoint:

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- Do ingestion doses of COPECs in omnivorous wildlife exceed TRVs or TEQs for adverse effects on survival, growth, or reproduction?

The following measurement endpoints were selected to evaluate risk to this endpoint receptor group:

- Comparison of estimated ingestion doses in omnivorous wildlife with TRVs and TEQs.

EXPOSURE ASSESSMENT

The primary objectives of the exposure assessment for this Addendum are to characterize the relevant exposure area, exposure pathways, and receptors and to determine a relevant exposure estimate. A single exposure area was evaluated in this Addendum; the BERA conducted for the site-wide assessment evaluated four additional exposure areas (including Allendale Pond, Lyman Mill Pond, Manton Pond, and the former Dyerville Pond), along with an upstream background area (Greystone Mill Pond), and a reference area (Assapumpset Pond and Brook). The BERA exposure areas are referenced in this Addendum as necessary to place the ecological findings in the general spatial context of the CSM and, to the extent possible, to provide an integrated risk analysis.

Exposure Point Concentrations

The maximum concentration of each analytical parameter detected in floodplain soil samples was selected as the exposure estimate for this Addendum. In addition, exposures were evaluated using the arithmetic average concentrations, which were also identified as exposure point concentrations (EPCs) in the BERA. EPCs were also developed for earthworm tissue using site-derived BSAFs as described below.

Identification of Exposure Models and Parameters

Chemical-specific intakes were calculated in a manner consistent with USEPA guidance for risk assessment. The following equations were used to estimate COPEC concentrations in biological tissue to evaluate both direct and indirect exposures:

$$C_{earthworm} = \frac{BSAF * C_{soil} * \%lipid}{\%TOC} \qquad \text{(Equation 1)}$$

where:

$C_{earthworm}$	=	chemical concentration in earthworm tissue (µg/g - ww)
$BSAF$	=	biota soil accumulation factor derived using site-specific data (expressed as $g_{organic\ carbon}$ - dw/g_{lipid} - ww)
C_{soil}	=	maximum chemical concentration in floodplain soil (µg/g – dw)
$\%\ lipid$	=	lipid content of earthworm (g_{lipid}/g; both ww basis)
$\%TOC$	=	total organic carbon content of floodplain soil ($g_{organic\ carbon}$/g; both ww basis)

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$$C_{avian_egg} = \frac{BMF * C_{earthworm} * \%lipid_{avuan_egg}}{\%lipid_{earthworm}} \qquad \text{(Equation 2)}$$

where:

C_{avian_egg}	=	estimated chemical concentration in avian egg tissue (mg/kg - ww)
BMF	=	literature-based biota magnification factor (expressed as $kg_{earthworm\ lipid}/kg_{avian_egg\ lipid}$)
$C_{earthworm}$	=	estimated chemical concentration in earthworm prey (mg/kg ww)
$\%\ lipid_{avian_egg}$	=	lipid content of avian egg tissue (ww basis)
$\%\ lipid_{earthworm}$	=	lipid content of earthworm tissue (ww basis)

A similar transfer factor was used to estimate small mammal tissue concentrations based on dietary exposure to contaminated earthworms. Biomagnification factors (BMFs) for vermivorous wildlife (e.g., American woodcock and short-tailed shrew) were estimated using transfer factors obtained from the literature that were derived for gull egg tissue (based on adult consumption of fish; Braune and Norstrom, 1989) and otter liver (based on consumption of fish; Leonards et al., 1997).

Estimated Daily Intakes (EDIs) of COPECs were calculated as the measure of exposure for each selected wildlife receptor. The EDIs are expressed as milligrams of contaminant per kilogram bodyweight ingested on a daily basis (mg/kg-day). The following dose model was used to estimate daily exposure of contaminants to wildlife receptors:

$$EDI = \{[(C_{soil} \times IR_{soil}) + (C_{food} \times IR_{food})] \times SUF\}/BW \qquad \text{(Equation 3)}$$

where:

EDI	=	daily dose resulting from ingestion of soil and food (mg/kg - day)
C_{soil}	=	concentration of COPEC in surface soil (mg/kg; dw basis)
IR_{soil}	=	estimate of receptor's daily ingestion rate of surface soil (kg/day)
C_{food}	=	concentration of COPEC in food tissue (mg/kg; ww basis)
IR_{food}	=	estimate of daily ingestion rate of food tissue (kg/day)
SUF	=	site use factor (unitless)
BW	=	body weight (kg)

EFFECTS ASSESSMENT

The purpose of the effects assessment is to characterize the relationship between the concentration or dose of COPEC administered or received and the incidence of adverse effects in the ecological endpoint receptor at the appropriate level of ecological organization (i.e., usually population- or community-level). The following types of information were used in this Addendum:

- TRVs that relate a threshold concentration or ingested dose to an adverse and relevant biological response. TRVs were established for floodplain soil and biological tissue (including invertebrates, birds, and mammals);
- Floodplain macroinvertebrate community study; and,
- Multiple year amphibian call survey.

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It is important to note that the second and third information types are site-specific measures of effects derived specifically for the BERA but which are also relevant to the evaluation of the Oxbow Area.

SUMMARY OF UNCERTAINTIES

Table ES-1 presents a summary of the major uncertainties identified in the Addendum. Uncertainties that likely resulted in risk estimates being under-estimated include:

- Lack of evaluation of floodplain plant exposures;
- Lack of evaluation of seasonal aquatic exposures (e.g., aquatic macroinvertebrates, amphibians);
- Lack of analytical floodplain soil data for certain chemical groups evaluated in the BERA, including HCX, coplanar PCBs, and PAHS; and,
- Lack of toxicity benchmark values and uptake factors for some COPECs.

Uncertainties that may have resulted in the risk estimates being over-estimated include:

- Assumption that complete exposure pathways and suitable habitat for vermivorous wildlife exist;
- Potential sampling bias to more depositional locations within the area;
- General bias in selecting conservative exposure parameters (including organic carbon content) and effect measures; and,
- Unclear functional relationship between the measurement and assessment endpoints.

Overall, it is believed that the conclusions are conservative in nature and that the derived risk estimates could be less than presented.

SUMMARY OF MAJOR FINDINGS

Table ES-2 summarizes the results of this Addendum for each of the assessment endpoints. A summary of the findings include the following:

- Based on a comparison of maximum and average floodplain soil concentrations to screening benchmarks, the soil invertebrate community occurring within the Oxbow Area may be at substantial risk of harm (i.e., Hazard Index [280] greatly exceeds one) due to exposure to pesticides (including dieldrin, lindane, 4,4-DDE, and 4,4'-DDD) and zinc in floodplain soil. However, other measures used to assess this endpoint do not support the conclusion that there is substantial risk of harm to the soil invertebrate community. For instance, the hazard quotients (HQs) for estimated earthworm tissue concentrations indicate less potential for risk (NOAEL HQ of 32 and a LOAEL HQ of 120). Furthermore, an evaluation of the soil invertebrate community study conducted to support the BERA suggests that the invertebrate fauna is comparable to other exposure areas at the Centredale Site and is not distinguishable from the upriver background area.
- Vermivorous mammal and bird populations that occur within the Oxbow Area appear to be at substantial risk of harm due to direct exposure to site-related contaminants in floodplain soil and prey items. 2,3,7,8-TCDD is the most substantial contributor to the estimated risks to vermivorous receptors. In addition, based on modeled tissue

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concentrations, consumption of contaminated earthworm prey may result in elevated tissue residues in these receptors, potentially resulting in adverse reproductive effects (i.e., bioaccumulation hazard).

- Dietary exposures and modeled tissue burdens in avian eggs and mammal liver tissue pose a substantial risk of harm to vermivorous wildlife species.
- Omnivorous mammal populations that forage within the study area are not at substantial risk of harm due to exposure to site-related contaminants in floodplain soil and terrestrial prey items.

NEXT STEPS

The Remedial Investigation (RI) for the Centredale Site (Battelle, 2005) has recently been completed and the Feasibility Study (FS) will soon be completed. The RI determined and summarized the sources, nature, and extent of contamination at the Centredale Site; characterized the fate and transport of contaminants; and evaluated potential human health and ecological risks resulting from exposure to site-related contaminants. The FS will evaluate risk management strategies and alternatives for remediating contamination that is found to pose an unacceptable risk to human health or the environment. The FS will also evaluate the long-term effectiveness of the short-term removal actions and determine whether additional action is required to affect a permanent remedy.

In support of the FS, preliminary remediation goals (PRGs) will be estimated for COPECs by a two-step process. In the first step, biota tissue concentrations for the most significant COPECs will be identified for various HQs of 0.1, 1, and 10. In the second step, using the concept of steady-state conditions between lipophilic substances in sediment and fish tissue, sediment concentrations corresponding to the risk-based tissue concentrations will be identified.

Following an evaluation of the applicability of the existing ecological PRGs for floodplain habitats, specific PRGs for the Oxbow Area may be discussed in further detail in a separate document. The calculated risks for the reference area and background area will obviously be a consideration in the derivation of PRGs and the selection of remedial objectives.

The results of the RI and FS will be used to formulate a Proposed Plan for the entire Centredale Site, including the Oxbow Area. The Proposed Plan will recommend remedial actions that will result in overall protection of human health and the environment, fulfill Superfund requirements, be acceptable to stakeholders, and satisfy USEPA remedial guidelines.

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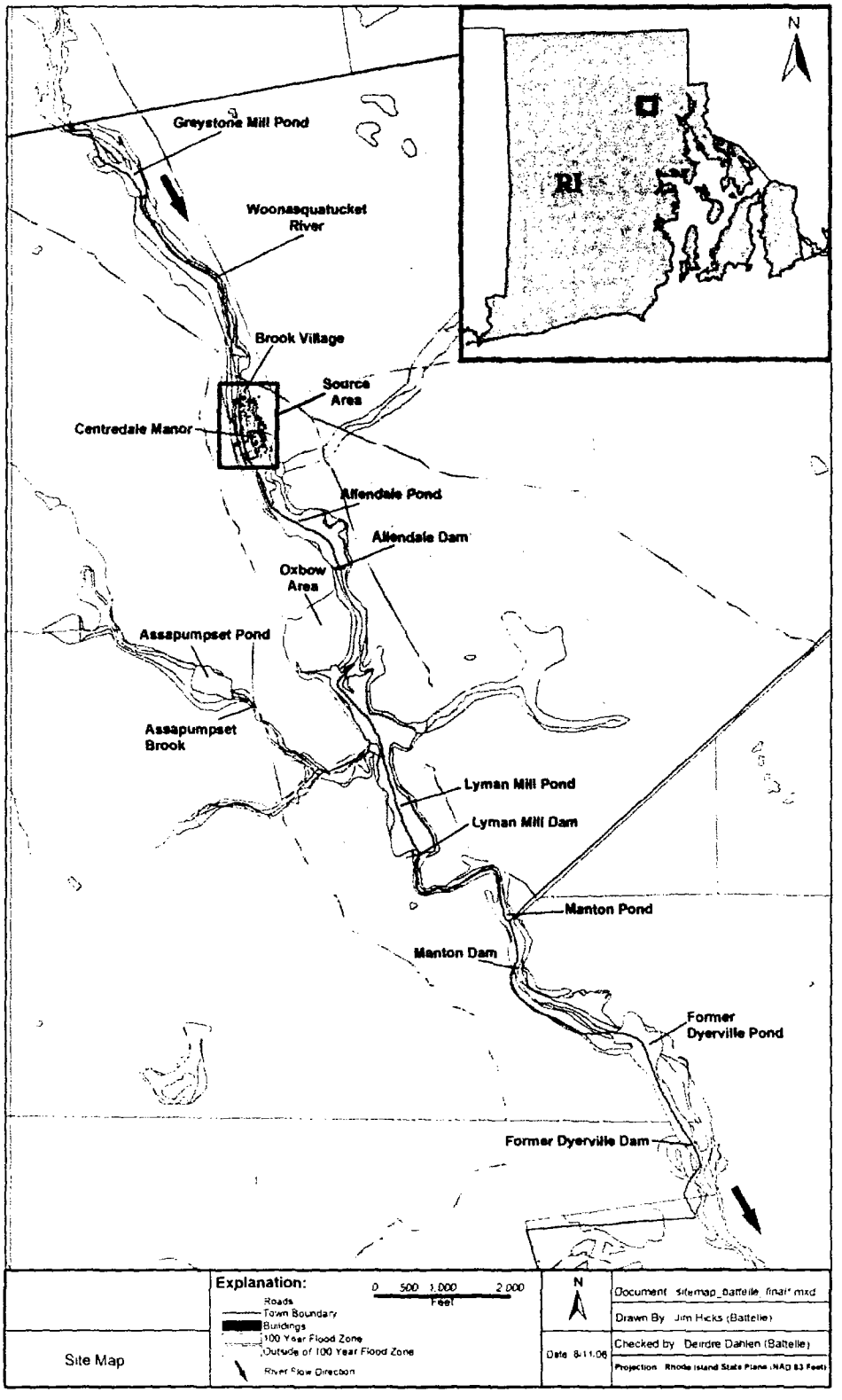

Figure ES-1. Site Locus Map.

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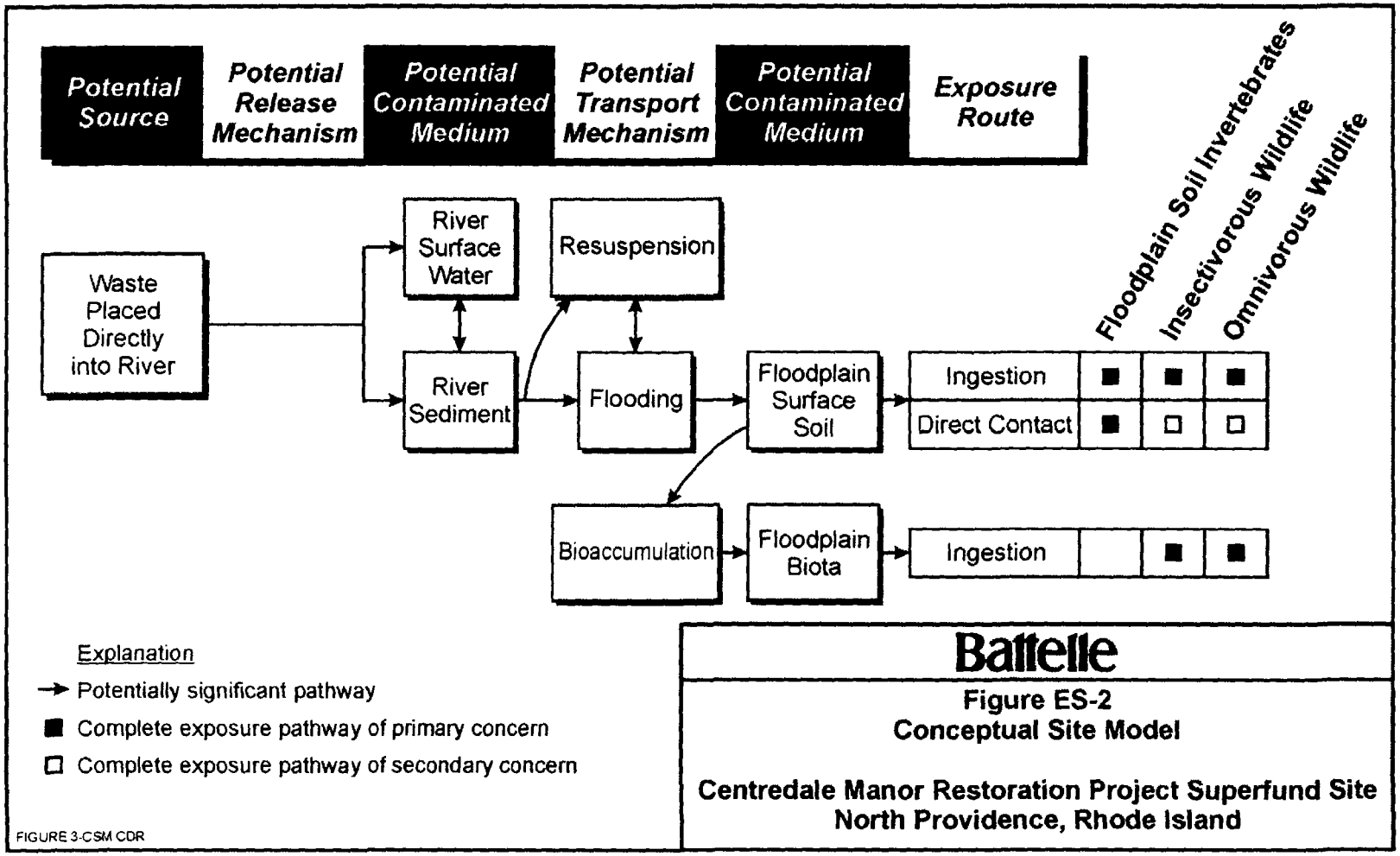

Figure ES-2. Conceptual Site Model.

TABLE ES-1. SUMMARY OF UNCERTAINTIES.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under- estimation (-) of Risk	Rationale
Problem Formulation		
Selection of Receptors of Concern	+	The urbanized and industrialized nature of the landscape in the vicinity of the Oxbow Area may limit habitat suitability for sensitive receptors such as the American woodcock
	-	Plants were not specifically evaluated in the Addendum. Although inorganic analytes were generally consistent with upgradient background concentrations, reported levels in floodplain soils could adversely affect these receptors.
	-	The Oxbow Area was considered to provide primarily floodplain (i.e., terrestrial) habitat for ecological receptors. However, seasonal ponding could result in exposures to aquatic invertebrates and amphibians. These exposures were not evaluated because surface water data are not available.
	+	The availability of soil invertebrates as a forage base for vermivorous wildlife was assumed but not verified. Depositional regions of the Oxbow Area may contain saturated hydric soils for sufficient periods of time to exclude or reduce the numbers of soil invertebrates. In these areas, the bioaccumulation hazard to vermivorous wildlife would be eliminated.
Identification and Selection of COPECs	-	HCX, PAHs, and coplanar PCBs were not included in the analytical parameters for soil samples collected at the Oxbow Area. Although this may result in exposures (and hazards) being under-estimated, the potential risks are anticipated to be considerably lower than those identified in the Addendum.
Area Boundary Delineation	+	The analytical chemistry results for the sample from location LPX-SD-4404 are distinctive and may not be within the normal flooding zone (and therefore not historically impacted by the site source area).
Exposure Assessment		
Exposure Parameters	+/-	Uncertainty is inherent in the use of literature-derived exposure parameters because they were not empirically measured at the site. The general use of conservative values likely resulted in wildlife hazards being over-estimated.

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TABLE ES-1. SUMMARY OF UNCERTAINTIES. (continued)

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under-estimation (-) of Risk	Rationale
Exposure Concentrations	+	Earthworm tissue concentrations were estimated using BSAFs that were normalized based on the minimum organic carbon concentration detected in the 2004 Oxbow Area floodplain soils. Floodplain soil carbon content is variable (8 - >30%); the average (of three soil samples) was almost 2.5 times the minimum value and use of the average TOC would have resulted in estimated earthworm tissue concentrations being reduced by this same factor.
Contaminant Distribution with Soil Depth	+/-	Floodplain soil samples were collected from 0-6 inches in depth only; data is lacking for other depth intervals where ecological exposure is possible.
Bioaccumulation Factors	-	The lack of soil/plant uptake factors for TCDD may have resulted in an underestimation of dietary exposures to omnivorous wildlife (raccoon).
	-	The lack of BMFs necessary to estimate wildlife tissue concentrations for certain COPECs may have resulted in an underestimation of risks.
Effects Assessment		
Toxicity Reference Values	+	The use of conservative application factors to derive benchmark doses may have resulted in risks being over-estimated for some COPECs.
	-	Avian toxicological data for antimony and cobalt were not available and, as a result, potential risks for these COPECs could not be quantified.
	+/-	CBRs were not available for all COPECs. In addition, the relatively high percentage of studies reporting unbounded results contributed significant uncertainty to the residue-based analysis. The general methodology employed likely resulted in the selection of conservative measures of effect.
Dioxin, Furan, and PCB Congeners	-	The TEQ approach does not explicitly account for antagonistic or synergistic interactions between congeners and may underestimate risk to wildlife; however, because TCDD was the primary risk driver this uncertainty is likely of little consequence.
Risk Characterization		
Hazard Quotients/ Hazard Indices	+/-	Uncertainty exists regarding the interpretation of the HQ or HI value of one as a definitive indicator of population level impacts to wildlife. The assessment is believed to be sufficiently conservative and the relationship between the assessment and measurement endpoints is not direct, resulting in a gray area for HQ or HI values in the vicinity of one.

TABLE ES-2. SUMMARY OF ECOLOGICAL RISK AT THE OXBOW AREA.

Receptor	Contaminant Group	Hazard Index[a] NOAEL	LOAEL
Soil invertebrates (soil screen)			
	Pesticides	66	
	PCBs	-	
	Metals	212	
	TEQ/TCDD	-	
	Total	278	
Soil invertebrates (tissue screen)			
	Pesticides	-	-
	PCBs	-	-
	Metals	31	122
	TEQ/TCDD	-	-
	Total	32	122
Short-tailed shrew	Pesticides	-	-
	PCBs	44	-
	Metals	69	8.2
	TEQ/TCDD	187	19
	Total	264	29
American woodcock	Pesticides	-	-
	PCBs	1.4	-
	Metals	27	2.2
	TEQ/TCDD	13	1.3
	Total	46	6.1
Raccoon	Pesticides	-	-
	PCBs	-	-
	Metals	-	-
	TEQ/TCDD	2.1	-
	Total	3.6	-

a. Hazard indices (HI) based on average COPEC concentrations at the Oxbow Area.

- Indicates that the HI was below 1.

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ACRONYMS AND ABBREVIATIONS

AE	Assessment endpoint
APB	Allendale Pond
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BMF	Biomagnification factor
BSAF	Biota-soil accumulation factor
BW	Body weight
CBR	Critical body residue
COPEC	Contaminant of potential ecological concern
CSM	Conceptual site model
dw	dry weight
DYR	Dyerville
EDI	Estimated daily intake
EPC	Exposure point concentration
ERAGs	Ecological Risk Assessment Guidance for Superfund
FS	Feasibility Study
GMP	Greystone Mill Pond
HCX	Hexachloroxanthene
HI	Hazard index
HQ	Hazard quotient
INCHEM	International Chemical Program
IRIS	Integrated Risk Information System
LC_{50}	Lethal concentration to cause mortality to 50% of test organisms
LMX	Lyman Mill Pond
LOAEL	Lowest observed adverse effect level
MAP	Manton Pond
mg/kg	milligrams per kilogram
MS/MSD	Matrix Spike/Matrix Spike Duplicate
ng/g	nanograms per gram
NOAEL	No observed adverse effect level
OCDD	Octachlorodibenzodioxin
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
pg/g	picograms per gram
PRG	Preliminary remediation goal
QC	Quality control
QSAR	Quantitative structure activity relationship
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
SLERA	Screening Level Ecological Risk Assessment
SRM	Standard reference material
SUF	Site use factor
TCDD	Tetrachlorodibenzo-*p*-dioxin
TEF	Toxic equivalency factor
TEQ	Toxic equivalency
TOC	Total organic carbon
TRV	Toxicity reference value

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µg/g	micrograms per gram
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	Volatile organic compound
ww	wet weight

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1.0 INTRODUCTION

This Addendum consists of an assessment of potential risks to ecological receptors that may be exposed in the Oxbow Area of the Centredale Manor Restoration Project Superfund Site ("Centredale Site") located in North Providence, Rhode Island. It is a supplement to the Baseline Ecological Risk Assessment (BERA) for the Centredale Site and is being conducted by the U.S. Environmental Protection Agency (USEPA) Region 1 and U.S. Army Corps of Engineers (USACE).

This Addendum follows work that was completed at the Centredale Site, including a BERA, Remedial Investigation (RI), and a Baseline Human Health Risk Assessment (BHHRA). These documents summarize existing conditions in specific areas of the Centredale Site with respect to exposure to and effects of contaminants in surface water, sediment, groundwater, surface soil, and biota. Additional sampling in the Oxbow Area of the Woonasquatucket River indicated elevated concentrations of contaminants in floodplain soils. This Addendum, along with previous work at the Centredale Site, will support risk management decisions such that remedial actions will allow the Woonasquatucket River and associated reaches and impoundments to return to a fishable and swimmable condition.

The approach used in this Addendum follows an established framework and guidelines for assessing ecological risks. Specifically, the USEPA guidance for ecological risk assessment, *Ecological Risk Assessment Guidance for Superfund, Process Document for Designing and Conducting Ecological Risk Assessments* (1997), established an eight-step process for assessing ecological risk. The first two steps comprise the screening-level evaluation step, with the goals of determining if the site poses no or negligible risk and identifying which contaminants and exposure pathways require further evaluation. Steps 3 through 7 comprise components of the BERA; Step 8 consists of risk management activities undertaken for the site.

A BERA that evaluated ecological risks to receptors exposed to aquatic and associated floodplain habitat at the Centredale Site has been conducted previously (MACTEC, 2004). The BERA evaluated four separate exposure areas within the river proper including the Allendale Pond reach, the Lyman Mill Pond reach, the Manton Pond reach, and the former Dyerville Pond reach; these four areas were designated as APB, LPX, MAP, and DYR, respectively. The BERA evaluated the following assessment endpoints:

1. Protection and maintenance (i.e., survival, growth, and reproduction) of aquatic and floodplain invertebrate communities which are a forage base for fish and wildlife.
2. Protection and maintenance of demersal, omnivorous fish populations as a forage base or sport fishery.
3. Protection and maintenance of pelagic, piscivorous, or semi-piscivorous fish populations as a forage base or sport fishery.
4. Protection and maintenance of piscivorous mammal and bird populations.
5. Protection and maintenance of insectivorous mammal and bird populations.
6. Protection and maintenance of omnivorous mammal and bird populations.

Three of these assessment endpoints (i.e., Assessment Endpoints # 1, 5, and 6) included evaluation of ecological receptors that utilize floodplain habitat and may be exposed to contamination within the study area. The BERA evaluated floodplain exposures in the Allendale

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Pond and Lyman Mill Pond reaches and also quantified ecological risks in similar habitat within the upgradient background area associated with Greystone Mill Pond (which was referred to as "GMP"). Although, the BERA evaluated floodplain habitat associated with Lyman Mill Pond, the possibility that flood stage conditions could periodically result in river water overtopping the western bank of the Woonasquatucket River below the Allendale Pond was not fully appreciated until after the BERA had been developed. Consequently, ecological exposures within the Oxbow Area were not identified in the Conceptual Site Model (CSM) and ecological (and human health) risks in this area were not evaluated. This Addendum is intended to address this data gap. As applicable, elements of the BERA (including field study results, derived uptake factors, and overall methodologies) were incorporated into this Addendum. This was done to make full use of previous analyses as well as to expedite the overall RI/FS schedule.

This Addendum presents the problem formulation, including the CSM, ecological receptors, and exposure pathways. The available data from the Oxbow Area is then summarized and compared to ecological screening benchmarks to identify the contaminants of potential ecological concern (COPECs). Each assessment endpoint is evaluated and potential risk is summarized. Finally, the uncertainties associated with the risk assessment are discussed.

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2.0 PROBLEM FORMULATION

The problem formulation establishes the goals, scope, and major issues for consideration in the risk assessment (USEPA, 1997; 1998). It contains specific information on the environmental setting and resources potentially at risk, the selection of COPECs and receptors of concern, a CSM with complete exposure pathways, and assessment and measurement endpoints.

2.1 ENVIRONMENTAL SETTING

The Woonasquatucket River flows 18 miles from North Smithfield to the Upper Narragansett Bay, draining an area of approximately 51.9 square miles. At its confluence, the river joins with the Moshassuck River in downtown Providence forming the Providence River. It is currently the focus of urban revitalization efforts and was recognized as an American Heritage River in August 1998. The upper section of the river is relatively pristine and rural; however, the urban portion of the river below the Smithfield line has been impacted by sewage and industrial waste for more than a century. The reach of the river that includes the Centredale Manor Restoration Project Site is classified as an "impaired water" by the State of Rhode Island under Section 303(d), with the cause of impairment attributed to pathogens, cadmium, copper, lead, polychlorinated biphenyls (PCBs), mercury, dioxins, low dissolved oxygen, and elevated nutrient levels (RIDEM, 2001).

The specific area within the Centredale Site that this document focuses on is the Oxbow Area floodplain. The area is approximately 27.5 acres and is characterized as a palustrine forested wetland dominated by mature red maple (*Acer rubrum*) bordered to the south by fringing palustrine emergent and scrub shrub wetland habitats. Although approximate acreage for the palustrine forested and emergent wetland habitat types has not been measured, the Corps is planning to perform a wetland delineation and functional assessment of the Oxbow Area, which will provide an acreage estimate in the near future. Adrian muck is found in the southern part of the Oxbow Area. This soil is very poorly drained and forms in depressions and drainage channels in an outwash plain. It is generally composed of black muck at the surface and fine sand in the subsurface. Vegetation includes yellow birch (*Betula alleghaniensis*), gray birch (*Betula populifolia*), dogwood (*Cornus amomum*), and black willow (*Salix nigra*). The palustrine emergent wetland is dominated by jewel weed (*Impatiens capensis*), smart weed (*Polygonum* spp.), nettle (*Laporteas* sp.), cattails (*Typha* sp.), wool grass (*Scirpus cyperinus*), and purple loosestrife (*Lythrum salicaria*). Photographs of the Oxbow Area that present various aspects of this habitat are presented in Appendix A.

Wildlife observed using these areas include tree swallows (*Tachycineta bicolor*), killdeer (*Charadrius vociferous*), Canada geese (*Branta canadensis*), mourning doves (*Zenaida macroura*), and mink (*Mustela vison*). Reptiles and amphibians also observed utilizing this area include snapping turtles (*Chelydra serpentina*) and green frogs (*Rana clamitans*).

2.1.1 Current and Reasonably Forseeable Uses of the Oxbow Area

The Oxbow Area is a relatively undisturbed and extensive wooded habitat that is protected from development by both federal and state statutes. As such, it provides some unique ecological benefits in an otherwise urbanized portion of the State. In addition, the area could provide other natural resource values with potentially significant education and recreation opportunities.

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2.2 CONCEPTUAL SITE MODEL

The CSM identifies the source, media, pathway, and route of exposures evaluated, and shows the relationship between the assessment and measurement endpoints (USEPA, 1997). It serves as a communication tool that illustrates the major pathways by which ecological receptors may be exposed to COPECs associated with releases of contaminants from the source area. Figure 3 presents a general CSM for the Oxbow Area of the Centredale Site.

Anthropogenic influences are evident in the Woonasquatucket River channel immediately below the Allendale Dam. The river channel has been straightened at the point where water from the former Allendale Mill entered the river immediately below the Allendale Dam (refer to Figure 3-3 in Battelle, 2005). Dredged material from the channelization was used to build a levee covered with cobbles from the river channel. Floodplain deposits were observed to the west of this ridge in a forested wetland during a field reconnaissance in 2003. These deposits indicate that overbank river flow has occurred in this area.

Historical aerial photography and field mapping revealed an abandoned channel in the forested wetland southwest of Allendale Dam (mapped as floodplain deposits in Figure 3-3 in Battelle, 2005). Abandoned channels are segments of a channel abandoned by the river when it shortens its course. This abandoned meander appears to be the response of the river to the man-made cut-off where the river was straightened. The area within the meander contains fine-grained sediment deposited as the river adjusted to its new path and the meander cut-off was filled. Analysis of historic topographic maps and field mapping conducted during the preparation of the RI report revealed evidence of three previous channels near this meander, reflecting channel migration (Battelle, 2005). During flooding, overbank deposits still may be introduced into the abandoned channel. The most recent meander loop is still in communication with the river during times of high water (as evident in the 1995 aerial photography).

2.2.1 Potential Ecological Receptors

Terrestrial invertebrates and wildlife may be exposed to COPECs in floodplain soil by direct contact, direct ingestion, or by consuming prey items that have bioaccumulated COPECs. Potential ecological receptors identified in the Oxbow Area include soil invertebrates, amphibians, reptiles, birds, and mammals. Further information for each receptor is provided in the following sections.

Soil Invertebrates. The soil invertebrate community consists of various insect, oligochate, collembola, mite taxa, and others. These organisms play a critical role in energy and nutrient transfer and cycling in the food web. Direct effects of COPECs on soil invertebrates can reduce the productivity of soil and impact the populations of animals that rely on these organisms for food. Although data for the Oxbow Area specifically are not available, a survey of the soil invertebrates occurring at the Centredale Site in 2001 by Normandeau Associates identified an earthworm-dominated macroinvertebrate community fauna (Normandeau Associates, 2002). Other represented invertebrate groups include both adult and immature insect taxa including beetles, moths, flies, and ants; as well as spiders, slugs, centipedes, millipedes, sow bugs, and nematode worms.

Amphibians. An anuran call survey was conducted during the amphibian breeding season in both 2001 and 2002 (USFWS, 2001; 2002). A diverse assemblage of amphibians was identified, noting the following species within the Centredale Site: wood frog (*Rana sylvatica*), pickerel frog (*R. palustris*), green frog (*R. clamitans*), bullfrog (*R. catesbeiana*), spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor*), American toad (*Bufo americanus*), and Fowler's toad

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(*B. woodhousei fowleri*). Although individual calling habitats were not necessarily identified during the survey period, the survey report suggested that the Oxbow Area was generally a productive and diverse habitat (USFWS, 2001; 2002).

Wildlife. The Oxbow Area provides potential habitat to various terrestrial mammalian and avian wildlife receptors. Insectivorous wildlife forage primarily on insects either captured in the air or picked off of vegetation or out of the soil. Wildlife that forage mainly on earthworms (i.e., vermivores) include the American woodcock (*Scolopax minor*) and the short-tailed shrew (*Blarina brevicauda*); these species are described below.

The American woodcock breeds from southern Canada south to Texas and Florida, with its winter range extending to southern New Jersey and the Ohio Valley (DeGraaf and Rudis, 1983). In New England, the woodcock is most common in Maine. It requires moist woodlands in early stages of succession, swamps, stream banks, or rich bottomlands that support abundant earthworm populations. Earthworms are the dietary staple, ranging from 50 to 90% of the diet, but some individuals also consume insect larvae. The woodcock's long bill is used to probe or glean food from the soil. Optimal habitat conditions support one pair of birds per six acres (DeGraaf and Rudis, 1983). The woodcock was selected as a receptor of concern to provide consistency with the BERA; however, it should be noted that woodcock are not likely to heavily utilize the mature red maple forested floodplain that occupies the majority of the Oxbow Area.

The short-tailed shrew occurs from Canada south to Texas and Florida, and is common in New England (DeGraaf and Rudis, 1983). It occurs in both forested and successional habitats, but is especially common along streams in scrub/shrub habitat characterized by loose leaf litter and high humidity. In optimal habitat, population estimates range as high as 50 individuals per acre (Baker, 1983). The short-tailed shrew is a voracious nocturnal and diurnal feeder consuming plants, worms, insects, snails, and small invertebrates.

Omnivorous wildlife species feed on a variety of prey items including insects, small mammals, birds, reptiles, and fruit. These organisms are typically opportunistic hunters and will feed on whatever is locally or seasonally abundant. Their varied diet exposes them to contaminants that may bioaccumulate in different prey items. The raccoon (*Procyon lotor*) is an omnivorous mammal that has been identified at the Oxbow Area and is described below.

The raccoon is a common mid-sized mammal that occurs throughout most of southern Canada and the United States. It is primarily nocturnal and is dormant during the winter. Preferred habitat includes a variety of woods, fields, and abundant water sources (DeGraaf and Rudis, 1983). Home range size varies with habitat quality and season, but is generally around one mile. Population densities range from 1 to 15 raccoons per acre, depending on habitat quality. The raccoon is an omnivorous opportunistic feeder that consumes mainly invertebrates in the spring and early summer and switches to available fruits and seeds from late summer through winter.

Rare, Threatened, and Endangered Receptors. The U.S. Fish and Wildlife Service (USFWS) and RIDEM were contacted regarding the presence of rare, threatened, or endangered species known to occur in the vicinity of the Centredale Site. The response from RIDEM and USFWS (Appendix B) indicates that no rare, threatened, or endangered species are located the vicinity of the Centredale Site.

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2.2.2 Complete Exposure Pathways

Ecological receptors may be exposed to site-related contaminants through a variety of exposure pathways. A complete exposure pathway involves a potential for contact between a receptor and contaminants, either through exposure to an abiotic medium (e.g., soil) or indirectly through prey consumption. Pathways are evaluated using available information on contaminant fate and transport, the ecosystems that are potentially affected, and the magnitude and extent of the contamination (USEPA, 1997).

Terrestrial animals, such as soil invertebrates, birds, and mammals may be exposed to contaminants that have migrated to the floodplain soils of the Oxbow Area. Potential exposure pathways include food intake, surface water ingestion, incidental soil ingestion, dermal contact, and possibly inhalation. However, due to the anticipated insignificance of the dermal and inhalation exposure routes (as compared to the other exposure routes), as well as substantial uncertainties associated with estimating ecological exposures for these pathways, they were not evaluated in this Addendum.

2.3 SUMMARY OF DATA

Seven floodplain surficial soil samples (0-0.5 ft) were collected on June 21, 2004 from the Oxbow Area to investigate the nature and extent of site-related contamination (Figure 2). Sample locations excluded areas of artificial fill or gravel, and targeted topographically low areas. Three surface soil samples were collected within the abandoned channel within the Oxbow Area. Two surface soil samples were collected north of the channel, and two were collected south of the channel. All samples were analyzed for dioxins/furans. Samples from three of the stations were also analyzed for polychlorinated biphenyls (PCBs) as Aroclors, pesticides/herbicides, metals, and total organic carbon (TOC) (Table 1). Chemical analyses of soil samples were conducted according to the Final Work Plan, *Sediment Sample Collection and Analysis at the Oxbow Area, Centredale Manor Restoration Project Superfund Site* (Battelle, 2004b). As noted in the report, soil samples from sample locations LPX-SD-4402 and LPX-SD-4407 contained less than 30% solids. The samples were centrifuged, the overlying water decanted and the moisture content determined again. The moisture content remained above 70% for both of these samples. The freeze-dried counterparts to these samples were obtained from Battelle's metals laboratory and used for PCB/pesticide analysis. Both the wet and freeze-dried samples were extracted and analyzed for PCB/pesticides.

Analytical data for the wet and freeze-dried samples from location LPX-SD-4407 were similar, and data from the freeze-dried sample was reported. PCB/pesticide data did not compare well, however, for the wet and dry samples from location LPX-SD-4402. For example, the concentration of Aroclor 1254 in the freeze-dried sample was approximately 20 times higher compared to the Aroclor concentration in the wet sample. A field duplicate was also collected from this location (LPX-SD-4402). PCB/pesticide data for the field duplicate was more comparable to data for the wet sample than for the freeze-dried sample. It appeared that sample heterogeneity was the most reasonable explanation for the differences. Therefore, the freeze-dried data was used to ensure a conservative estimate of exposure. Further discussion regarding this sampling event and the analyses performed are available in the *Task RI-12 Oxbow Area Sediment Investigation, Chemistry Data Report* (Battelle, 2004a). These results are comparable to samples collected by Tetra Tech NUS (2000a) in 1999 in the vicinity of the Oxbow Area. The analytical results for the 1999 samples were evaluated in the RI (Battelle, 2004a).

Dioxins/Furans

At each of the seven sampling locations, 25 dioxin/furan analytical parameters were quantified, including 17 individual dioxin/furan congeners and eight homologue groups. In addition, Toxic Equivalency Factors (TEFs), based on both avian and mammal, were also calculated (Table 2). Figure 4 presents a summary of the analytical results for the dioxin and furan congener concentrations detected in Oxbow Area floodplain surface soils. Congener concentrations range from 0.14 picogram/gram (pg/g) to 4,270 pg/g. With one exception, 2,3,7,8-TCDD was the congener detected with the highest concentration in these floodplain samples and this compound is elevated above background (average Greystone - ~20 pg/g [see Figure 20 of MACTEC, 2004]; range of Oxbow Area soils – 12 to 4,270 pg/g). The highest 2,3,7,8-TCDD concentration was detected at LPX-SD-4405, which is within 75 feet of the Woonasquatucket River (Figure 2) in an area where floodwaters appear to routinely overflow the banks of the river. Appendix A presents a photograph (Figure f) showing the bank condition in this area. Concentrations of octachlorodibenzodioxin (OCDD) are also relatively high compared to other congeners, with concentrations in excess of 1,000 pg/g detected in four of the seven samples. Concentrations of this congener appear to be consistent with floodplain soil data collected from the Greystone Mill Pond (average Greystone ~5,000 pg/g [see Figure 20 of MACTEC, 2004]; range of Oxbow Area soils: 142 to 4,100 pg/g). For the most part, concentrations of other congeners were at or less than 100 pg/g.

The congener pattern detected at LPX-SD-4404 is distinctive compared to the other samples in that the maximum concentrations of 14 of the 17 analyzed congeners were detected in this sample (Figure 4). Calculated TEQ concentrations and the relative importance of individual congeners for the seven samples are plotted in Figure 5. The 2,3,7,8-TCDD concentration contributes less than 5% to the TEQ in LPX-SD-4404, whereas it is the primary component of the other TEQs. In addition, the lowest TEQ concentration is associated with LPX-SD-4404. This sample was collected at a location at the toe of an extensive fill area and it appears to be located outside of the 100-year floodzone (Figure 2).

TEQ concentrations for Oxbow Area sampling locations are elevated relative to background conditions; average TEQ concentration in Greystone Mill Pond floodplain soil samples was approximately 60 pg/g (Figure 9, MACTEC, 2004) as compared those in the Oxbow Area (range from 347 to 4,298 pg/g, see Table 2 and Figure 5). In general, the RI report determined that the TEQ concentrations in the Oxbow Area floodplain soils were within the range measured in sediment samples from Allendale and Lyman Mill Ponds (see Table 4-9 of Battelle, 2005) and concluded that low-lying areas in the forested wetland have been affected by contamination from the Centredale Site.

PCBs

Three locations were analyzed for the presence of PCBs (as Aroclors): LPX-SD-4402, LPX-SD-4404, and LPX-SD-4407 (Figure 2). In addition to total Aroclors, only Aroclor 1254 and Aroclor 1268 were detected in Oxbow Area surface soil samples. Figure 6 presents a summary of detected Aroclor concentrations for these samples, which range from 8 to over 3,000 ng/g (nanograms per gram; parts per billion). Aroclor 1254 appears to dominate the total Aroclor composition at locations LPX-SD-4402 and LPX-SD-4407; whereas Aroclor 1268 dominates at LPX-SD-4404. Concentrations of Aroclor 1268, but not Aroclor 1254, appear to be consistent with background conditions (average Aroclor 1268 concentrations in Greystone floodplain soils is approximately 90 pg/g [Figure 36 of MACTEC, 2004], which is similar to the result for LPX-SD-4404 (103 pg/g) and considerably higher than levels detected at the other two locations in the Oxbow Area. In combination with the dioxin/furan results, this finding gives further credence to a separate migration pathway affecting this location.

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Pesticides/Herbicides
Three locations were analyzed for pesticide compounds: LPX-SD-4402, LPX-SD-4404, and LPX-SD-4407 (Figure 2). Detected pesticide concentrations are all less than 100 ng/g, with maximum concentrations ranging from 0.76 ng/g (lindane) to 63.4 ng/g (dieldrin); relatively low level 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD concentrations were detected in the three samples (Figure 6). In general, pesticide concentrations appear to be consistent with Greystone floodplain soil results with the exception of dieldrin (LPX-SD-4402) and 4,4'-DDE and 4,4'-DDD (LPX-SD-4407) (Figure 6 compared with Figure 36 of MACTEC, 2004).

Metals
Four locations were analyzed for inorganic analytes: LPX-SD-4401, LPX-SD-4402, LPX-SD-4404, and LPX-SD-4407 (Figure 2). Figure 7 presents a summary of select inorganic concentrations for these samples. With the exception of selenium (detected in three of the four samples), all metals were detected at each location. As observed with the majority of dioxin and furan congeners other than 2,3,7,8-TCDD, the highest concentrations for most metals were detected at station LPX-SD-4404 (Figure 2).

2.4 CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN

Consistent with USEPA Region 1 policy, all analytes selected as COPECs in environmental media (based on screening benchmark exceedances) for site exposure areas were retained to estimate total site risks. Individual dioxin and furan congeners and homologue groups were not specifically identified as COPECs because a toxic equivalency (TEQ) approach, based on 2,3,7,8-TCDD, was employed in the assessment.

A total of 15 metals, five pesticides, two Aroclors plus total Aroclors, and TEQs for birds and mammals were retained as COPECs for the Oxbow Area (Table 2). A discussion of the COPEC screening process is presented below.

2.4.1 Development of Exposure Estimates for COPEC Screening

Table 2 presents summary statistics for each analytical parameter, including minimum and maximum detected concentrations, detection frequency, location of maximum detected concentration, presumed data distribution, and various measures of central tendency of the distribution (arithmetic mean, geometric mean, and median). Consistent with USEPA guidance, the maximum detected concentration was used as the point estimate of exposure for the purpose of the COPEC screening process.

2.4.2 Floodplain Soil Benchmarks

Screening benchmarks and toxicity reference values (TRVs) used to evaluate the potential hazard to soil invertebrates and wildlife associated with exposure to the surface soil exposure point concentrations (EPCs). In general, toxicity information available in USEPA's ECOTOX database and other online resources (e.g., Integrated Risk Information System [IRIS] and International Chemical Database [INCHEM]) were reviewed to identify toxicity values for soil invertebrates, mammals, and birds. This information was supplemented with data reported in toxicity benchmark reports prepared for Oak Ridge National Laboratory (e.g., Efroymson et al., 1997; Sample et al., 1996; Will and Suter, 1995) and other ecotoxicity review documents. Toxicity values were not identified for amphibians due to the lack of specific toxicological data for these receptors.

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Floodplain Soil Invertebrate Benchmarks. Measures of effects to the floodplain soil invertebrate community associated with the Woonasquatucket River floodplain soils were based on literature-derived toxicological benchmarks. The values for earthworms and soil invertebrates that were used to select the COPECs are summarized in Appendix D (Table D-3) of the BERA (MACTEC, 2004).

The effects considered for earthworms were measures of reproduction (e.g., cocoon formation) or mortality. Reproductive effects data are generally more sensitive than other endpoints; therefore, these data were selected when available. A factor of 0.1 was applied to toxicity data for reproductive effects to derive a no observed adverse effects level (NOAEL) equivalent. Mortality data based on LC_{50}s (the concentration that is lethal to 50% of a population of test organisms) was adjusted by a factor of 0.2 to derive a lowest observed adverse effect level (LOAEL). A second factor of 0.1 was applied to the LOAEL to derive a NOAEL (MACTEC, 2004).

Data for soil and litter invertebrates are presented in Efroymson et al. (1997), who derived the 10^{th} percentile of the distribution of various toxic effects thresholds for soil invertebrate receptors. These values were selected, if available; otherwise soil benchmarks summarized by USEPA Region IV were used. For chemicals that lacked empirically-derived benchmarks, soil benchmarks were estimated using Quantitative Structure Activity Relationships (QSARs).

Wildlife-based Benchmarks. Floodplain soil concentrations protective of incidental soil ingestion and consumption of contaminated prey pathways for wildlife receptors were developed to support the COPEC screening process in the BERA. These benchmarks were developed using conservative exposure assumptions and were derived using a process similar to that employed to calculate preliminary remediation goals (PRGs) (MACTEC, 2005). The value developed for the most sensitive wildlife receptor for each analyte is presented in Table D-3 of the BERA (MACTEC, 2004).

The lower of the soil invertebrate and wildlife-based soil concentrations was selected as the screening benchmark. These values used to identify COPECs for floodplain soil medium are presented in Table 2.

2.4.3 Contaminants of Potential Ecological Concern for Floodplain Soil

COPECs were identified by comparing the maximum detected concentration of each analytical parameter to the selected screening benchmark. A summary of the COPEC screening process is summarized for each category of contaminants.

Dioxins/Furans

Most dioxin/furan congeners, except for three, were detected at all seven locations; the other three were detected at six locations (i.e., detection frequency equal to 86%). The only COPEC retained was 2,3,7,8-TCDD. Its maximum concentration was significantly higher than the conservative screening benchmark for floodplain soil. The maximum concentrations for most dioxin/furan compounds, including 2,3,7,8-TCDD, were found at station LPX-SD-4405 which is situated nearest to the Allendale Dam. It is located approximately 300 feet downstream of the dam and 100 feet west of the riverbank (Figure 2).

PCBs

Each detected Aroclor had maximum detected concentrations that were greater than the conservative screening benchmark values; therefore, they were retained as COPECs. The remaining six Aroclors were not detected in any sample (i.e., detection frequency equal to zero). Total Aroclor was found at all three locations with the maximum levels detected at LPX-SD-

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shrew were estimated using literature-derived uptake factors. Exposure modeling was conducted using the inputs presented in Table 20 of the BERA (MACTEC, 2004).

2.5.3 Omnivorous Wildlife Populations

AE (3): Protection and maintenance of omnivorous mammal populations.

The following risk question was established for this assessment endpoint:

- Do doses of COPECs ingested by omnivorous wildlife (as represented by the raccoon) exceed TRVs or TEQs for adverse effects on survival, growth, or reproduction?

The following measurement endpoint was selected to evaluate risk to this endpoint receptor group:

- Comparison of estimated ingestion doses in omnivorous mammals with TRVs and TEQs.

Risks to omnivorous mammals (raccoons) were evaluated by comparing estimated dietary doses associated with the consumption of contaminated drinking water, prey, and the incidental ingestion of soil with TRVs and TEQs.

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3.0 ECOLOGICAL RISK EVALUATION

This section provides an ecological risk evaluation for the floodplain soil invertebrate community, vermivorous bird and mammal populations, and omnivorous mammal populations that may be present in the Oxbow Area of the Centredale Site. The risk evaluation uses the measurement endpoints described in Section 2.5. For each receptor category, results of the benchmark screening are presented along with a summary of applicable site-specific data collected to support the BERA (MACTEC, 2004). In addition, average COPEC concentrations were also used to derive preliminary risk estimates to allow a more complete comparison to the associated findings in the BERA.

For each assessment endpoint, the components of the exposure and effect evaluations are described, followed by the risk characterization analysis and a summary of the assessment findings.

3.1 FLOODPLAIN SOIL INVERTEBRATE COMMUNITY

Potential risks to the floodplain soil invertebrate community were evaluated using the measurement endpoints discussed in Section 2.5. These include (1) a comparison of floodplain soil COPEC concentrations to benchmarks/guidelines; (2) a comparison of estimated COPEC concentrations (derived using site-specific BSAFs) in floodplain soil invertebrates to literature-derived CBR values; and (3) a site-specific study of floodplain soil invertebrate community structure/function conducted to support the BERA of other floodplain habitat within the Centredale Site.

3.1.1 Exposure Assessment

Exposure to COPECs in floodplain soil by invertebrates were evaluated using measured Oxbow Area floodplain soil data, estimated earthworm tissue data (derived using site-specific BSAFs), and historical data collected in 2001 to support the BERA. Table 2 summarizes the maximum and average COPECs concentrations that were used to estimate exposure to floodplain invertebrates in this evaluation.

Table 3 presents the estimated maximum and average concentrations of COPECs in earthworm tissue based on uptake modeling using the site-derived BSAFs. As described in the BERA (MACTEC, 2004), analytical chemistry data for co-located earthworm tissue and associated soil samples were used to develop BSAFs for predictive uptake modeling of bioaccumulating COPECs. These samples were collected from 11 locations throughout the Centredale Site and were used to evaluate whether prey tissue concentrations posed a risk of direct harm to invertebrates or to vermivorous wildlife that may forage on these organisms. In addition, these BSAFs were used to develop PRGs protective of ecological exposures in floodplain habitat. Table A-1 of the BERA (MACTEC, 2004) presents a summary of the analytical samples for floodplain soil and earthworm tissue that were used in to develop the earthworm tissue BSAFs. Table J-8 in the BERA (MACTEC, 2004) presents the earthworm BSAFs developed for the Centredale Site.

The following equation was used to estimate concentrations in earthworm tissue based on measured concentrations in floodplain soil:

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$$C_{earthworm} = \frac{BSAF * C_{soil} * \%lipid}{\%TOC} \qquad \text{(Equation 1)}$$

where:

$C_{earthworm}$	=	chemical concentration in earthworm tissue (µg/g - ww)
BSAF	=	biota soil accumulation factor derived using site-specific data (expressed as $g_{organic\ carbon}$ - dw/g_{lipid} - ww)
C_{soil}	=	maximum chemical concentration in floodplain soil (µg/g – dw)
% lipid	=	lipid content of earthworm (g_{lipid}/g; both ww basis)
%TOC	=	total organic carbon content of floodplain soil ($g_{organic\ carbon}$/g; both ww basis)

Table 3 summarizes estimated maximum and average tissue concentrations for COPECs in Oxbow Area earthworms. For this Addendum, the average earthworm lipid content (i.e., 2.7 %) measured in the three earthworm samples collected in Lyman Mill Pond Exposure Area during the June 2001 field sampling program was used to estimate Oxbow Area earthworm lipid content. TOC was measured in three floodplain soil samples collected in the Oxbow Area in 2004; as indicated in Table 2, concentrations range from 13 to 36%. The average TOC measured in LPX-SD-4402 and corresponding field duplicate (i.e., 8.9%) was conservatively selected as the input parameter in Equation 1 for the purposes of modeling COPEC uptake into floodplain invertebrates. If the average TOC measured in the three floodplain soils (21.6%, Table 2) were used to estimate the $C_{earthworm}$ term in the above equation, the estimated concentrations would have been over two times lower than was assumed in this Addendum (i.e., 21.6/8.9).

3.1.2 Effects Assessment

The measurement endpoints selected to evaluate this assessment endpoint are discussed in the following section.

Comparison of floodplain soil COPEC concentrations to benchmarks/guidelines. TRVs used to evaluate the potential hazard associated with invertebrate exposure to surface soil are presented in Table D-3 of the BERA (MACTEC, 2004). For this Addendum, the TRVs were compared to the maximum and average COPEC concentrations for floodplain soil (Table 2) to derive hazard quotients (HQs) as ratios of the exposure estimate to the TRV (Table 4).

Comparison of measured site-specific COPEC concentrations in floodplain soil invertebrates to literature-derived critical body residue (CBR) values. Critical body residue data, as described in the BERA (MACTEC, 2004) were compiled from various sources. For each contaminant class and general effect category (i.e., mortality, growth, and reproduction), LOAELs and NOAELs were selected. Occasionally either a NOAEL or LOAEL could not be established from the information in the database, resulting in an unbounded estimator of the effect threshold for a given taxon/effect category (Table G-1 of the BERA). CBRs (Table G-1 of the BERA) were compared to the estimated earthworm tissue concentrations to derive HQs as ratios of the exposure estimate (either maximum or average estimated earthworm tissue concentration) to the CBR estimate (either based on the NOAEL or LOAEL) (Table 5).

Site-specific study of floodplain soil invertebrate community structure/function. In 2001, the floodplain soil community associated with the Woonasquatucket River was surveyed at 11 sampling stations. At each location, the soil invertebrate community was sampled and a

representative floodplain soil sample was collected. A total of 19 soil invertebrate taxa, including seven species of earthworms, were identified in Allendale Pond, Lyman Mill Pond, and Greystone Mill Pond floodplain soil samples. Earthworms numerically dominated the taxonomic community samples, representing approximately 73% of the overall fauna collected. *Aporrectoda rosea* dominated the upriver background stations and *Lumbricus rubellus* was dominant in the Centredale Site sampling locations. Other invertebrates included arthropods, gastropods, and nematodes. Additional details are presented in Appendix E of the BERA (MACTEC, 2004).

No specific information regarding the status of the floodplain soil community associated with the Oxbow Area is available. However, the relationships between floodplain soil chemistry and the findings of the 2001 invertebrate community study were used in this Addendum to make inferences about the status of the Oxbow Area invertebrates (see Section 3.1.3).

3.1.3 Risk Characterization

This section provides an evaluation of each of the measurement endpoints established to characterize risk to the floodplain soil invertebrate community.

Comparison of floodplain soil COPEC concentrations to benchmarks/guidelines. TRVs were compared to the maximum and average COPEC concentrations for floodplain soils and an HQ was determined. Results are presented in Table 4. The HQs derived using the maximum detected COPEC concentrations for all five pesticides exceed one. Dieldrin has the highest exceedence level, with an HQ of 130. The HQs for total Aroclor, Aroclor 1254, Aroclor 1268, and 2,3,7,8-TCDD are less than one. Of the 15 metals analyzed, nine have HQs that exceed one. Chromium and zinc have the highest risk at 260 and 19, respectively.

HQs were also derived by comparing the average exposure to the TRVs to provide a better point of reference to the results of the BERA. For pesticides, only the HQ for 4,4'-DDT does not exceed one (0.51). The average total pesticide hazard index (HI) (the sum of all the HQs) is 66, compared with the maximum HI of 170. As with the maximum HQ for Aroclors and 2,3,7,8-TCDD, the average HQs do not exceed one for any COPECs. Seven of the 15 metals have HQs greater than one, with chromium, manganese, and zinc having the highest HQ values (180, 8.3, and 6.4, respectively).

Total Oxbow Area risks, as represented by the HI are 480 using the maximum soil concentration and 280 using the average soil concentration. The majority of risk is attributed to metals and pesticides (see histograms identified as "OXB" in Figure 8).

Comparison of estimated COPEC concentrations in floodplain soil invertebrates to literature-derived critical body residue (CBR) values. The CBRs obtained from the summary of tissue effects data presented in Table G-1 of the BERA (MACTEC, 2004) were compared to soil EPCs to determine potential risk to soil invertebrates. Results are presented in Table 5 and Figure 9. No PCB HQ exceeds one for any comparison. For pesticides, only the dieldrin HQ exceeds one for the maximum soil concentration compared to the NOAEL. For the maximum soil concentration of metals, the HQs for five metals (cadmium, copper, lead, vanadium, and zinc) exceed both the NOAEL and LOAEL benchmarks. A NOAEL was not available for barium, but the estimated tissue concentration does exceed the LOAEL-based CBR. A LOAEL value was not available for manganese, but the estimated tissue concentration slightly exceeds the NOAEL-based CBR (2.8). For the average concentration of metals in the Oxbow Area, estimated tissue concentrations of cadmium, lead, vanadium, and zinc all exceed both the NOAEL- and the

LOAEL-based CBR values. The NOAEL-based HQ for copper is 1.0. The results for the average estimated tissue concentrations of selenium, barium, and manganese are similar to findings based on the maximum concentrations. The estimated tissue concentration of 2,3,7,8-TCDD only slightly exceeds the NOAEL-based CBR (HQ - 1.1).

Total Oxbow Area risks are 83 for a NOAEL-based HQ and 240 for a LOAEL-based HQ using the maximum soil concentration. For the average soil concentration, the NOAEL-based HQ is 32 and the LOAEL-based HQ is 120. Inorganic contaminants are the major contributor to risk (Figure 9).

Site-specific study of floodplain soil invertebrate community structure/function. According to the BERA (MACTEC, 2004), the floodplain soil invertebrate community along the Woonasquatucket River is comprised of organisms that are typically found in forested habitats along stream banks. The number of taxa found at sampling stations downstream of the Centredale Site was generally greater than found in the background area. Organisms found at upstream background stations were also found at downstream stations and no organisms were restricted to upstream stations exclusively. Based on a comparison of the relative abundance of organisms, the species diversity, and the overlap of shared fauna, no adverse effects were evident in the floodplain invertebrate communities associated with Allendale Pond and Lyman Mill Pond, relative to the upstream background locations. Further details are provided in Appendix E of the BERA (MACTEC, 2004).

Based on the similarity of soil chemistry, the findings of the BERA suggest that the invertebrate fauna should be comparable to other exposure areas within the Centredale Site and not distinguishable from the upriver background area.

3.1.4 Risk Assessment Summary for Soil Floodplain Invertebrates

Tables 6 and 7 present the results of the incremental risk evaluation for the soil and earthworm tissue media. Regarding the comparison to soil benchmarks, the incremental risks for the Oxbow Area are dominated by pesticide compounds and metals (primarily, zinc). The risk associated with dieldrin exposure dominates the incremental risk estimates (Table 6); pesticides also dominated the incremental risk estimates for the Allendale Pond floodplain area in the BERA (Table 77, MACTEC, 2004); although the magnitude of the incremental risk is somewhat higher for the Oxbow Area. In contrast, the incremental risk for the residue-based assessment of estimated earthworm tissue concentrations were considerably lower, with only cadmium and zinc contributing to the incremental risk significantly (LOAEL-based incremental risk estimates of 20 and 1.7, respectively) (Table 7).

Based on a comparison of maximum and average floodplain soil concentrations to screening benchmarks, the soil invertebrate community occurring within the Oxbow Area may be at potential risk of harm due to exposure to site-related contaminants in floodplain soils associated with exposure to a number of pesticides (including dieldrin, lindane, 4,4-DDE, and 4,4'-DDD) and zinc. However, the analysis of estimated earthworm tissue concentrations presents less indication that the community is at risk of harm. An evaluation of the soil invertebrate community study that was conducted to support the BERA also provides less indication of risk to this receptor group.

3.2 VERMIVOROUS WILDLIFE POPULATIONS

This section evaluates risk to vermivorous bird populations (as represented by the American woodcock) and mammal populations (as represented by the short-tailed shrew). Two

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measurement endpoints were selected to evaluate the assessment endpoint for these receptors (Section 2.5) including: (1) a comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs; and (2) a comparison of measured and estimated vermivorous wildlife tissue and/or egg residues with CBR data. The following section describes the estimation of vermivorous wildlife tissue and development of a food web model to predict exposure and the data used in the assessment.

3.2.1 ***Exposure Assessment***

Comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs. To predict the exposure of vermivorous wildlife to COPECs from the ingestion of soil invertebrates, a food web model was used to calculate a daily dose of COPECs as a result of consumption by the representative species. Estimated Daily Intakes (EDIs) of COPECs were calculated as the measure of exposure for each selected wildlife receptor. The EDIs are expressed as milligrams of contaminant per kilogram bodyweight ingested on a daily basis (mg/kg-day). The following dose model was used to estimate daily exposure of contaminants to wildlife receptors:

$$EDI = \{[(C_{soil} \times IR_{soil}) + \sum (C_{foodi} \times IR_{foodi})] \times SFF \} / BW \qquad \text{(Equation 2)}$$

where:

EDI	=	daily dose resulting from ingestion of soil and food (µg/g - day)
C_{soil}	=	concentration of COPEC in surface soil (µg/g; dw basis)
IR_{soil}	=	estimate of receptor's daily ingestion rate of surface soil (kg/day)
C_{food}	=	concentration of COPEC in food tissue (µg/g; ww basis)
IR_{food}	=	estimate of daily ingestion rate of food tissue (kg/day)
SUF	=	site use factor (unitless)
BW	=	body weight (kg)

As discussed in Section 3.1.1., site-specific biota-soil accumulation factors (BSAFs) were used to estimate the uptake of bioaccumulating COPECs into earthworm tissue (Table 3), which was assumed to be the primary prey type consumed by vermivorous wildlife that forage in the Oxbow Area.. The exposure parameter values summarized in Tables 8 and 9 are consistent with those employed in the BERA.

Dose estimates to wildlife receptors were estimated using both maximum and average exposure estimates. Exposure dose estimates for the woodcock and short-tailed shrew based on exposure to maximum contaminant concentrations in the Oxbow Area are presented in Appendix C.

Appendix D presents the corresponding dose estimates based on the average exposure estimates. Two exposure related assumptions were used to calculate the average dose estimates; these included incorporating information on a receptor's typical foraging range (rather than assuming 100% site utilization) and the use of average rather than maximum detected concentrations in exposure media (i.e., soil and contaminated biota).

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Comparison of estimated vermivorous avian egg and mammalian tissue concentrations with CBR data. Literature derived biomagnifications factors (BMFs) were used to estimate the TCDD TEQs in vermivorous mammal and avian egg tissues. The development of BMFs is discussed in Section 7.1.2 of the BERA (MACTEC, 2004). The following equation was used to estimate receptor tissue concentrations (either eggs for the woodcock or whole body tissue for the short-tailed shrew) based on prey tissue concentrations:

$$C_{avian_egg} = \frac{BMF * C_{earthworm} * \%lipid_{avuan_egg}}{\%lipid_{earthworm}} \qquad \text{(Equation 3)}$$

where:

C_{avian_egg}	=	estimated chemical concentration in avian egg tissue (mg/kg - ww)
BMF	=	literature-based biota magnification factor (expressed as $kg_{earthworm\ lipid}/kg_{avian_egg\ lipid}$)
$C_{earthworm}$	=	estimated chemical concentration in earthworm prey (mg/kg ww)
$\%\ lipid_{avian_egg}$	=	lipid content of avian egg tissue (ww basis)
$\%\ lipid_{earthworm}$	=	lipid content of earthworm tissue (ww basis)

A similar transfer factor was used to estimate small mammal tissue concentrations based on dietary exposure to contaminated earthworms. BMFs for vermivorous wildlife were estimated using transfer factors obtained from the literature that were derived for gull egg tissue (based on adult consumption of fish; Braune and Norstrom, 1989) and otter liver (based on consumption of fish; Leonards et al., 1997). Estimated woodcock egg tissue concentrations for 4,4'-DDE, and dieldrin (only pesticides COPECs with both available BMFs and egg tissue CBRs) and TCDD TEQ are presented in Table 10. Table 11 presents the TCDD TEQ estimate for whole body shrew tissue.

3.2.2 Effects Assessment

The data used to establish the relationship between exposure and adverse effects to vermivorous receptors for both measurement endpoints are discussed below.

Comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs. Dose estimates were compared to TRVs compiled to support the BERA to derive HQs based on both NOAEL and LOAEL effect levels. TRVs used to derive hazard estimates are presented along with the exposure estimates in Tables C.1 and C.2 for the woodcock and shrew receptors, respectively. The selected TRVs were based on studies that reported effects on the key demographic endpoints of mortality, growth, or reproduction (Table D-4 of the BERA) (MACTEC, 2004). No avian bird TRV for either antimony or cobalt is available and the potential risks to birds associated with exposure to these two floodplain soil COPECs is discussed in the uncertainty evaluation.

Comparison of estimated vermivorous avian egg and mammalian tissue concentrations with CBR data. CBRs based on NOAEL and LOAEL values for avian egg and mammal whole body tissue are presented in Table G-1 of the BERA (MACTEC, 2004). Wildlife tissue concentrations derived using both the maximum and average estimated earthworm tissue concentrations were

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compared to both NOAEL- and LOAEL-based CBRs to estimate potential for adverse effects associated with the bioaccumulation of COPECs to wildlife receptors.

3.2.3 Risk Characterization

The results of the exposure and effects evaluations were combined to characterize potential risks to vermivorous wildlife receptors exposed to contaminated food and soil at the Oxbow Area. Results from the dose modeling and tissue residue analyses are discussed separately.

Comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs. Hazard quotients for the woodcock and short-tailed shrew receptors based on maximum exposure estimates are presented in Tables C.1 and C.2, respectively. Tables C.1-2 and C.1-4 present estimated doses based on exposure to maximum concentrations to floodplain soil and contaminated earthworms to the woodcock receptor, respectively; C.2-3, C.2-5, and C.2-7 present estimated doses based on maximum concentrations to floodplain soil, floodplain plants, and contaminated earthworms to the shrew receptor, respectively. NOAEL- and LOAEL-based hazard estimates are combined across all exposure pathways for the woodcock (Tables C.1-5 and C.1-6, respectively) and shrew (Tables C.2-8 and C.2-9). Appendix D presents the corresponding hazard quotients based on the average exposure estimates. NOAEL- and LOAEL-based hazard estimates are combined across all exposure pathways for the woodcock (Tables D.1-5 and D.1-6, respectively) and shrew (Tables D.2-8 and D.2-9).

For the American woodcock, 12 COPECs exceed the NOAEL-based HQ using the maximum soil concentration: lead, dioxin (presented as TEQ bird), zinc, chromium, beryllium, total Aroclor, cadmium, Aroclor 1254, 4,4'-DDE, selenium, 4,4'-DDD, and barium (Table C.1-5). The total risk (HI) is 110, with the majority of risk attributed to lead (33%), followed by dioxin (28%), zinc (15%), chromium (6%), beryllium (4%), total Aroclor and cadmium (3%), Aroclor 1254 and 4,4'-DDE (2%) (Figure 10). The remaining COPECs contribute 1% to the total risk. Sixty-four percent of the total risk to the woodcock can be attributed to the ingestion of soil, while 36% can be attributed to the ingestion of soil invertebrates. The estimated exposure does of only five COPECs exceed the LOAEL-based TRVs (i.e., HQ greater than one): lead, dioxin, zinc, chromium, and total Aroclor. The total risk is 14, with the majority from lead (26%), dioxin (22%), zinc (13%), chromium (10%), and total Aroclor (9%) (Table C.1-6, Figure 10).

Using the average soil concentration, estimated exposures for seven COPECs exceed the NOAEL-based TRV: dioxin, lead, zinc, chromium, beryllium, cadmium, and total Aroclor (Table D.1-5). The total risk is 46 with the majority of risk attributed to dioxin (29%), lead (25%), zinc (13%), and chromium (11%). For the LOAEL-based risk, the exposure dose estimates for only three COPECs exceeded respective TRVs: dioxin, lead and chromium. The total risk was slightly above one (6.1) with 21% of it attributed to dioxin, 19% attributed to lead, and 17% attributed to chromium (Table D.1-5).

For the short-tailed shrew, the dose estimates for 12 COPECs exceed the NOAEL-based TRVs using the maximum soil concentration: dioxin (presented as TEQ mammal), copper, antimony, cobalt, vanadium, cadmium, arsenic, total Aroclor, Aroclor 1254, selenium, molybdenum, and zinc. The total HI is 610. The majority of risk (73%) is attributed to dioxin, followed by copper (9%), antimony (7%), and cobalt (3%) (Figure 11). The additional COPECs contribute 1% or less to the total risk. Sixty-one percent of the risk to the shrew can be attributed to the ingestion of invertebrates, while the ingestion of soil comprise 38% of the risk, and the ingestion of plants accounting for only 2% of the total risk (Table C.2-8). For the LOAEL-based analysis, the HQs of only seven COPECs exceed one: dioxin, copper, antimony, selenium, vanadium, cobalt, and zinc (Table C.2-9, Figure 11). The total HI is 66. Dioxin accounts for the majority of the risk

(68%), followed by copper (9%), antimony (7%), selenium (4%), vanadium and cobalt (3%), and zinc (2%).

Using the average soil concentrations, only zinc is eliminated as a primary risk contributor for the NOAEL-based comparison. The total risk based on average soil concentrations is 260 rather than 610 as determined for evaluation of maximum conditions. The largest contributions of risk are from five COPECs: dioxin (71%), antimony and copper (7%), cobalt (5%), and vanadium (3%) (Table D.2-8). The total HI for the LOAEL-based analysis is 29, with the majority of risk attributed to dioxin (64%), antimony (7%), copper and selenium (6%), vanadium (5%), and cobalt (4%) (Table D.2-9).

Figures 10 and 11 present graphically the NOAEL- and LOAEL-based hazard quotient estimates for the American woodcock and short-tailed shrew receptors, respectively. The HQs based on average exposure estimates are presented to facilitate comparison with the result derived in the BERA for the other exposure areas containing floodplain habitat (i.e., Allendale Pond "APB" and Lyman Mill Pond "LPX") along with results for the upriver background area (i.e., Greystone Mill Pond "GMP"). Only the subset of COPECs contributing most substantially to the overall Hazard Index (HI) is presented. In both Figures 10 and 11, the primary contribution of the TCDD TEQ (and specifically 2,3,7,8-TCDD; Figure 5) to the overall risk estimate is evident, as is the substantial risk relative to background conditions for this COPEC. While various inorganic COPECs also contribute to the overall risk estimates, their significance is less than that of TCDD TEQ; moreover, hazard estimates at the Oxbow Area based on vermivorous wildlife exposure to inorganic COPECs are similar to the estimates derived for the Greystone background area.

Relative to the risk findings presented in the BERA (MACTEC, 2004), potential risks to both vermivorous wildlife receptors exposed in the Oxbow Area are somewhat higher than either for Allendale Pond and Lyman Mill Pond (Figures 10 and 11).

Comparison of estimated vermivorous avian egg and mammalian tissue concentrations with CBR data. Tables 10 and 11 summarize the hazard quotients derived by comparing maximum estimated woodcock egg tissue and shrew liver concentrations to NOAEL- and LOAEL-based CBRs.

Joint estimated egg tissue residue and CBR values were only available for two pesticides (LOAEL-based CBRs only): 4,4'-DDE and dieldrin. For the maximum soil concentrations both HQs exceed one with a combined HI of 4.2. For the average soil concentration, only the HQ for 4,4'-DDE slightly exceeds one (1.1). For total dioxin (TEQ bird) all HQs exceed one. Thus, dioxin contributes the majority of the total risk to the avian egg tissue endpoint (Figure 12).

Tables 10 and 11 also present HQs based on estimated average COPEC concentrations in woodcock egg and shrew liver to NOAEL- and LOAEL-based CBRs.

Estimated mammalian tissue data for pesticides and dioxins were compared to NOAEL- and LOAEL-based CBRs to determine any potential risks to mammals (Table 11). Only risk from dioxin was calculated. For the maximum soil concentration, the NOAEL-based HQ was 46, the LOAEL-based HQ was 30; for the average soil concentration, the NOAEL-based HQ was 17, the LOAEL-based HQ was 11 (Figure 13).

3.2.4 Risk Assessment Summary for Vermivorous Wildlife Populations

Tables 12 and 13 present the results of the incremental risk evaluation for the woodcock and shrew receptors, respectively. Only those COPECs with calculated NOAEL-based incremental

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HQs exceeding one are presented. In both cases, the incremental risks (i.e., Oxbow Area estimates minus the results for the Greystone background area) are dominated by the TEQ-bird (and specifically 2,3,7,8-TCDD). For the woodcock receptor, the NOAEL- and LOAEL-based incremental HQs for the TCDD TEQ are 13 and 1.3, respectively and this is the only COPEC with a LOAEL-based HQ in excess of one (Table 12). The remaining NOAEL- and LOAEL-based HQs for the other COPECs (zinc, lead, and total Aroclors) bracket the value of one which is the area of greatest interpretive uncertainty with regards to whether these exposures would actually pose a threat to the woodcock. The incremental risk findings for the woodcock are similar to those derived in the BERA (Table 150 of MACTEC, 2004) where NOAEL- and LOAEL-based incremental HQs of 6.6 and 0.6 were estimated for Allendale Pond Exposure Area.

The results of the incremental risk evaluation for the shrew receptor are similar (Table 13). 2,3,7,8-TCDD (TEQ-mammal) makes the most substantial contribution to the overall incremental risks) and there was a similar finding in the BERA for the Allendale Pond Exposure Area where NOAEL- and LOAEL-based HQs for this COPEC are 130 and 13, respectively (Table 151 of MACTEC, 2004). Incremental risk estimates (34 and 3.4 for NOAEL- and LOAEL-based HQs, respectively) for Lyman Mill Pond Exposure Area are approximately one third less than observed in Allendale (Table 151 of MACTEC, 2004). Other COPECs contributing to the incremental risks include antimony, total Aroclor, Aroclor 1254, and cadmium. With the exception of antimony, only the NOAEL-based HQs for these other COPECs slightly exceed one and thus make an insignificant contribution to the overall risks to the shrew receptor. The NOAEL- and LOAEL-based HQs for antimony are 13 and 1.3, respectively (Table 13) and because both estimates exceed one, it is concluded that exposure to this COPEC could also have an adverse Site-related effect on shrew populations. Nonetheless, 2,3,7,8-TCDD makes by far the most substantial contribution to the overall incremental risks determined for the Oxbow Area.

Vermivorous mammal and bird populations that occur within the Oxbow Area appear to be at substantial risk of harm due to direct exposure to site-related contaminants in floodplain soil and bioaccumulated in prey items. 2,3,7,8-TCDD is the most substantial contributor to the estimated risks to vermivorous receptors. In addition, consumption of contaminated earthworm prey may result in elevated tissue residues in these receptors resulting in adverse reproductive effects (i.e., bioaccumulation hazard). Dietary exposures and modeled tissue burdens in avian eggs and mammal liver tissue also pose a substantial risk of harm to vermivorous wildlife species.

These results assume that complete exposure pathways exist for these wildlife receptors in the Oxbow Area. The uncertainties associated with this assumption (including presence of sensitive receptor in an urbanized setting and adequate forage base) are discussed in Section 4.

3.3 OMNIVOROUS MAMMAL POPULATIONS

This section evaluates risk to omnivorous mammal populations (as represented by the raccoon) from exposure to COPECs. The single measurement endpoint selected to evaluate the assessment endpoint for this receptor was the comparison of ingestion dose estimates to TRVs and TEQs. No comparison of CBRs to estimated omnivorous mammal tissue was conducted due to the uncertainties associated with tissue residues in receptors that consume a wide variety of food types. This section presents the approach used to model COPEC exposures by omnivorous mammals.

3.3.1 Exposure Assessment

Daily dose estimates were derived for the raccoon receptor using the procedures described in Section 3.2.1. The exposure parameters presented in Table 14 (which are consistent with those employed in the BERA) were used to estimate daily exposures associated with the incidental soil ingestion and consumption of contaminated food pathways.

As was done for the vermivorous receptors, dose estimates to the omnivorous wildlife receptor were estimated using both maximum and average exposure estimates. Exposure dose estimates for the raccoon based on exposure to maximum concentrations in the Oxbow Area are presented in Tables C.3-3, C.3-5, and C.3-7 present estimated doses based on maximum concentrations to floodplain soil, floodplain plants, and contaminated earthworms to the raccoon receptor, respectively; Tables C.3-2, C.3-4, and C.3-6, document the exposure parameter assumptions used to derive the exposure estimates for each of these three environmental media. Table C.3-1 presents the estimated plant tissue concentrations that were derived using literature BAFs as was done in the BERA.

Appendix D presents the corresponding dose estimates based on the average exposure estimates for the raccoon receptor. Two exposure related assumptions were relaxed to calculate the average dose estimates; these included incorporating information on a receptor's typical foraging range (rather than assuming 100% site utilization) and the use of average rather than maximum detected concentrations in exposure media (i.e., soil and contaminated biota).

3.3.2 Effects Assessment

Dose estimates were compared to TRVs compiled to support the BERA to derive HQs based on both NOAEL and LOAEL effect levels. TRVs used to derive hazard estimates are presented along with the exposure estimates in Tables C.3. The selected TRVs were based on studies that reported effects on the key demographic endpoints of mortality, growth, or reproduction (Table D-4 of the BERA) (MACTEC, 2004).

3.3.3 Risk Characterization

The results of the exposure and effects evaluations were combined to characterize potential risks to omnivorous mammal receptors exposed to contaminated food and soil at the Oxbow Area.

Hazard quotients for the raccoon, based on maximum exposure estimates, are presented in Appendix C. Tables C.3-3, C.3-5, and C.3-7 present estimated doses based on maximum concentrations to floodplain soil, floodplain plants, and contaminated earthworms to the raccoon receptor. NOAEL- and LOAEL-based hazard estimates are combined across all exposure pathways and presented in Tables C.3-8 and C.3-9, respectively.

For the raccoon, eight COPECs exceed one for the NOAEL-based maximum soil HQ (Table C.3-8). The total risk is 80, with the majority of risk attributed to dioxin (TEQ mammal) (61%), total Aroclor and Aroclor 1254 (10%), antimony (5%), cobalt and arsenic (3%), vanadium (2%), and molybdenum (1%) (Figure 14). The soil ingestion pathway contributes the majority of the risk (61%), followed by the ingestion of terrestrial invertebrates (36%). For the LOAEL-based HQs, three COPECs exceed one: 2,3,7,8-TCDD, total Aroclor, and Aroclor 1254. The total risk is 11 with the majority of it attributed to 2,3,7,8-TCDD (42%), followed by total Aroclor and Aroclor 1254 (18% each).

Appendix D presents the corresponding hazard quotients based on the average exposure estimates. NOAEL- and LOAEL-based hazard estimates are combined across all exposure

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pathways in Tables D.3-8 and D.3-9. Using the average soil concentration, only dioxin has a NOAEL-based HQ above one, and contributed to 59% of the total risk (3.6). The HQ for no COPEC exceeds one in the analysis based on LOAELs. The total risk is also below one (0.51).

Figure 14 graphically presents the NOAEL- and LOAEL-based hazard quotient estimates for the raccoon receptor exposed to floodplain soils in the Oxbow Area. The HQs based on average exposure estimates are presented to facilitate comparison with the result derived in the BERA for the other exposure areas containing floodplain habitat (i.e., Allendale Pond "APB" and Lyman Mill Pond "LPX") along with results for the upriver background area (i.e., Greystone Mill Pond "GMP"). Only the subset of COPECs contributing most substantially to the overall Hazard Index (HI) is presented. Although the NOAEL-based HQ for TCDD TEQ (i.e., 2,3,7,8-TCDD) exceeds one, the LOAEL-based HQ does not exceed one, nor do the HQs for any other COPEC. The risk estimates for the Oxbow Area appear to be elevated relative to the BERA findings for Allendale Pond and Lyman Mill Pond; however, the Oxbow Area findings appear to support a similar conclusion that the raccoon is not at substantial risk of harm associated with foraging activities within this area. As discussed further in the BERA (MACTEC, 2004), the exposure modeling for the raccoon assumed that an individual raccoon only spends 50% of its time foraging within the Woonasquatucket River; the aquatic exposures were found to pose more significant risks to this receptor (MACTEC, 2004).

3.3.4 Risk Assessment Summary for Omnivorous Mammal Populations

Table 15 presents the results of the incremental risk evaluation for the raccoon. TCCD TEQ was the only COPEC with calculated NOAEL-based incremental HQs exceeding one and this only slightly (i.e., 1.6). These findings support a conclusion that the raccoon population (and other receptors with similar diets) is not likely at substantive risk of harm as a result of foraging within the Oxbow Area. Omnivorous mammal populations that forage within the study area are not at substantial risk of harm due to exposure to site-related contaminants in floodplain soil and terrestrial prey items.

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4.0 ECOLOGICAL RISK UNCERTAINTY ANALYSIS

This section includes a discussion of major limitations of the analyses, any sources of uncertainties, and, if possible, any indication as to whether these uncertainties and limitations may have resulted in an over- or under-estimation of risk. The uncertainty section may also include unusual site conditions or extenuating circumstances that may be pertinent to risk management decisions. Uncertainties in the quantification of risk associated with the site are identified and their impacts on risk estimates are discussed below.

Uncertainties associated with the selection of COPECs, exposure assessment, effects assessment, and overall risk characterizations are discussed. The major uncertainties are summarized in Table 16.

4.1 PROBLEM FORMULATION

The main problem formulation uncertainties are associated with the selection of receptors, the identification and selection of COPECs, and the spatial boundary of the exposure area.

4.1.1 Selection of Receptors of Concern

Receptor species were selected that would be expected to receive elevated exposures to contaminants that bioaccumulate in floodplain habitat. Although considerable time was spent by trained biologists in the study area during the 2001 field sampling program, no quantitative census of wildlife populations occurred and the presence of the selected wildlife receptors at the Oxbow Area have not been confirmed. It is possible that the available habitat, which is located within an urbanized area, is not capable of supporting sensitive species such as the woodcock, for instance.

Consistent with the approach employed in the BERA, this Addendum did not specifically evaluate plant species as a receptor group; however, there is no indication that plants are sensitive to TCDD and other COPECs with dioxin-like effects as they lack the Ah receptor. Although certain inorganic analytes are known to have phytotoxic effects, levels of inorganic COPECs at the Oxbow Area were shown to be generally consistent with background conditions for the watershed.

As noted during a Centredale Site visit in April 2006, portions of the Oxbow Area are ponded throughout part of the year. While only exposures to floodplain soil by soil invertebrates and wildlife were evaluated in the Addendum, aquatic invertebrates and amphibians may be additional receptors that could be seasonally exposed. These receptors were not evaluated in the Addendum because surface water data were not available. Further habitat characterization work that is planned to be conducted by USACE (including a vernal pool survey, wetland delineation, and functional assessment) will provide additional information necessary to evaluate the significance of these other exposures.

Furthermore, one of the assumptions for the wildlife exposure modeling is that the habitat provides a soil invertebrate forage base adequate to support populations of vermivorous wildlife such as woodcock and shrews. To the extent that surface hydrology results in Oxbow Area soils to remain saturated throughout a substantial portion of the year, this assumption may result in exposures to these receptors being over-estimated. This would particularly be the case if COPEC

concentrations are positively correlated with the more depositional, higher organic carbon areas that would be more prone to prolonged flooding conditions.

4.1.2 Identification and Selection of COPECs

The extensive environmental investigations have provided a substantial body of information that has been utilized in the BERA. The identification of COPECs was done in a conservative manner that assured that the quantification of risk to ecological receptors included all relevant potential stressors. The use of conservative screening benchmarks that considered both invertebrate and wildlife protectiveness ensured that all relevant contaminants were retained for the analysis.

Although Oxbow Area floodplain soil samples were not analyzed for certain analytical parameters evaluated in the BERA (including PAHs, coplanar PCB congeners, and HCX), it is unlikely that the conclusions drawn in this report would have been significantly affected had these additional data been available. Based on the toxicological assessment conducted in the BERA, HCX is most likely a relatively poor aryl hydrocarbon (Ah) receptor agonist compared to TCDD and exposure to the most elevated concentrations detected in Centredale Site media posed minimal ecological risk. The risk findings presented in this Addendum are very much in accordance with the BERA findings (in both nature and magnitude of the hazards posed) and there is no reason to suspect that general fate and transport characteristics of site-related contaminants would somehow operate differently in the Oxbow Area compared to other portions of the Centredale Site. Given the predominant role of TCDD as the primary risk contributor to wildlife in both assessments, the conclusions presented appear to be robust ones.

4.1.3 Area Boundary Delineation

An additional uncertainty relates to the determination of the boundary of the Oxbow Area. Consistent with the CSM, the 100-year flood elevation was used to determine the spatial boundaries of the Oxbow Area. Although there remains some uncertainty regarding the most appropriate elevation for boundary determination, it is possible that one location (LPX-SD-4404; see Figure 2) lacks a complete migration pathway from the source area. The analytical chemistry results for the sample collected from this location are distinctive in that the maximum concentrations of most inorganic analytes were detected in this sample. In addition, the dioxin/furan congener "signature" associated with this sample was unique with TCDD representing only a small fraction of the total TEQ concentration. If this sample were excluded from the analysis, the hazard levels identified for the soil invertebrate endpoint would have been lower; however, risks to wildlife would be unaffected, since TCDD is the primary risk driver for these receptors.

4.2 EXPOSURE AND MODELING UNCERTAINTIES

The major exposure-related uncertainties are associated with the selection of exposure parameters and estimation of bioaccumulation factors for various environmental media.

4.2.1 Exposure Parameters

The relationship between receptor size and dietary intake is a critical factor in estimating exposure. In addition, dietary composition affects exposure because different food sources contain varying levels of COPECs. Although literature information exists for dose calculation inputs such as body weight, ingestion rate, and dietary composition for each receptor evaluated in this Addendum, natural populations may exhibit considerable variability in these parameters. Use of literature-derived exposure parameters increases uncertainty, which could result in an over- or underestimation of the typical exposures encountered by receptors at the Oxbow Area. The

wildlife exposure models were parameterized using available information for adult females for each selected receptor species and average values were selected for the parameter values where a range of data were provided.

4.2.2 Contaminant Distribution with Soil Depth

Oxbow Area floodplain soil analytical data are available for samples collected from the topmost 6-inch soil layer only. Although this depth is most relevant to the exposure pathways evaluated for ecological risk, exposures to deeper soil intervals (e.g., 6-12 inches) are also possible. It is not clear how this uncertainty affects the magnitude of exposure to the primary risk contributors. It is noted, however, that additional soil sampling may be required to complete the remedial design.

4.2.3 Bioaccumulation Factors

Site-specific prey tissue data were available to estimate exposures to most of the wildlife receptor species evaluated in the BERA, which minimized uncertainties associated with this aspect of exposure estimation for the Addendum. Derived BSAFs were used to estimate earthworm tissue concentrations because no measured biota data were available.

Literature uptake factors were used to estimate plant tissue concentrations because no site-specific tissue data were collected. There is greater uncertainty associated with the use of literature values. In addition, although TCDD is known to bioaccumulate in the tissue of some aquatic plant species (e.g., Yockim et al., 1978), no attempt to model the uptake of dioxin, furan, or PCB congeners into plant tissue was made in the wildlife exposure modeling. As a result, dietary exposures to omnivorous wildlife (e.g., raccoon) may be underestimated.

COPEC uptake into biological tissue was estimated using a conservative estimate of organic carbon content in the Oxbow Area. Estimated earthworm tissue concentrations would have been almost 2.5 times lower if the average TOC value (rather than the lowest measured value) had been used in the exposure modeling.

Exposure estimates for avian egg and mammal tissue were likely underestimated because BMF values were only available for a subset of COPECs. For instance, no BMF was available for estimating uptake of Aroclor mixtures or bioaccumulating inorganic analytes into avian egg tissue; for mammal tissue, the only non dioxin/furan congener BMF available was for total Aroclors. The lack of BMFs resulted in risks for this endpoint being underestimated.

4.3 ECOLOGICAL EFFECTS

The major effects-related uncertainties are associated with the selection of toxicity reference values; the BERA provides a detailed discussion of those related to the site-derived data (i.e., floodplain soil community study) that was referenced in the Addendum.

4.3.1 Toxicity Reference Values

Potential uncertainties are related to the appropriateness of literature-derived toxicity data. TRVs used in the BERA were based on an extensive search of both primary peer-reviewed literature and secondary literature, such as government reports and technical conference proceedings. The number and types of information sources reviewed is believed to be adequate to capture the majority of relevant sources of ecotoxicological literature.

Chronic toxicological data were selected preferentially in developing TRVs. However, available toxicological data are not always associated with chronic exposure duration. Therefore, there are

uncertainties in extrapolating the results of shorter term exposures to the chronic exposures assumed for receptors at the Oxbow Area. Chronic NOAELs were the preferred toxicity endpoint for selection of TRVs; however, ecological toxicity data were limited for some COPECs and some wildlife guilds. Therefore, other endpoints (e.g., subchronic NOAELs or LC_{50} values) were selected for use as TRVs. When an endpoint other than a chronic NOAEL was selected as a TRV, an uncertainty factor was applied to the reported value to provide an additional level of conservatism in the risk estimation process. The use of conservative application factors may result in risks being overestimated.

There are little or no toxicological data available for some COPECs. For instance, no avian effects data were available for antimony or cobalt and there was no information available to establish CBRs for some of the analytes estimated in earthworm and wildlife tissue. As a result, ecological hazards posed by certain COPECs could not be quantified. This may underestimate ecological risks at the Oxbow Area. Another uncertainty related to the CBRs concerns that the use of unbounded study results (i.e., cases where studies that only reported an effect or lack of effect to an organism over the tissue concentration range evaluated). Use of unbounded data occasionally resulted in a LOAEL-based CBR being lower than the corresponding NOAEL-based value. This is counterintuitive and an artifact of the method used to derive the CBRs and highlights the uncertainties associated with the available tissue residue effects data.

In general, uncertainty is also associated with the extrapolation of literature-derived toxicity endpoints (especially laboratory-based studies) to equivalent endpoints for measurement endpoint receptors at the site because of discrepancies in exposure conditions. The majority of the toxicity data evaluated and used in the BERA were derived from laboratory studies. Laboratory settings do not necessarily mimic field conditions and exposures and typically are designed to control various factors in order to isolate one parameter in particular. Although controlled experiments result in a more valid interpretation of the isolated parameters, uncertainty is associated with the assumption that field exposures are equivalent to laboratory exposure conditions.

4.3.2 Dioxin and Furan Congeners

Wildlife exposures to dioxin and furan congeners were estimated using TRVs similar to those recommended in USEPA (1993) and the consensus-based TEFs from Van den Berg et al. (1998). This approach represents the most recent risk assessment approach for evaluating dioxins and furans. This approach has been employed because there is not adequate toxicity testing for each of the hundreds of dioxin and furan congeners. Although the use of TEFs has a sound scientific basis, there is some uncertainty (including assumption of additivity and methods used to determine relative potency) associated with their use in estimating the ecological effects from exposure to dioxin-like compounds. However, the predominant congener detected in Oxbow Area floodplain soils is 2,3,7,8-TCDD. Since this congener is considered to be the most toxic of the dioxin and furan congeners, the issue is relatively unimportant for this particular assessment.

The TEQ approach also does not account for toxicity of dioxin/furan and PCB congeners that have a non AhR-mediated toxicological mechanism. However, risk associated with exposure to compounds that exhibit non-dioxin like effects was separately considered using toxicological data for PCB mixtures.

4.4 Risk Characterization Uncertainties

In addition to the uncertainties introduced as a result of the data availability and representativeness issues discussed above, the major source of uncertainty associated with risk characterization involves the interpretation of HQ results. Due to the conservative assumptions

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that were made in developing both exposure and effects assessments, HQs that are greater than one do not indicate that a substantial population- or community-level harm has occurred. Attempts were made to bound these uncertainties in the Addendum by considering risk associated with both chronic NOAELs and LOAELs and evaluating risks using both maximum and average exposure estimates.

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5.0 CONCLUSIONS

Table 17 summarizes the results for each of the assessment endpoints. The findings for each endpoint receptor are summarized below.

Floodplain Soil Invertebrates. Based on a comparison of maximum and average floodplain soil concentrations to screening benchmarks, the soil invertebrate community occurring within the Oxbow Area may be at substantial risk of harm (i.e., Hazard Index [280] greatly exceeds one) due to exposure to pesticides (including dieldrin, lindane, 4,4-DDE, and 4,4'-DDD) and zinc in floodplain soil. However, other measures used to assess this endpoint do not support the conclusion that there is substantial risk of harm to the soil invertebrate community. For instance, the hazard quotients (HQs) for estimated earthworm tissue concentrations indicate less potential for risk (NOAEL HQ of 32 and a LOAEL HQ of 120). Furthermore, an evaluation of the soil invertebrate community study conducted to support the BERA suggests that the invertebrate fauna is comparable to other exposure areas at the Centredale Site and is not distinguishable from the upriver background area.

Vermivorous Wildlife Populations. Vermivorous mammal and bird populations that occur within the Oxbow Area appear to be at substantial risk of harm due to direct exposure to site-related contaminants in floodplain soil and prey items. 2,3,7,8-TCDD is the most substantial contributor to the estimated risks to vermivorous receptors. In addition, based on modeled tissue concentrations, consumption of contaminated earthworm prey may result in elevated tissue residues in these receptors, potentially resulting in adverse reproductive effects (i.e., bioaccumulation hazard). Dietary exposures and modeled tissue burdens in avian eggs and mammal liver tissue pose a substantial risk of harm to vermivorous wildlife species.

Omnivorous Mammal Populations. Omnivorous mammal populations that forage within the study area are not at substantial risk of harm from site-related contaminants in floodplain soil and terrestrial prey items.

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Figures

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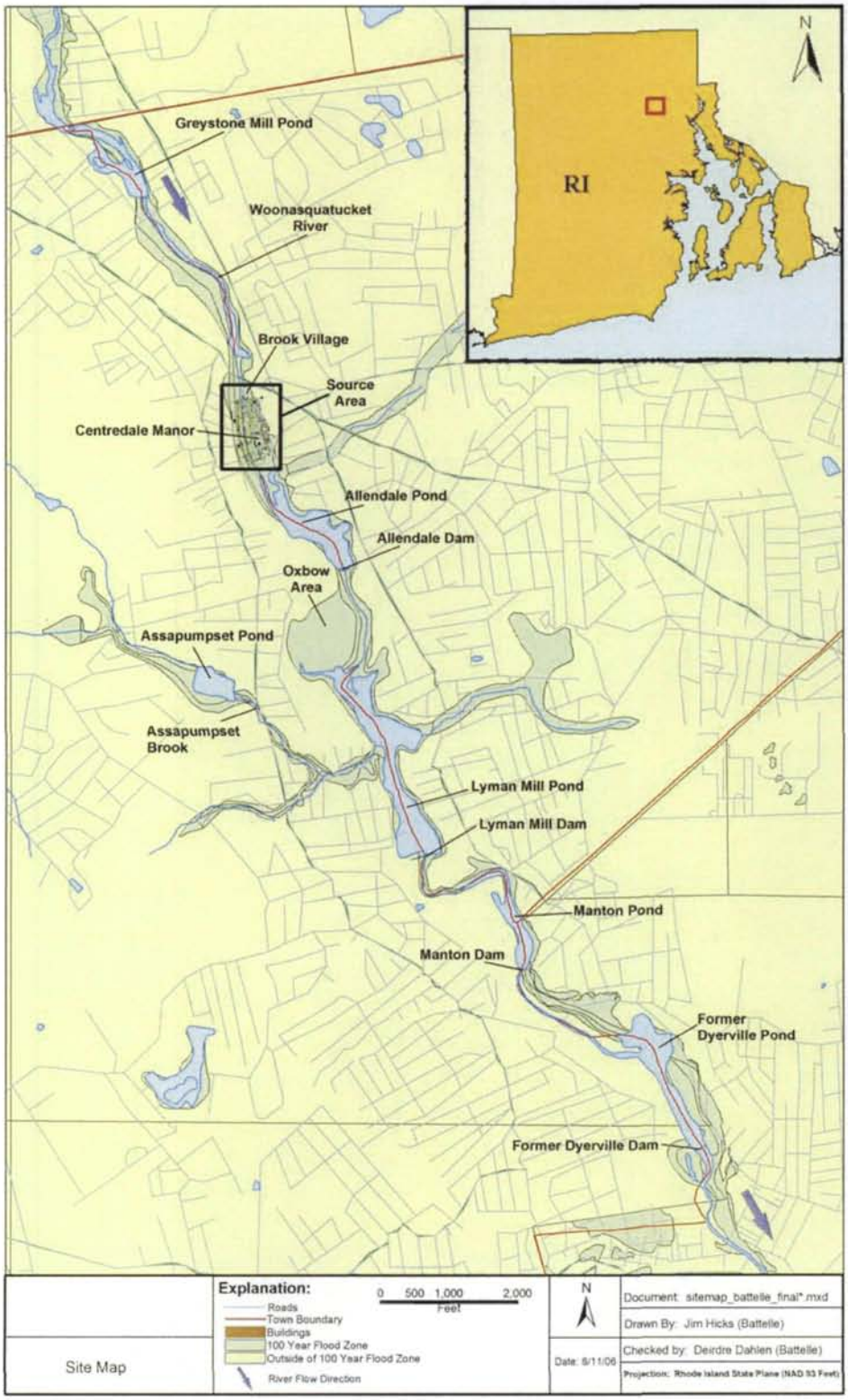

Figure 1. Site Locus Map.

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Figure 2. Site Layout and Sampling Locations.

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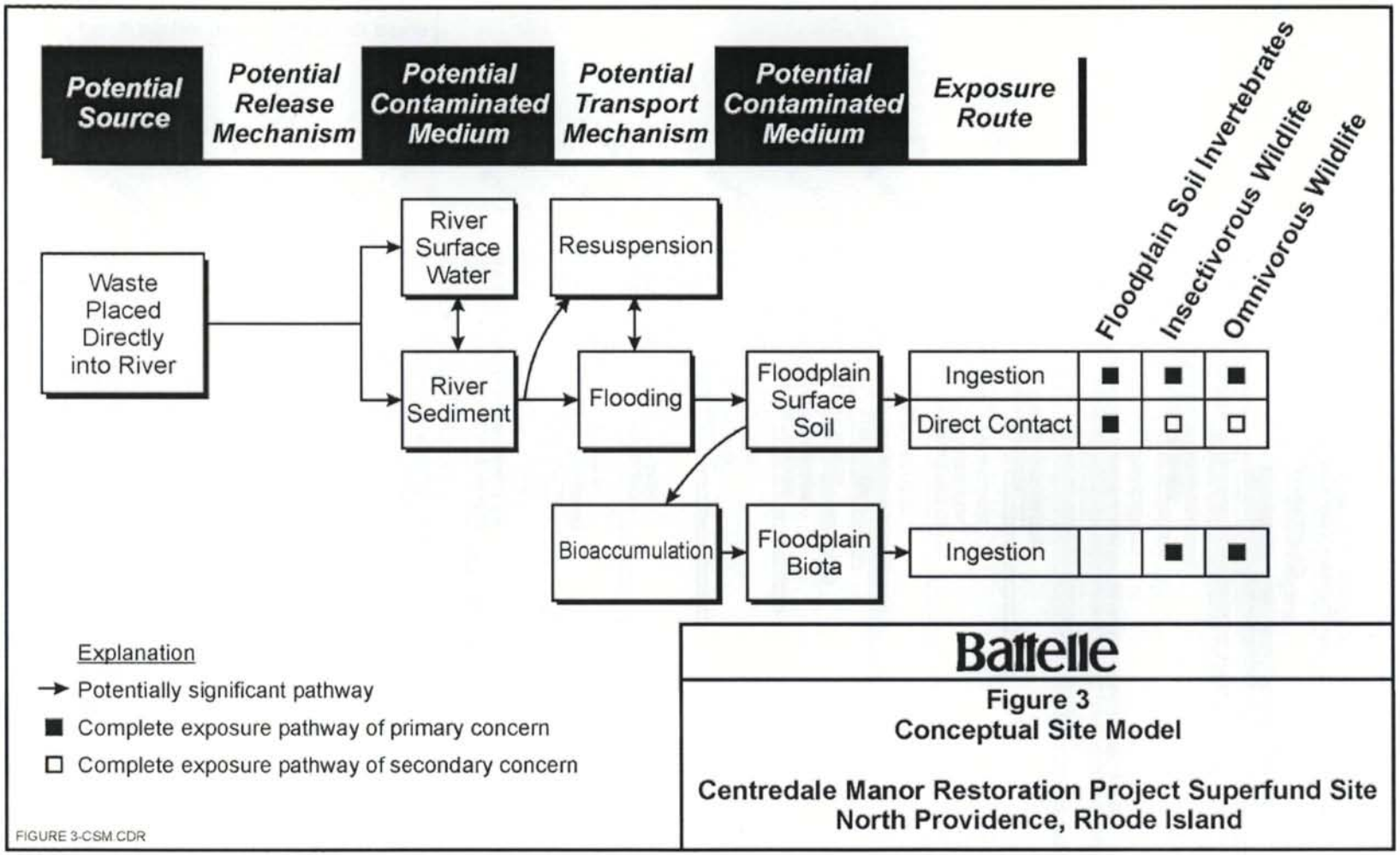

Figure 3. Conceptual Site Model.

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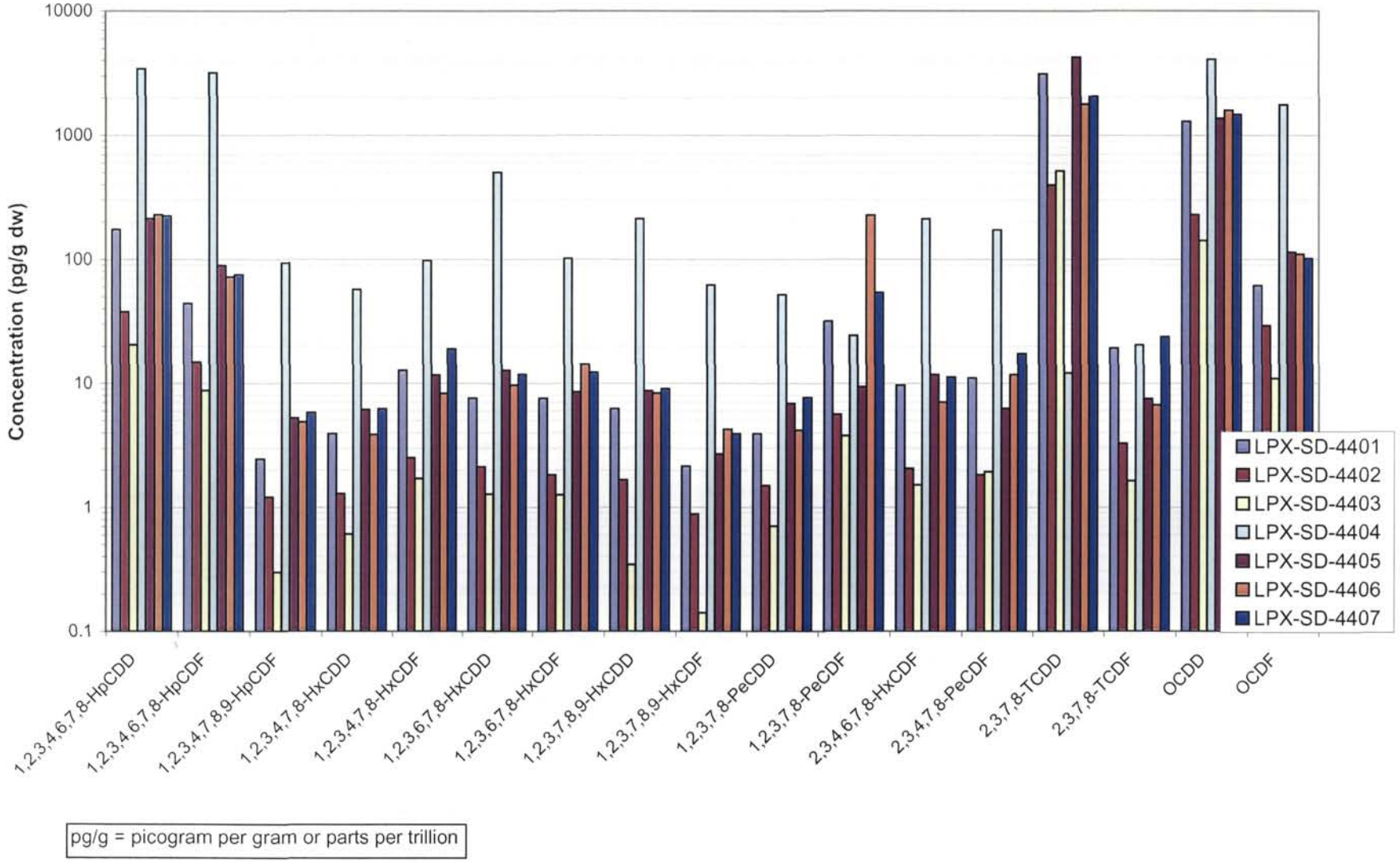
FIGURE 4
DIOXIN AND FURAN CONGENER CONCENTRATIONS IN FLOODPLAIN SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



pg/g = picogram per gram or parts per trillion

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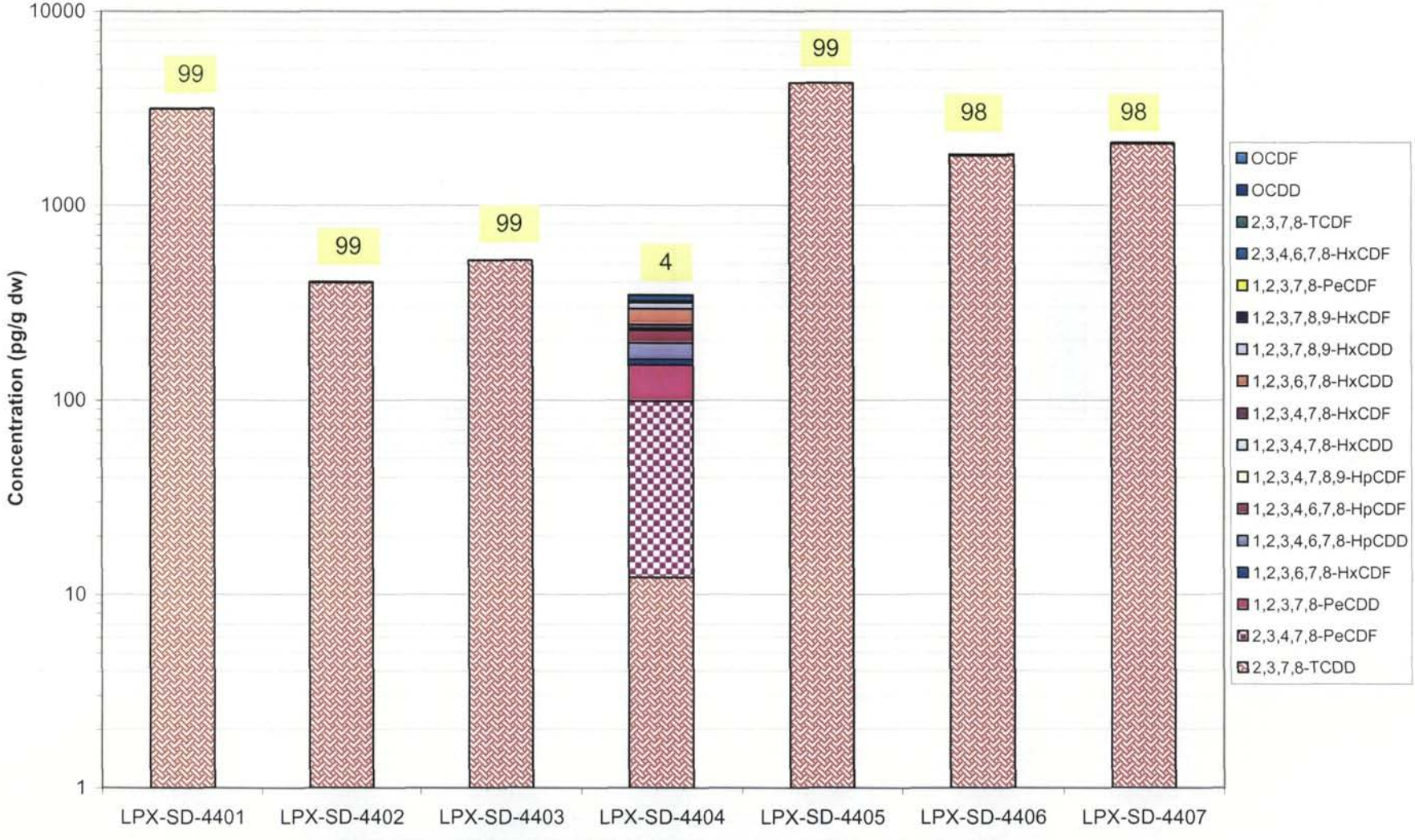
FIGURE 5
TEQ CONGENER COMPOSITION IN INDIVIDUAL FLOODPLAIN SOIL SAMPLES

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



Boxed values are the percentage of the total TEQ contributed by 2,3,7,8-TCDD; TEQs calculated using mammalian TEFs (Van den Berg et al., 1998).

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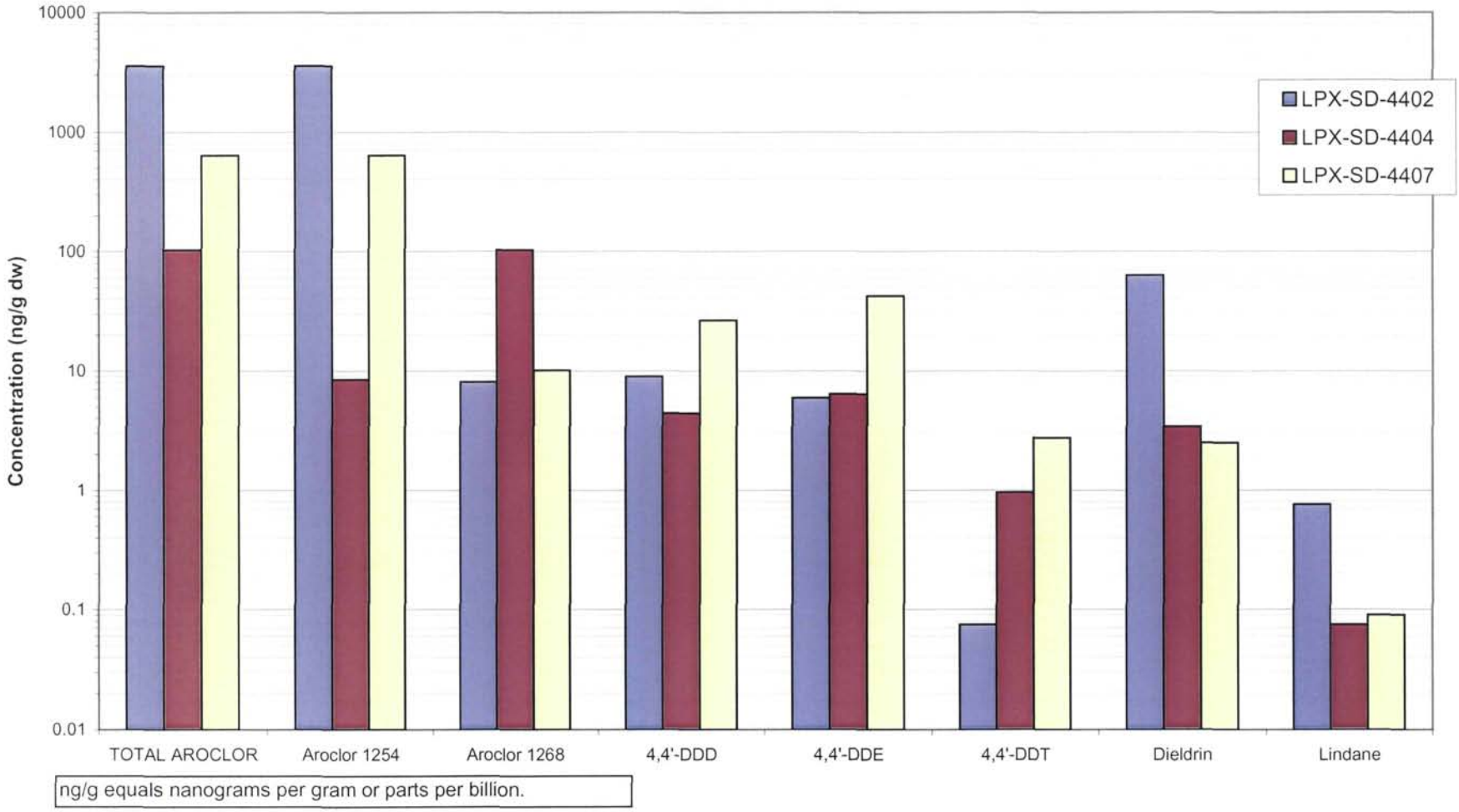
FIGURE 6
SELECT PESTICIDE AND PCB AROCLOR CONCENTRATIONS IN FLOODPLAIN SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



ng/g equals nanograms per gram or parts per billion.

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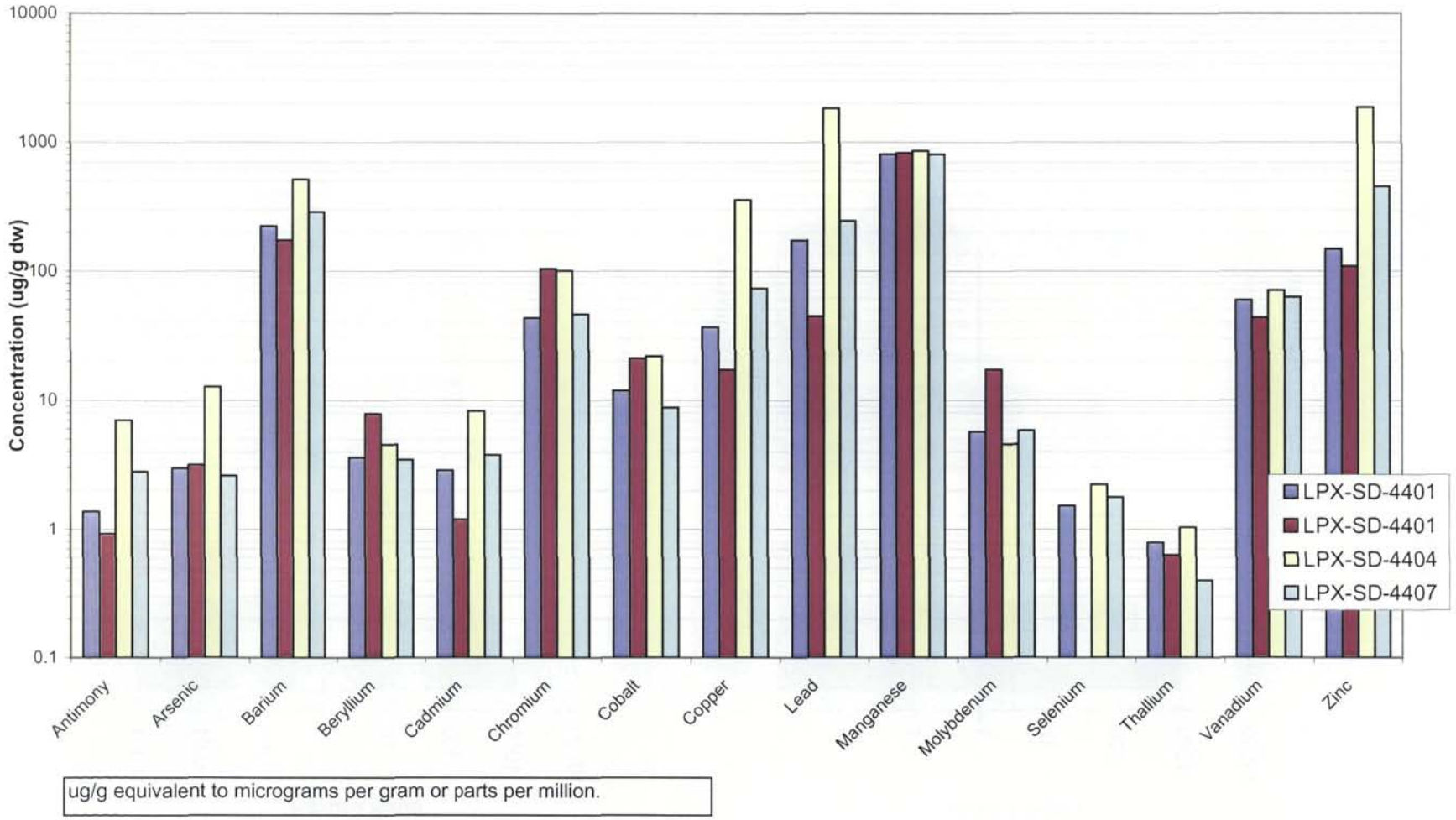
FIGURE 7
SELECT INORGANIC CONCENTRATIONS IN FLOODPLAIN SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



ug/g equivalent to micrograms per gram or parts per million.

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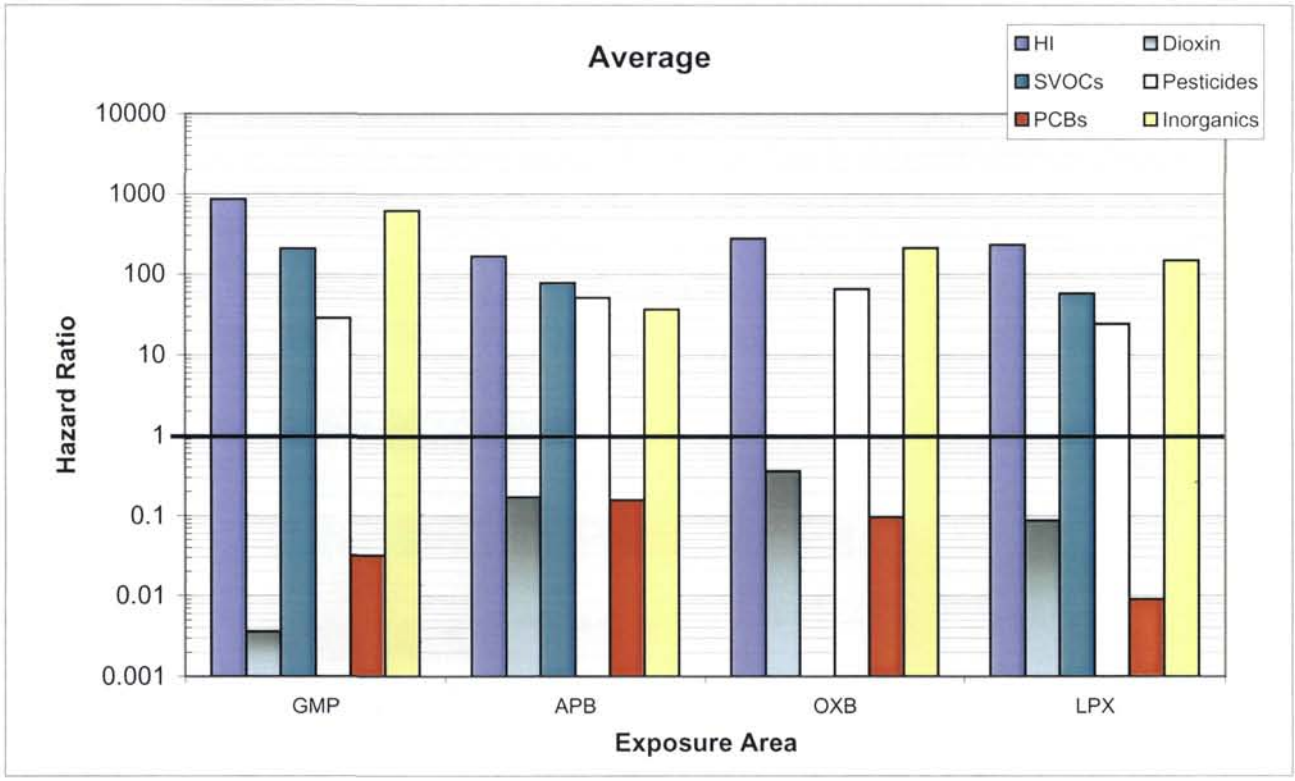
FIGURE 8
HAZARD RATIOS BY CONTAMINANT CATEGORY FOR OXBOW AND BERA FLOODPLAIN SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



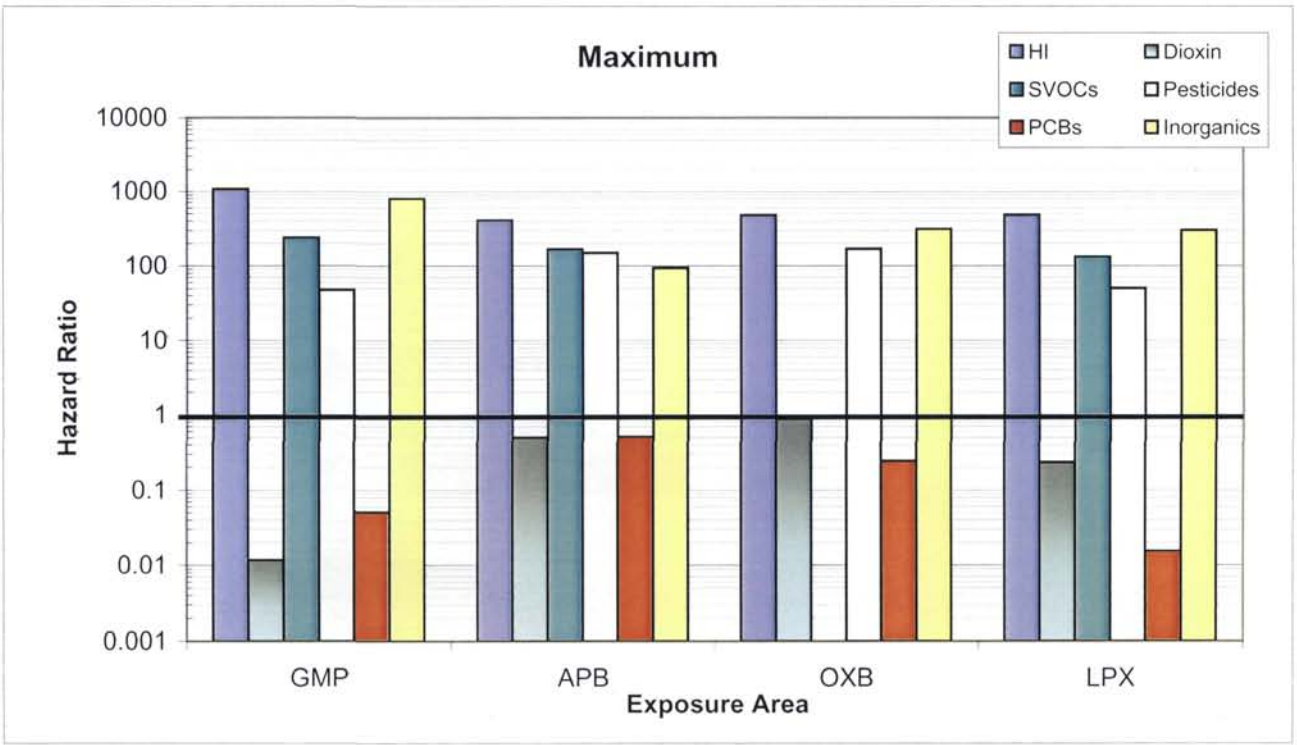


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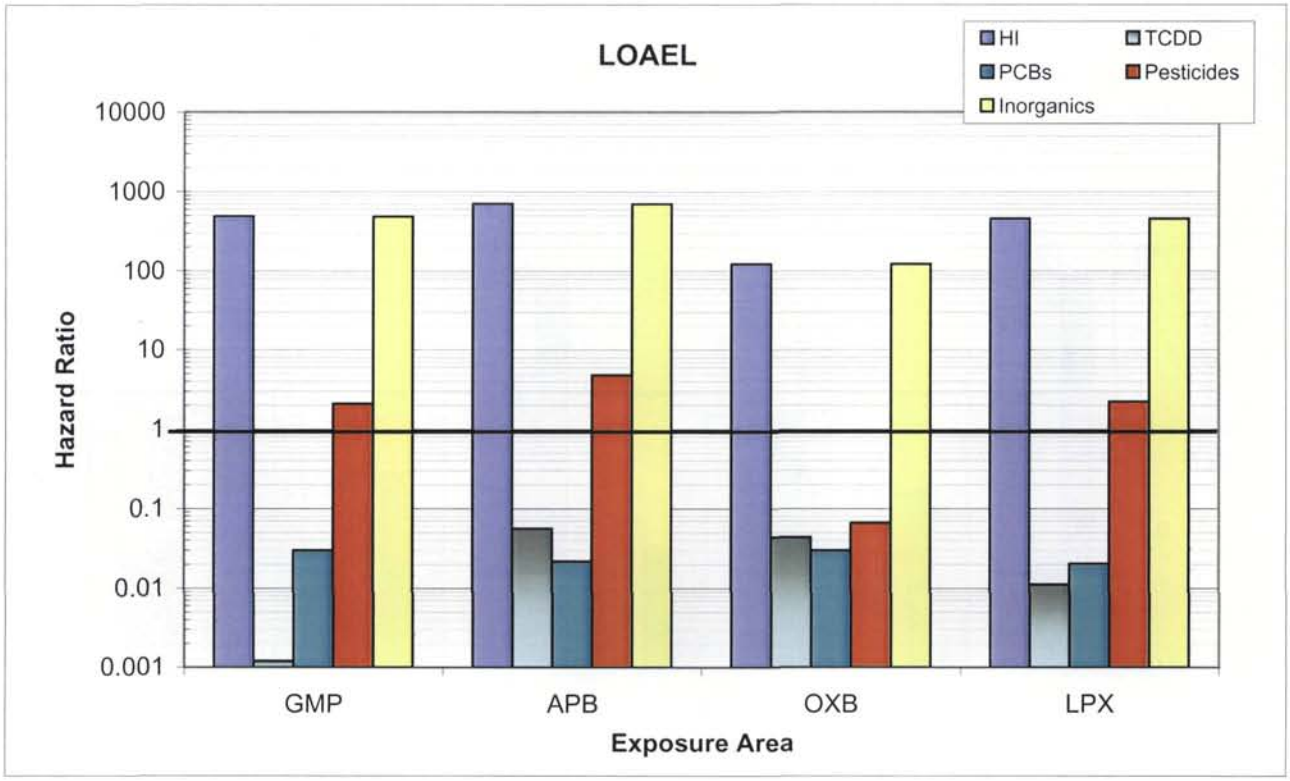
FIGURE 9
CBR HAZARD RATIOS BY CONTAMINANT CATEGORY FOR OXBOW AND BERA EARTHWORM TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



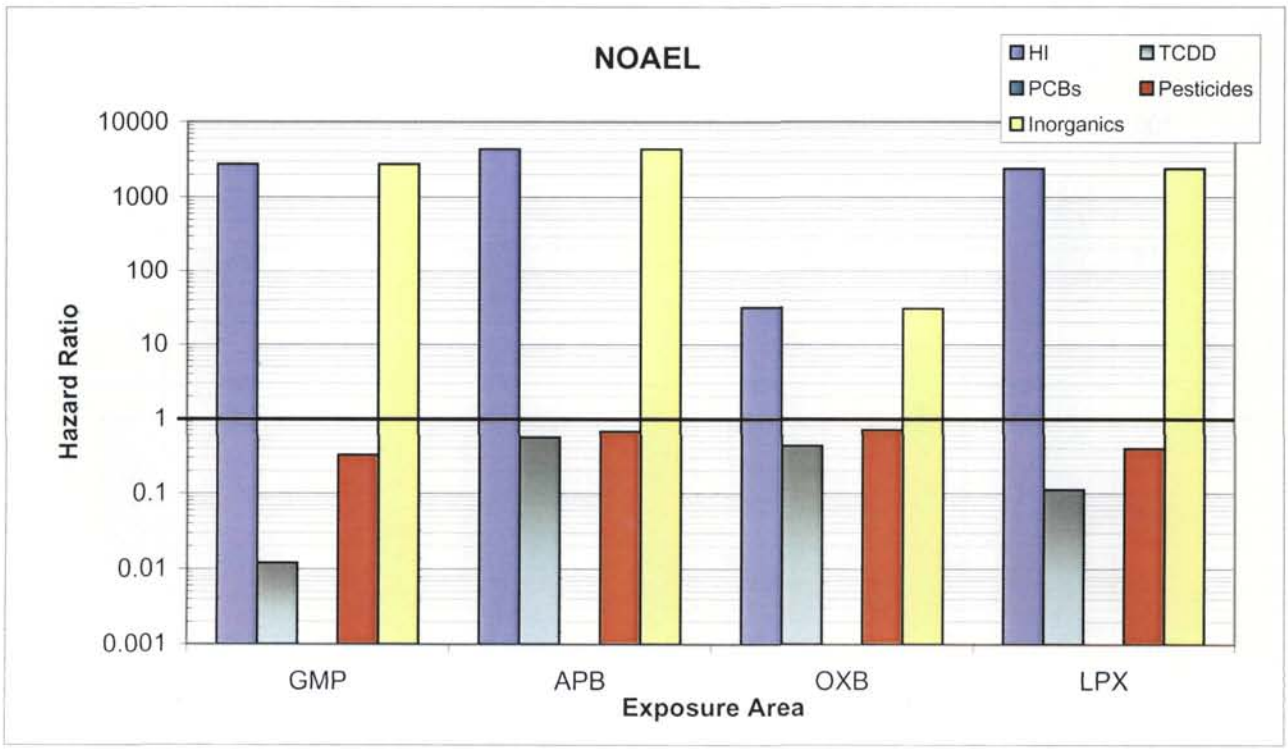


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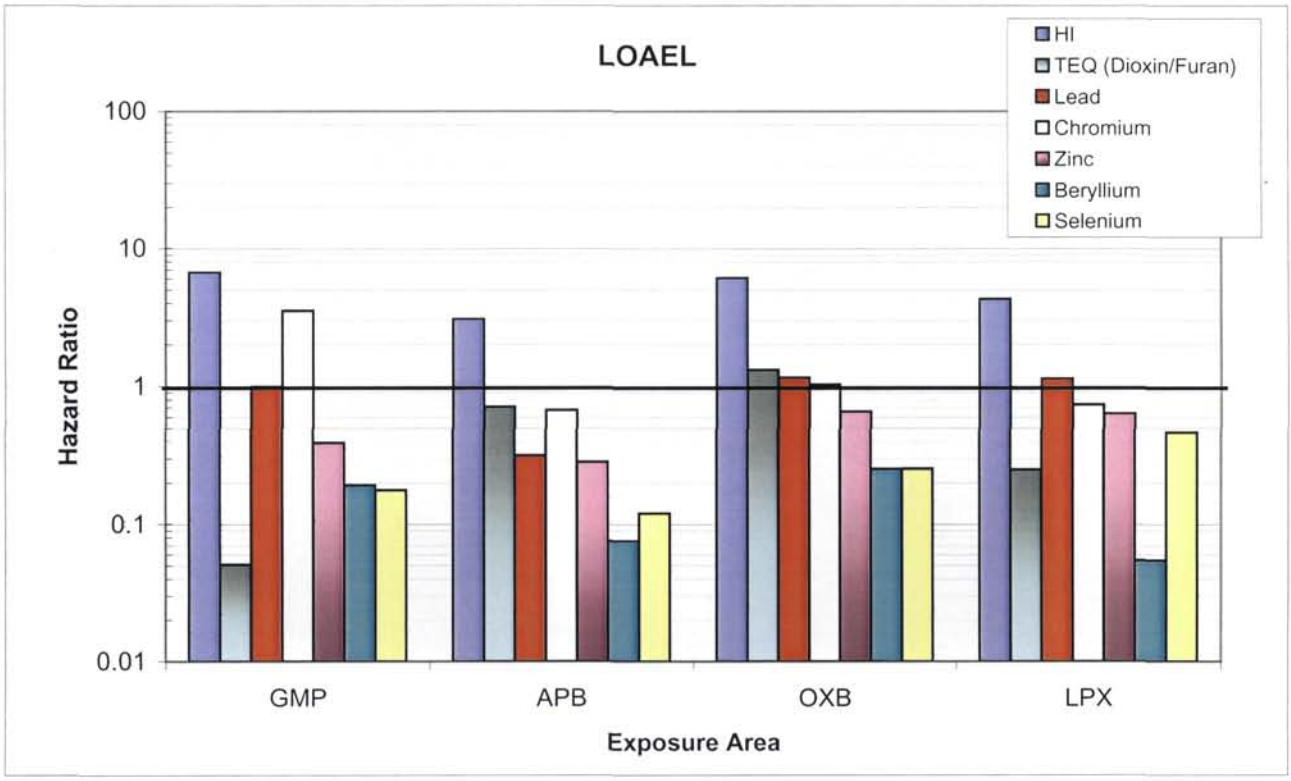
FIGURE 10
SUMMARY OF WILDLIFE EXPOSURE MODELING - AMERICAN WOODCOCK

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



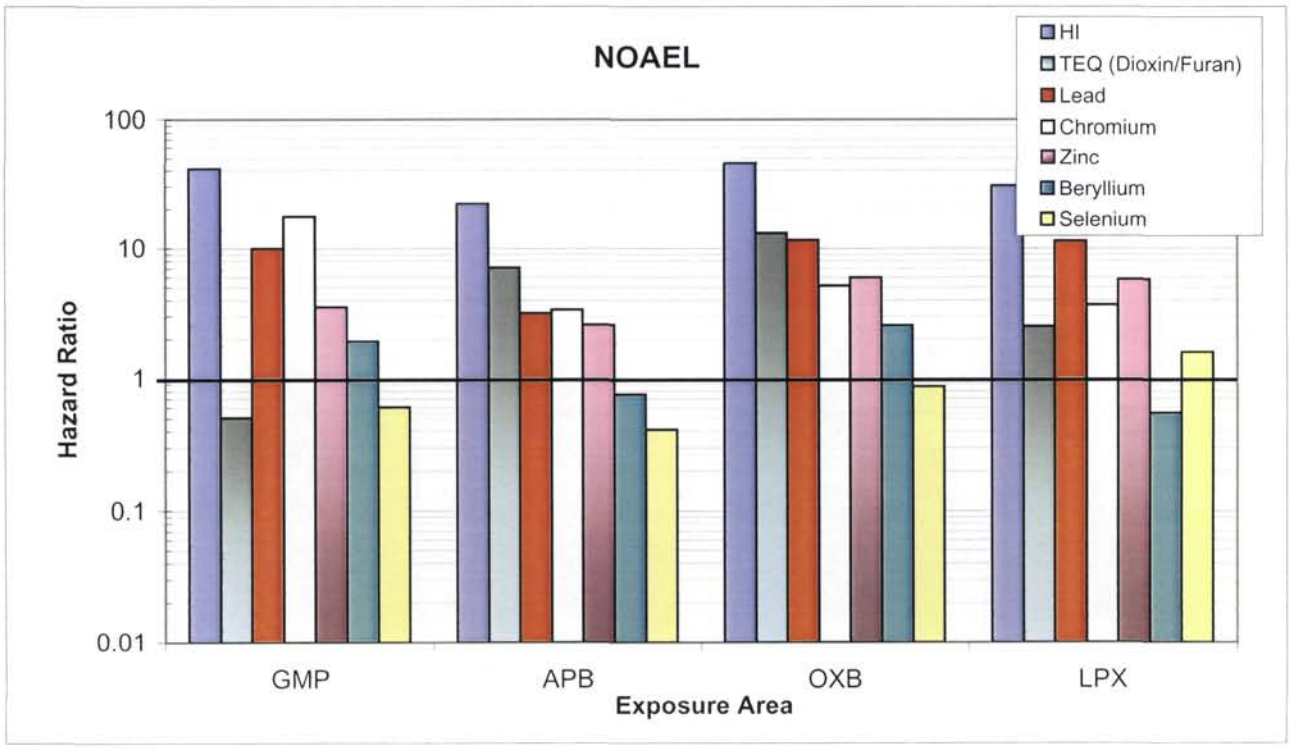


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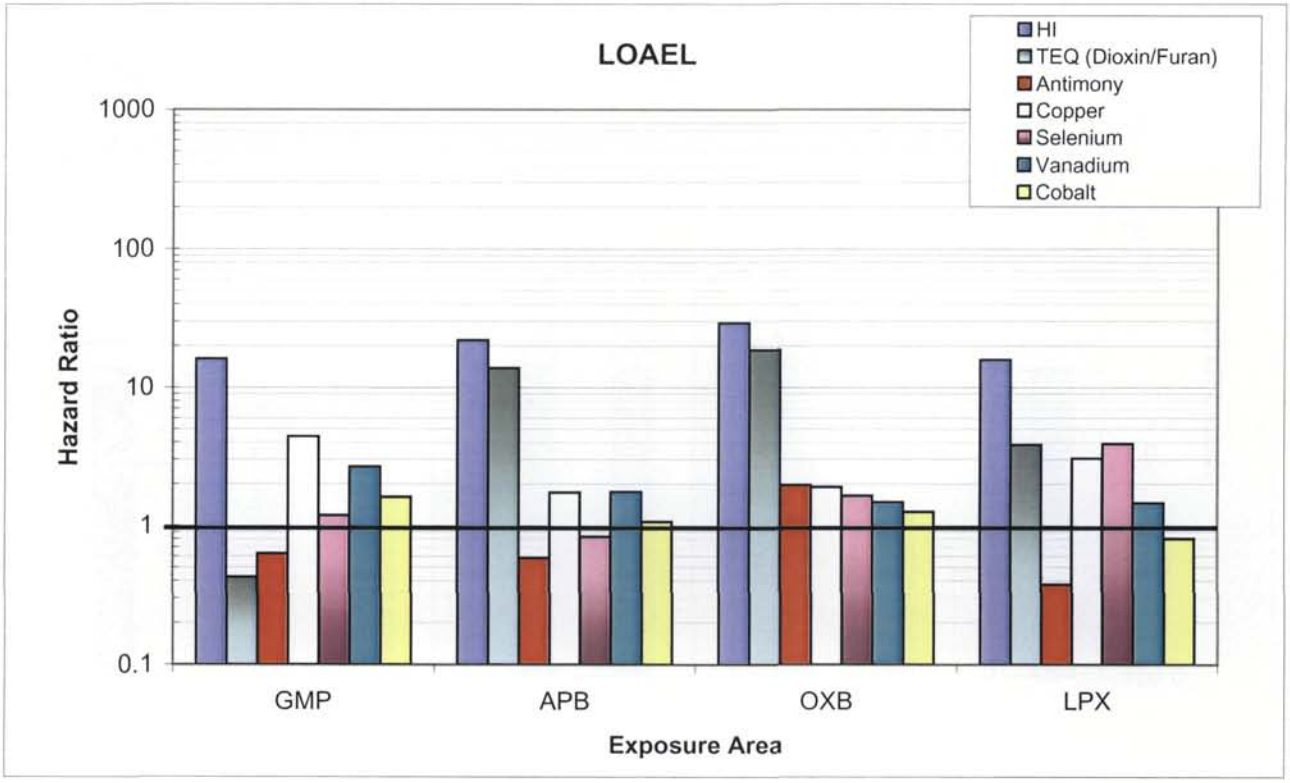
FIGURE 11
SUMMARY OF WILDLIFE EXPOSURE MODELING - SHORT-TAILED SHREW

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



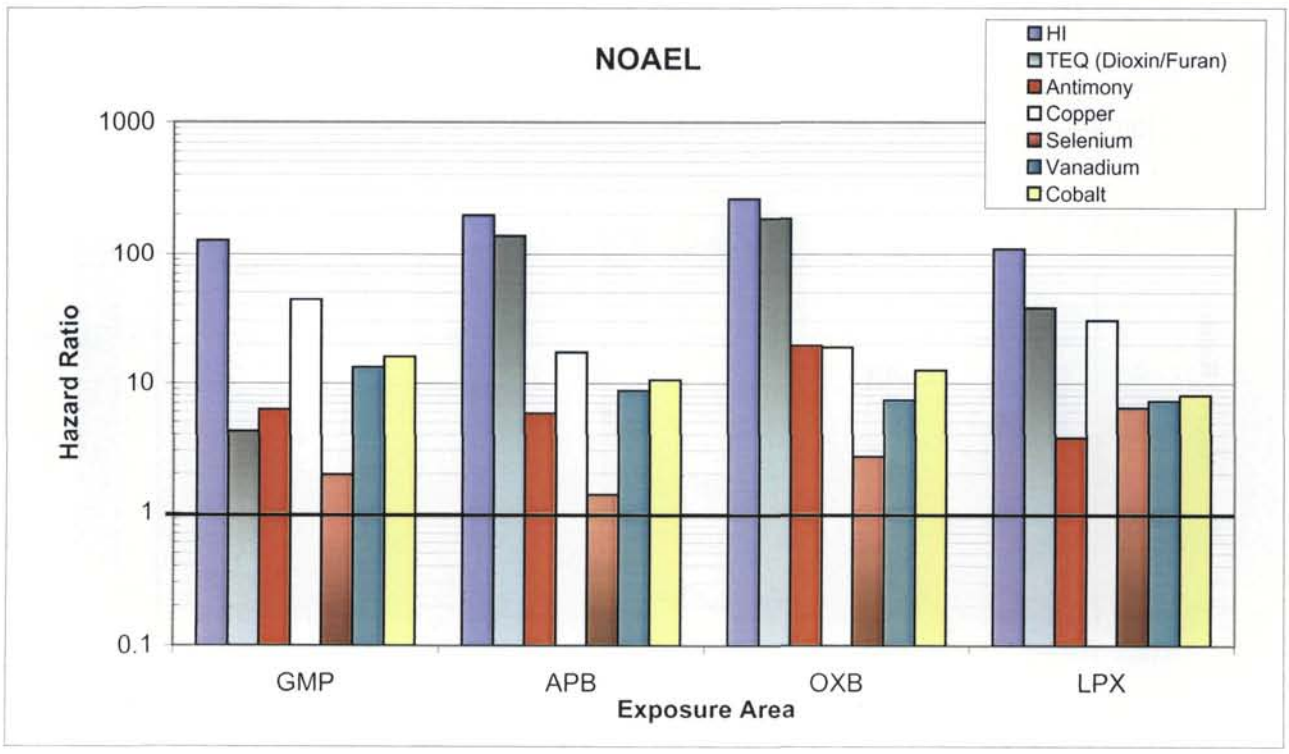


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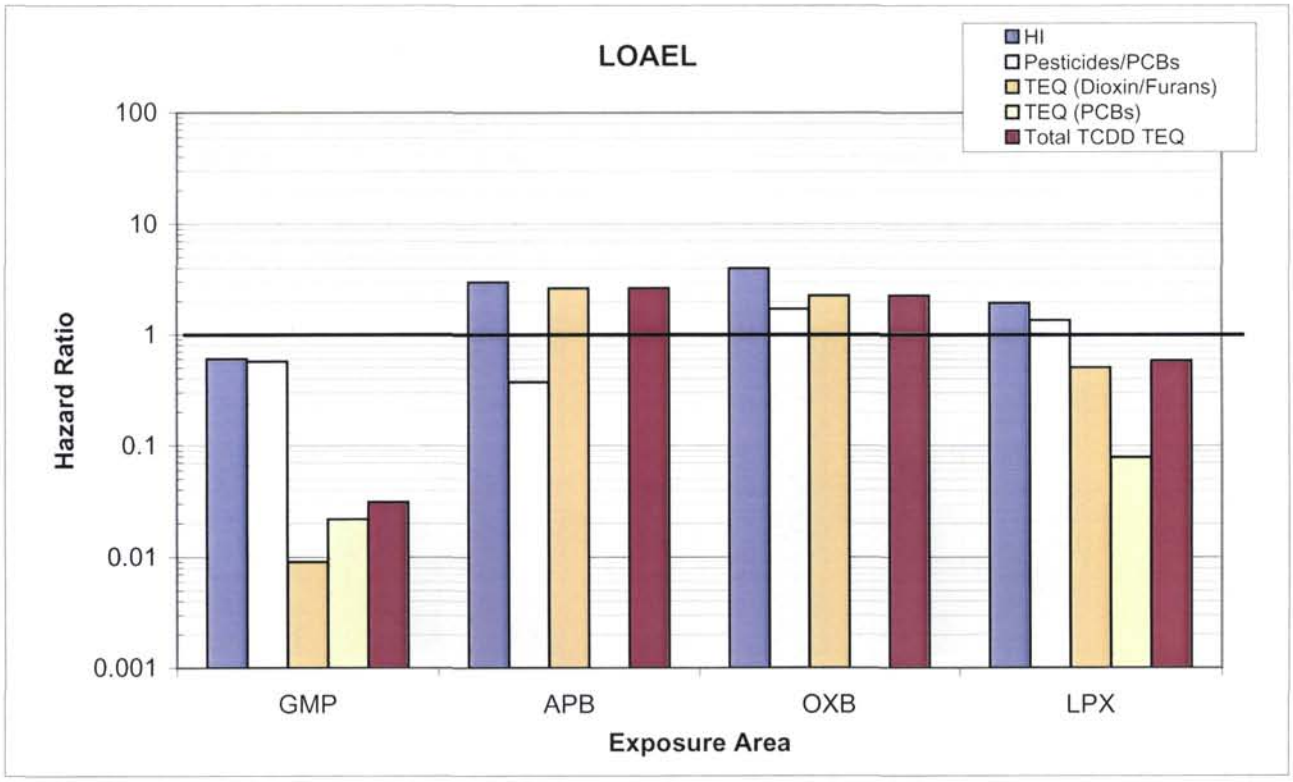
FIGURE 12
CBR HAZARD RATIOS -ESTIMATED VERMIVOROUS BIRD EGG TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



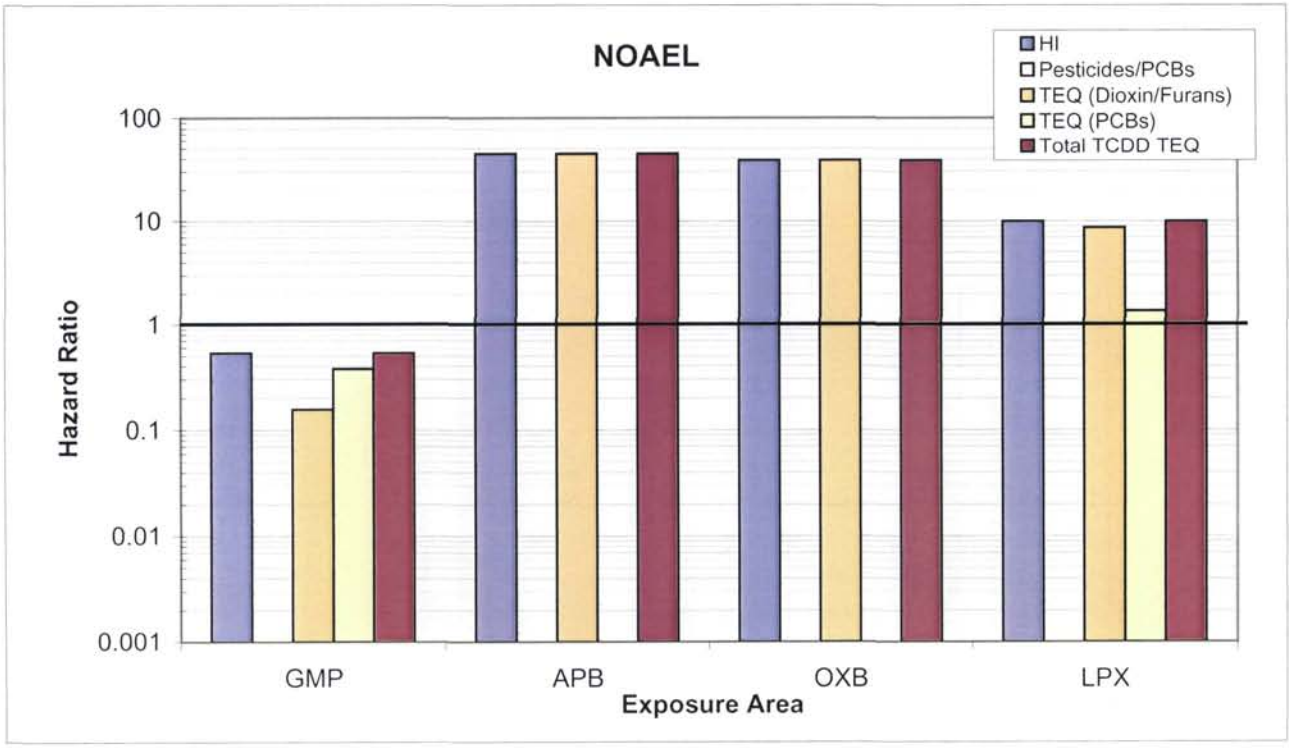


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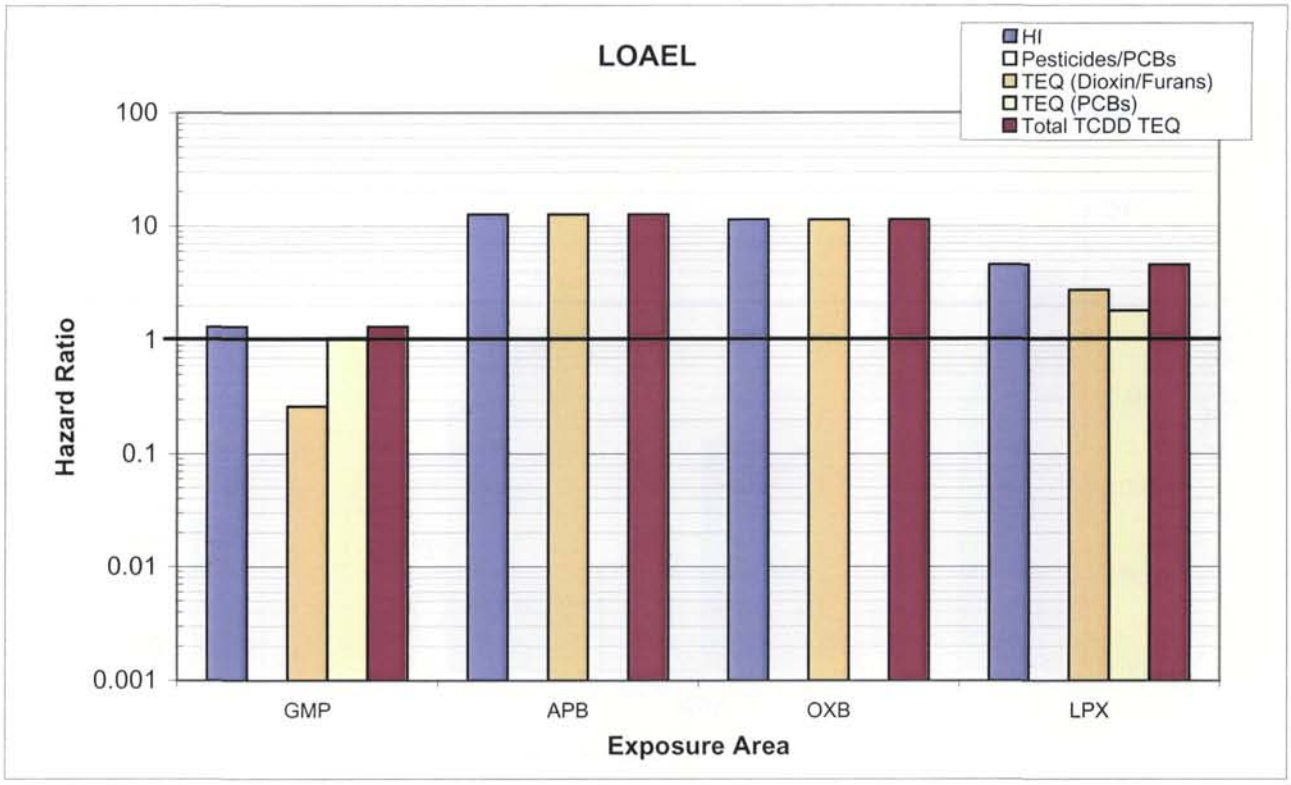
FIGURE 13
CBR HAZARD RATIOS - ESTIMATED VERMIVOROUS MAMMAL TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



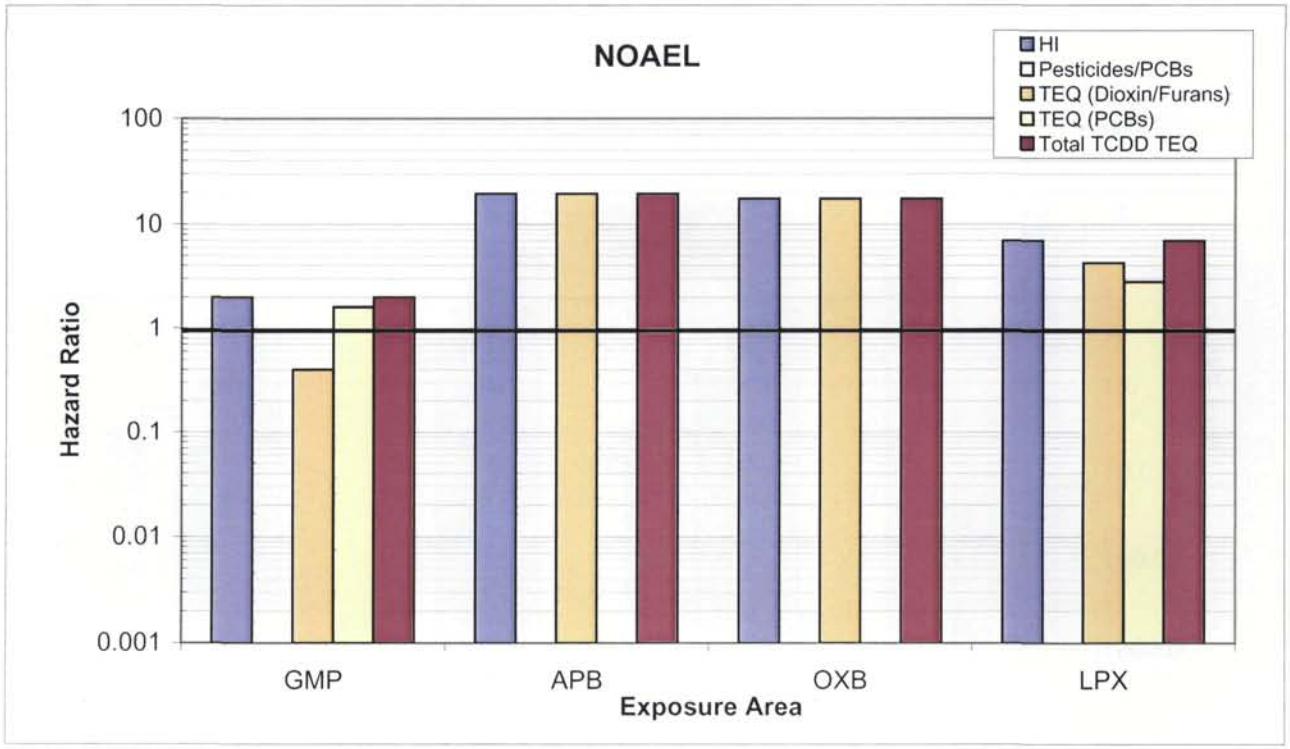
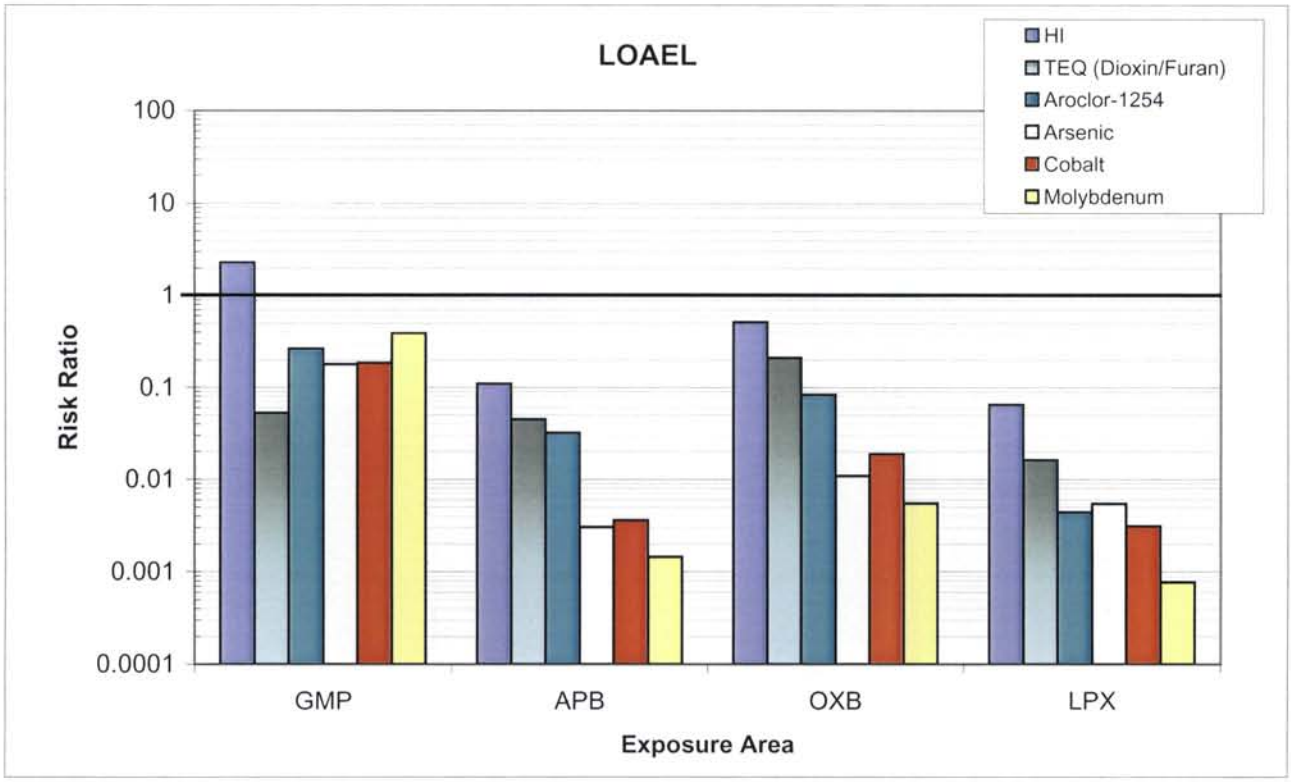
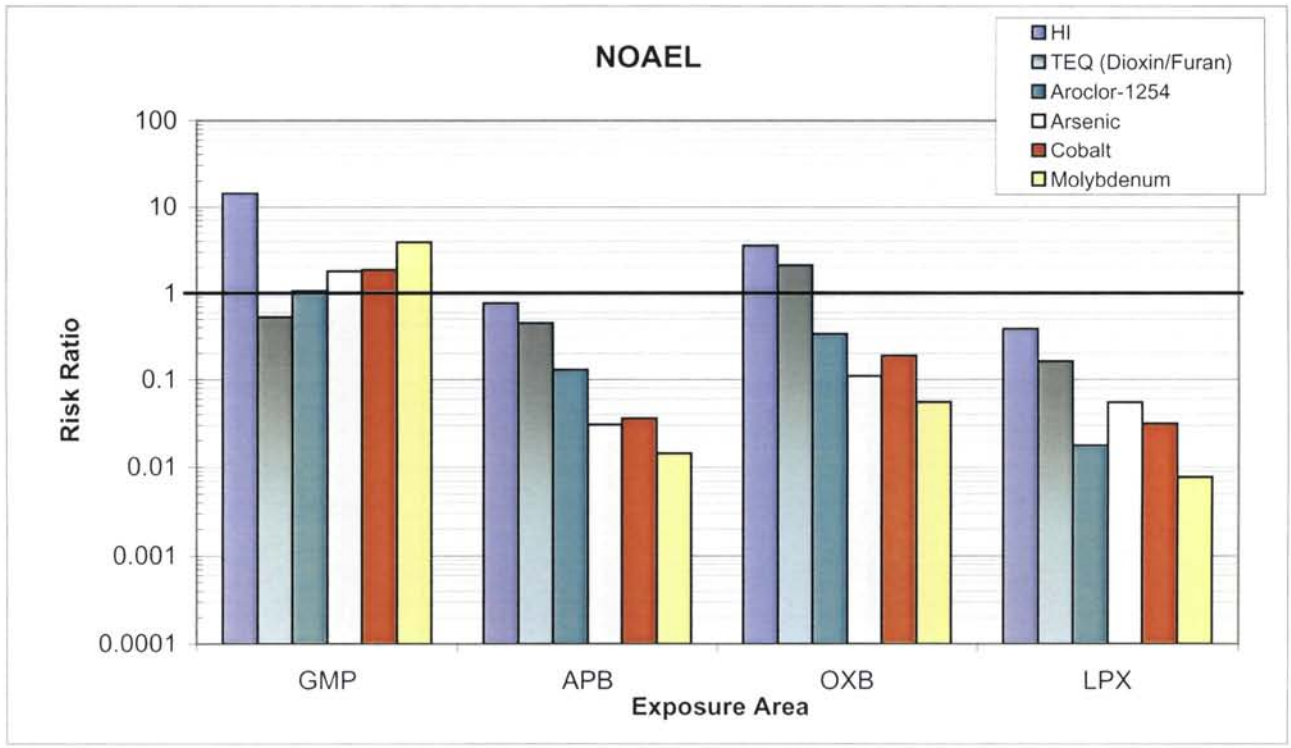


FIGURE 14
SUMMARY OF WILDLIFE EXPOSURE MODELING - RACCOON (Floodplain Exposures)

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island





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Tables

TABLES

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TABLE 1. SURFACE SOIL (0-0.5 FT) SAMPLES COLLECTED FROM THE OXBOW AREA IN JUNE 2004.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Sample ID	Analytical Parameters			
	Dioxin/Furan	PCB/Pesticide	Metals	TOC
LPX-SD-4401	✓		✓	
LPX-SD-4402	✓	✓[a]	✓	✓
LPX-SD-4403	✓			
LPX-SD-4404	✓	✓	✓	✓
LPX-SD-4405	✓			
LPX-SD-4406	✓			
LPX-SD-4407	✓	✓[b]	✓	✓
Field QC Samples				
LPX-DU-062104A[c]			✓	
LPX-DU-062104B[d]	✓	✓		✓
PC00562	✓			
PC01090	✓			

a. Sample contained <30% solids; the sample was extracted twice, first using the wet, low-solids content sediment material and again using freeze-dried material from the same sample location. Sample data for the wet and freeze-dried material extracts did not compare well, and data for freeze-dried sample was used in the SLERA.
b. Sample contained <30% solids; the sample was extracted twice, first using the wet, low-solids content sediment material and again using freeze-dried material from the same sample location. Sample data for the wet and freeze-dried material extracts compared well, and data for the freeze-dried sample is reported.
c. Field duplicate from sample location LPX-SD-4401.
d. Field duplicate from sample location LPX-SD-4402.

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TABLE 2
SELECTION OF CONTAMINANTS OF ECOLOGICAL CONCERN (COPECs)

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

CAS Number	Chemical	Median Concentration	Minimum Concentration	Maximum Concentration (detected)	Maximum (detected) Qualifier	Units	Location of Maximum (detected)	Detection Frequency	Concentration Used for Risk Screening[a]	Floodplain Soil Benchmark[b]	Retain as COPEC?	Rationale for Contaminant Deletion or Selection[c]	Data Distribution	Arithmetic Mean	Arithmetic Standard Deviation	Geometric Mean	Geometric Standard Deviation
	Dioxin/Furans/HCX																
35822-46-9	1,2,3,4,6,7,8-HpCDD	213.000	21	3440		PG/G_DRYWT	LPX-SD-4404	7/7	3440	nva	No	D	Lognormal			175.536	5.109
67562-39-4	1,2,3,4,6,7,8-HpCDF	72.300	8.8	3190		PG/G_DRYWT	LPX-SD-4404	7/7	3190	nva	No	D	Lognormal			70.901	6.654
55673-89-7	1,2,3,4,7,8,9-HpCDF	4.900	0.30	94		PG/G_DRYWT	LPX-SD-4404	6/7	94	nva	No	D	Lognormal			3.850	5.814
39227-28-6	1,2,3,4,7,8-HxCDD	3.930	0.61	58		PG/G_DRYWT	LPX-SD-4404	7/7	58	nva	No	D	Lognormal			4.284	4.180
70648-26-9	1,2,3,4,7,8-HxCDF	11.700	1.7	98		PG/G_DRYWT	LPX-SD-4404	7/7	98	nva	No	D	Lognormal			10.003	3.816
57653-85-7	1,2,3,6,7,8-HxCDD	9.670	1.3	504		PG/G_DRYWT	LPX-SD-4404	7/7	504	nva	No	D	Lognormal			10.638	6.822
57117-44-9	1,2,3,6,7,8-HxCDF	8.550	1.3	102		PG/G_DRYWT	LPX-SD-4404	7/7	102	nva	No	D	Lognormal			8.300	4.253
19408-74-3	1,2,3,7,8,9-HxCDD	8.360	0.34	213		PG/G_DRYWT	LPX-SD-4404	6/7	213	nva	No	D	Lognormal			6.540	7.059
72918-21-9	1,2,3,7,8,9-HxCDF	2.700	0.14	62		PG/G_DRYWT	LPX-SD-4404	6/7	62	nva	No	D	Lognormal			2.576	6.273
40321-76-4	1,2,3,7,8-PeCDD	4.190	0.71	52		PG/G_DRYWT	LPX-SD-4404	7/7	52	nva	No	D	Lognormal			4.671	3.905
57117-41-6	1,2,3,7,8-PeCDF	24.400	3.8	227	EMPC	PG/G_DRYWT	LPX-SD-4406	7/7	227	nva	No	D	Lognormal			21.199	4.124
60851-34-5	2,3,4,6,7,8-HxCDF	9.700	1.5	212		PG/G_DRYWT	LPX-SD-4404	7/7	212	nva	No	D	Lognormal			9.312	4.989
57117-31-4	2,3,4,7,8-PeCDF	11.100	1.8	173		PG/G_DRYWT	LPX-SD-4404	7/7	173	nva	No	D	Lognormal			9.830	4.667
1746-01-6	2,3,7,8-TCDD	1800.000	12	4270	J#	PG/G_DRYWT	LPX-SD-4405	7/7	4270	0.89	Yes	C	Normal	1745	1567		
51207-31-9	2,3,7,8-TCDF	7.540	1.6	24		PG/G_DRYWT	LPX-SD-4407	7/7	24	nva	No	D	Lognormal			8.241	2.762
3268-87-9	OCDD	1380.000	142	4100		PG/G_DRYWT	LPX-SD-4404	7/7	4100	nva	No	D	Lognormal			922.573	3.279
39001-02-0	OCDF	102.000	11	1770		PG/G_DRYWT	LPX-SD-4404	7/7	1770	nva	No	D	Lognormal			89.140	4.813
TEB	TEQ-BIRD	1851.115	374	4298		PG/G_DRYWT	LPX-SD-4405	7/7	4298	nva	No	D	Lognormal	1824	1519	1233.140	2.785
TEM	TEQ-MAMMAL	1830.933	347	4291		PG/G_DRYWT	LPX-SD-4405	7/7	4291	nva	No	D	Lognormal	1809	1518	1211.914	2.823
Total HpCDD	Total HpCDD	415.000	40	10700	J	PG/G_DRYWT	LPX-SD-4404	7/7	10700	nva	No	D	Lognormal			370.161	5.906
Total HpCDF	Total HpCDF	136.000	14	5360	J	PG/G_DRYWT	LPX-SD-4404	7/7	5360	nva	No	D	Lognormal			131.437	6.543
Total HxCDD	Total HxCDD	116.800	23	4930	J	PG/G_DRYWT	LPX-SD-4404	6/7	4930	nva	No	D	Lognormal			150.172	10.233
Total HxCDF	Total HxCDF	131.000	15	6590	J	PG/G_DRYWT	LPX-SD-4404	7/7	6590	nva	No	D	Lognormal			140.306	7.166
Total PeCDD	Total PeCDD	90.350	12	547	J	PG/G_DRYWT	LPX-SD-4404	6/7	547	nva	No	D	Lognormal			76.327	6.798
Total PeCDF	Total PeCDF	175.000	14	1630	J	PG/G_DRYWT	LPX-SD-4404	7/7	1630	nva	No	D	Lognormal			139.235	4.583
Total TCDD	Total TCDD	1910.000	118	4460	J	PG/G_DRYWT	LPX-SD-4405	7/7	4460	nva	No	D	Lognormal			1090.711	3.723
Total TCDF	Total TCDF	127.000	21	471	J	PG/G_DRYWT	LPX-SD-4404	7/7	471	nva	No	D	Lognormal			124.742	3.288
	Metals																
7440-36-0	Antimony	2.085	0.92	7.0		UG/G_DRYWT	LPX-SD-4404	4/4	7.0	0.045	Yes	C	None	3.026	2.774	2.231	2.437
7440-38-2	Arsenic	3.075	2.6	13		UG/G_DRYWT	LPX-SD-4404	4/4	13	0.22	Yes	C	None	5.390	4.945	4.215	2.106
7440-39-3	Barium	258.000	174	514		UG/G_DRYWT	LPX-SD-4404	4/4	514	130	Yes	C	None	300.000	150.102	275.606	1.590
7440-41-7	Beryllium	4.075	3.5	7.9		UG/G_DRYWT	LPX-SD-4402	4/4	7.9	0.77	Yes	C	None	4.878	2.071	4.601	1.462
7440-43-9	Cadmium	3.320	1.2	8.3		UG/G_DRYWT	LPX-SD-4404	4/4	8.3	1.70	Yes	C	None	4.020	3.018	3.210	2.223
7440-47-3	Chromium	73.550	43	104	J	UG/G_DRYWT	LPX-SD-4402	4/4	104	0.40	Yes	C	None	73.550	33.473	67.590	1.619
7440-48-4	Cobalt	16.550	8.8	22		UG/G_DRYWT	LPX-SD-4404	4/4	22	0.13	Yes	C	None	15.973	6.829	14.862	1.567
7440-50-8	Copper	54.950	17	357		UG/G_DRYWT	LPX-SD-4404	4/4	357	0.71	Yes	C	None	121.025	159.020	63.730	3.640
7439-92-1	Lead	210.000	44	1835		UG/G_DRYWT	LPX-SD-4404	4/4	1835	20	Yes	C	None	574.850	844.231	243.011	4.651
7439-96-5	Manganese	818.000	809	859		UG/G_DRYWT	LPX-SD-4404	4/4	859	100	Yes	C	None	826.000	23.580	825.751	1.029
13939-06-5	Molybdenum	5.770	4.6	17		UG/G_DRYWT	LPX-SD-4402	4/4	17	0.32	Yes	C	None	8.355	5.990	7.166	1.818
7440-02-0	Nickel	30.800	18	32		UG/G_DRYWT	LPX-SD-4402	4/4	32	53	No	B	None	28.100	6.511	27.423	1.308
7782-49-2	Selenium	1.650	0.21	2.2		UG/G_DRYWT	LPX-SD-4404	3/4	2.2	0.34	Yes	C	None	1.431	0.887	1.053	3.011
7440-22-4	Silver	1.045	0.45	11		UG/G_DRYWT	LPX-SD-4404	4/4	11	38	No	B	None	3.411	5.134	1.530	3.971
7440-28-0	Thallium	0.711	0.40	1.0		UG/G_DRYWT	LPX-SD-4404	4/4	1.0	0.24	Yes	C	None	0.715	0.267	0.675	1.495
7440-62-2	Vanadium	61.250	44	71		UG/G_DRYWT	LPX-SD-4404	4/4	71	0.72	Yes	C	None	59.300	11.511	58.389	1.231
7440-66-6	Zinc	301.500	109	1867		UG/G_DRYWT	LPX-SD-4404	4/4	1867	76	Yes	C	None	644.750	829.272	342.534	3.617

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TABLE 2
SELECTION OF CONTAMINANTS OF ECOLOGICAL CONCERN (COPECs)

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

CAS Number	Chemical	Median Concentration	Minimum Concentration	Maximum Concentration (detected)	Maximum (detected) Qualifier	Units	Location of Maximum (detected)	Detection Frequency	Concentration Used for Risk Screening[a]	Floodplain Soil Benchmark[b]	Retain as COPEC?	Rationale for Contaminant Deletion or Selection[c]	Data Distribution	Mean	Standard Deviation	Mean	Standard Deviation
	PCB as Aroclors																
1336-36-3	TOTAL AROCLOR	637.830	103	3583		NG/G_DRY	LPX-SD-4402	3/3	3583	20	Yes	C	None	1441.413	1874.097	617.679	5.896
12674-11-2	Aroclor 1016	8.495	8.1		U	NG/G_DRY		0/3		110	No	A	None	8.927	1.084	8.684	1.126
11104-28-2	Aroclor 1221	8.480	8.1		U	NG/G_DRY		0/3		120	No	A	None	8.910	1.081	8.868	1.125
11141-16-5	Aroclor 1232	8.480	8.1		U	NG/G_DRY		0/3		100	No	A	None	8.910	1.081	8.868	1.125
53469-21-9	Aroclor 1242	8.480	8.1		U	NG/G_DRY		0/3		98	No	A	None	8.910	1.081	8.868	1.125
12672-29-6	Aroclor 1248	8.480	8.1		U	NG/G_DRY		0/3		100	No	A	None	8.910	1.081	8.868	1.125
11097-69-1	Aroclor 1254	637.830	8.5	3583	J	NG/G_DRY	LPX-SD-4402	2/3	3583	92	Yes	C	None	1409.870	1908.368	268.614	22.523
11096-82-5	Aroclor 1260	8.495	8.1		U	NG/G_DRY		0/3		28	No	A	None	8.927	1.084	8.884	1.126
11100-14-4	Aroclor 1268	10.140	8.1	103		NG/G_DRY	LPX-SD-4404	1/3	103	28	Yes	C	None	40.453	54.272	20.392	4.088
	Pesticides/Herbicides																
72-54-8	4,4'-DDD	8.990	4.420	27		NG/G_DRY	LPX-SD-4407	3/3	27	2.5	Yes	C	None	13.330	11.700	10.184	2.488
72-55-9	4,4'-DDE	6.420	6.0	42		NG/G_DRY	LPX-SD-4407	3/3	42	2.5	Yes	C	None	18.243	20.887	11.740	3.040
50-29-3	4,4'-DDT	0.960	0.075	2.8	J	NG/G_DRY	LPX-SD-4407	2/3	2.8	2.5	Yes	C	None	1.265	1.368	0.584	6.383
319-84-6	a-BHC	0.075	0.075		U	NG/G_DRY		0/3		2.5	No	A	None	0.082	0.012	0.081	1.146
5103-71-9	a-chlordane	1.190	0.070	7.7	J	NG/G_DRY	LPX-SD-4407	2/3	7.7	100	No	B	None	2.980	4.109	0.862	10.650
309-00-2	aldrin	0.970	0.070	1.6	J	NG/G_DRY	LPX-SD-4402	2/3	1.6	2.5	No	B	None	0.893	0.788	0.481	5.419
319-85-7	b-BHC	0.070	0.065		U	NG/G_DRY		0/3		1.00	No	A	None	0.072	0.008	0.071	1.111
319-86-8	d-BHC	0.065	0.080		U	NG/G_DRY		0/3		100	No	A	None	0.088	0.010	0.088	1.122
60-57-1	Dieldrin	3.430	2.5	63	J	NG/G_DRY	LPX-SD-4402	3/3	63	0.50	Yes	C	None	23.107	34.881	8.172	5.935
959-98-8	endosulfan I	0.085	0.085		U	NG/G_DRY		0/3		100	No	A	None	0.092	0.012	0.091	1.130
33213-65-9	endosulfan II	0.100	0.080	3.4		NG/G_DRY	LPX-SD-4404	1/3	3.4	100	No	B	None	1.183	1.894	0.300	6.152
1031-07-8	endosulfan sulfate	0.100	0.095		U	NG/G_DRY		0/3		100	No	A	None	0.105	0.013	0.104	1.131
72-20-8	endrin	0.085	0.080		U	NG/G_DRY		0/3		1.00	No	A	None	0.088	0.010	0.088	1.122
7421-93-4	endrin aldehyde	1.900	0.12	9.5	J	NG/G_DRY	LPX-SD-4402	2/3	9.5	54	No	B	None	3.842	4.989	1.276	9.340
53494-70-5	endrin ketone	0.100	0.080	1.7		NG/G_DRY	LPX-SD-4404	1/3	1.7	100	No	B	None	0.637	0.947	0.240	5.551
5103-74-2	g-chlordane	2.930	2.1	6.9		NG/G_DRY	LPX-SD-4407	3/3	6.9	100	No	B	None	3.983	2.596	3.484	1.861
76-44-8	heptachlor	0.095	0.075	0.73		NG/G_DRY	LPX-SD-4404	1/3	0.73	39	No	B	None	0.300	0.373	0.173	3.494
1024-57-3	heptachlor epoxide	0.085	0.070	0.18		NG/G_DRY	LPX-SD-4404	1/3	0.18	43	No	B	None	0.112	0.060	0.102	1.647
58-89-9	Lindane	0.090	0.075	0.76	J	NG/G_DRY	LPX-SD-4402	1/3	0.76	0.050	Yes	C	None	0.308	0.391	0.172	3.824
72-43-5	methoxychlor	0.115	0.110		U	NG/G_DRY		0/3		100	No	A	None	0.122	0.016	0.121	1.137
57-74-9	Technical Chlordane	10.170	8.1	30		NG/G_DRY	LPX-SD-4404	1/3	30	100	No	B	None	16.127	12.127	13.549	2.013
8001-35-2	Toxaphene	8.500	8.1		U	NG/G_DRY		0/3		100	No	A	None	8.932	1.084	8.889	1.126
	Ancillary																
	Total Organic Carbon	15.730	13	36		Percent	LPX-SD-4407	3/3					None	21.633	12.635	19.493	1.721

Shaded cells indicate chemicals selected as COPECs.

a. Maximum detected concentration used for screening.

b. Floodplain soil screening values presented in Table D-3 in Baseline Ecological Risk Assessment (MACTEC, 2004); lower of soil invertebrate and wildlife benchmarks selected. Table values originally presented in units of ug/g and adjusted as necessary.

c. Rationale for deleting or retaining analyte:

A - Not retained because compound was not detected in any sample.

B. Not retained because soil benchmark is greater than maximum detected concentration

C. Retained because maximum detected concentration exceeds screening benchmark value.

D. Individual dioxin and furan congeners and homologue groups were not specifically identified as COPECs because a toxic equivalency approach was employed in the assessment.

TABLE 3
ESTIMATED EARTHWORM TISSUE CONCENTRATIONS DERIVED USING SITE-SPECIFIC BSAFs

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

CAS Number	Chemical	Floodplain Soil			Earthworm BSAFs[a]	Estimated Earthworm Tissue[b]		
		Maximum	Average	Units		Maximum	Average	Units
	Metals							
7440-36-0	Antimony	7.0	3.0	UG/G_DRYWT	0.699	1.5E+00	6.3E-01	UG/G_WETWT
7440-38-2	Arsenic	13	5.4	UG/G_DRYWT	0.112	4.3E-01	1.8E-01	UG/G_WETWT
7440-39-3	Barium	514	300	UG/G_DRYWT	0.236	3.6E+01	2.1E+01	UG/G_WETWT
7440-41-7	Beryllium	7.9	4.9	UG/G_DRYWT	0.144	3.4E-01	2.1E-01	UG/G_WETWT
7440-43-9	Cadmium	8.3	4.0	UG/G_DRYWT	4.016	9.9E+00	4.8E+00	UG/G_WETWT
7440-47-3	Chromium	104	74	UG/G_DRYWT	0.083	2.6E+00	1.8E+00	UG/G_WETWT
7440-48-4	Cobalt	22	16	UG/G_DRYWT	0.120	7.9E-01	5.7E-01	UG/G_WETWT
7440-50-8	Copper	357	121	UG/G_DRYWT	0.098	1.1E+01	3.6E+00	UG/G_WETWT
7439-92-1	Lead	1835	575	UG/G_DRYWT	0.145	8.0E+01	2.5E+01	UG/G_WETWT
7439-96-5	Manganese	859	826	UG/G_DRYWT	0.201	5.2E+01	5.0E+01	UG/G_WETWT
7439-98-7	Molybdenum	17.3	8.4	UG/G_DRYWT	0.082	4.2E-01	2.0E-01	UG/G_WETWT
7782-49-2	Selenium	2.2	1.4	UG/G_DRYWT	1.730	1.2E+00	7.4E-01	UG/G_WETWT
7440-28-0	Thallium	1.0	0.71	UG/G_DRYWT	0.176	5.5E-02	3.8E-02	UG/G_WETWT
7440-62-2	Vanadium	71	59	UG/G_DRYWT	0.080	1.7E+00	1.4E+00	UG/G_WETWT
7440-66-6	Zinc	1867	645	UG/G_DRYWT	0.618	3.5E+02	1.2E+02	UG/G_WETWT
	Pesticides/Herbicides							
72-54-8	4,4'-DDD	0.027	0.013	UG/G_DRYWT	0.466	3.7E-03	1.9E-03	UG/G_WETWT
72-55-9	4,4'-DDE	0.042	0.018	UG/G_DRYWT	0.545	6.9E-03	3.0E-03	UG/G_WETWT
50-29-3	4,4'-DDT	0.0028	0.0013	UG/G_DRYWT	0.210	1.7E-04	7.9E-05	UG/G_WETWT
60-57-1	Dieldrin	0.063	0.023	UG/G_DRYWT	0.583	1.1E-02	4.0E-03	UG/G_WETWT
58-89-9	Lindane	0.00076	0.00031	UG/G_DRYWT	1.331	3.0E-04	1.2E-04	UG/G_WETWT
	PCB as Aroclors							
12767-79-2	TOTAL AROCLOR	3.6	1.4	UG/G_DRYWT	0.366	3.9E-01	1.6E-01	UG/G_WETWT
11097-69-1	Aroclor 1254	3.6	1.4	UG/G_DRYWT	0.354	3.8E-01	1.5E-01	UG/G_WETWT
11100-14-4	Aroclor 1268	0.10	0.040	UG/G_DRYWT	0.428	1.3E-02	5.2E-03	UG/G_WETWT
	Dioxin/Furans [c]							
1746-01-6	2,3,7,8-TCDD	0.0043	0.0017	UG/G_DRYWT	0.252	3.2E-04	1.3E-04	UG/G_WETWT
35822-46-9	**1,2,3,4,6,7,8-HpCDD**	**0.0034**	**0.00062**	**UG/G_DRYWT**	**0.218**	**2.2E-04**	**4.0E-05**	**UG/G_WETWT**
67562-39-4	**1,2,3,4,6,7,8-HpCDF**	**0.0032**	**0.00050**	**UG/G_DRYWT**	**0.213**	**2.0E-04**	**3.2E-05**	**UG/G_WETWT**
55673-89-7	**1,2,3,4,7,8,9-HpCDF**	**0.000094**	**0.000016**	**UG/G_DRYWT**	**0.251**	**7.0E-06**	**1.2E-06**	**UG/G_WETWT**
39227-28-6	**1,2,3,4,7,8-HxCDD**	**0.000058**	**0.000011**	**UG/G_DRYWT**	**0.696**	**1.2E-05**	**2.4E-06**	**UG/G_WETWT**
70648-26-9	**1,2,3,4,7,8-HxCDF**	**0.000098**	**0.000022**	**UG/G_DRYWT**	**0.172**	**5.1E-06**	**1.1E-06**	**UG/G_WETWT**
57663-85-7	**1,2,3,6,7,8-HxCDD**	**0.00050**	**0.000078**	**UG/G_DRYWT**	**na**	**-**	**-**	**UG/G_WETWT**
57117-44-9	**1,2,3,6,7,8-HxCDF**	**0.00010**	**0.000021**	**UG/G_DRYWT**	**0.415**	**1.3E-05**	**2.6E-06**	**UG/G_WETWT**
19408-74-3	**1,2,3,7,8,9-HxCDD**	**0.00021**	**0.000035**	**UG/G_DRYWT**	**0.199**	**1.3E-05**	**2.1E-06**	**UG/G_WETWT**
72918-21-9	**1,2,3,7,8,9-HxCDF**	**0.000062**	**0.000011**	**UG/G_DRYWT**	**4.569**	**8.5E-05**	**1.5E-05**	**UG/G_WETWT**
40321-76-4	**1,2,3,7,8-PeCDD**	**0.000052**	**0.000011**	**UG/G_DRYWT**	**1.027**	**1.6E-05**	**3.4E-06**	**UG/G_WETWT**
57117-41-6	**1,2,3,7,8-PeCDF**	**0.00023**	**0.000051**	**UG/G_DRYWT**	**1.083**	**7.4E-05**	**1.7E-05**	**UG/G_WETWT**
60851-34-5	**2,3,4,6,7,8-HxCDF**	**0.00021**	**0.000036**	**UG/G_DRYWT**	**0.500**	**3.2E-05**	**5.5E-06**	**UG/G_WETWT**
57117-31-4	**2,3,4,7,8-PeCDF**	**0.00017**	**0.000032**	**UG/G_DRYWT**	**0.299**	**1.6E-05**	**2.9E-06**	**UG/G_WETWT**
1746-01-6	**2,3,7,8-TCDD**	**0.0043**	**0.0017**	**UG/G_DRYWT**	**0.252**	**3.2E-04**	**1.3E-04**	**UG/G_WETWT**
51207-31-9	**2,3,7,8-TCDF**	**0.000024**	**0.000012**	**UG/G_DRYWT**	**0.125**	**8.9E-07**	**4.4E-07**	**UG/G_WETWT**
3268-87-9	**OCDD**	**0.0041**	**0.0015**	**UG/G_DRYWT**	**0.219**	**2.7E-04**	**9.6E-05**	**UG/G_WETWT**
39001-02-0	**OCDF**	**0.0018**	**0.00031**	**UG/G_DRYWT**	**0.234**	**1.2E-04**	**2.2E-05**	**UG/G_WETWT**
TEB	TEQ-BIRD	0.0043	0.0018	UG/G_DRYWT	0.339	4.4E-04	1.9E-04	UG/G_WETWT
TEM	TEQ-MAMMAL	0.0043	0.0018	UG/G_DRYWT	0.353	4.5E-04	1.9E-04	UG/G_WETWT

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TABLE 3
ESTIMATED EARTHWORM TISSUE CONCENTRATIONS DERIVED USING SITE-SPECIFIC BSAFs

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Notes:

a. Mean Biota Soil Accumulation Factors (BSAFs) presented in Table J-8 of the BERA (MACTEC, 2004). Units are $g_{OC}(drywt)/g_{lipid}(wetwt)$.

b. Earthworm tissue concentrations were estimated by multiplying the soil concentration (either maximum or arithmetic average) by the BSAF and the estimated earthworm lipid percentage and dividing by estimated soil TOC.

2.66%	Average earthworm lipid percentage of Lyman Mill earthworm samples collected to support the BERA (Table 20; MACTEC, 2004).
8.88%	Average TOC in LPX-SD-4402 and field duplicate (RI samples collected by Battelle in 2004); conservative estimate of soil TOC, lowest TOC was measured at this location and average of 3 Oxbow sampling locations was 0.02163 g OC/g.

c. **Bold** font indicates chemicals that were not selected as COPECs because a toxic equivalency approach was employed in the SLERA; however, earthworm tissue concentrations were estimated for individual dioxin and furan congeners in order to estimate wildlife tissue concentrations.

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TABLE 4
SOIL INVERTEBRATE HAZARD QUOTIENTS FOR COPECs IN OXBOW AREA FLOODPLAIN SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Chemical	Detection Frequency	Units	Exposure Point Concentration		TRV[b]	Hazard Quotients	
			MAX[a]	AVG[a]		MAX[c]	AVG[d]
Pesticides							
4,4'-DDD	3/3	UG/G	0.02658	0.0133	0.0025	**1.1E+01**	**5.3E+00**
4,4'-DDE	3/3	UG/G	0.04236	0.018	0.0025	**1.7E+01**	**7.3E+00**
4,4'-DDT	2/3	UG/G	0.00276	0.0013	0.0025	**1.1E+00**	5.1E-01
Dieldrin	3/3	UG/G	0.06338	0.0231	0.0005	**1.3E+02**	**4.6E+01**
Lindane	1/3	UG/G	0.00076	0.00031	0.00005	**1.5E+01**	**6.2E+00**
					Total Pesticides	**1.7E+02**	**6.6E+01**
PCBs							
TOTAL AROCLOR	3/3	UG/G	3.6	1.4	137	2.6E-02	1.0E-02
Aroclor-1254	2/3	UG/G	3.6	1.4	17	2.2E-01	8.5E-02
Aroclor-1268	1/3	UG/G	0.10	0.040	861	1.2E-04	4.7E-05
					Total PCBs	2.4E-01	9.6E-02
Inorganics/Metals							
Antimony	4 / 4	UG/G	7.0	3.0	3.5	**2.0E+00**	8.6E-01
Arsenic	4 / 4	UG/G	13	5.4	60	2.1E-01	9.0E-02
Barium	4 / 4	UG/G	514	300	3000	1.7E-01	1.0E-01
Beryllium	4 / 4	UG/G	7.9	4.9	1.1	**7.2E+00**	**4.4E+00**
Cadmium	4 / 4	UG/G	8.3	4.0	20	4.1E-01	2.0E-01
Chromium	4 / 4	UG/G	104.0	73.6	0.4	**2.6E+02**	**1.8E+02**
Cobalt	4 / 4	UG/G	22.0	16.0	1000	2.2E-02	1.6E-02
Copper	4 / 4	UG/G	357	121	50	**7.1E+00**	**2.4E+00**
Lead	4 / 4	UG/G	1835	575	500	**3.7E+00**	**1.1E+00**
Manganese	4 / 4	UG/G	859	826	100	**8.6E+00**	**8.3E+00**
Molybdenum	4 / 4	UG/G	17	8.4	200	8.7E-02	4.2E-02
Selenium	3 / 4	UG/G	2.2	1.4	70	3.2E-02	2.0E-02
Thallium	4 / 4	UG/G	1.0	0.71	1	**1.0E+00**	7.1E-01
Vanadium	4 / 4	UG/G	71	59	20	**3.6E+00**	**3.0E+00**
Zinc	4 / 4	UG/G	1867	645	100	**1.9E+01**	**6.4E+00**
					Total Inorganics/Metals	**3.1E+02**	**2.1E+02**
Dioxins							
2,3,7,8-TCDD	1 / 4	UG/G	0.0043	0.0017	0.0048	8.8E-01	3.6E-01
					Total	**4.8E+02**	**2.8E+02**

Notes:

a. MAX and AVG EPCs defined as the maximum detected and arithmetic mean COPEC concentrations presented in Table 2.

b. Soil Toxicity Reference Values (TRVs) based on lowest available invertebrate screening benchmark values as summarized in the BERA (MACTEC, 2004; Table D-3).

c. MAX Hazard Quotient is the ratio of the maximum concentration to the TRV.

d. AVG Hazard Quotient is the ratio of the average concentration to the TRV.

Shaded cells indicate a hazard quotient greater than 1.

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TABLE 5
CBR-BASED HAZARD QUOTIENTS FOR COPECs IN OXBOW EARTHWORM TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Chemical	Detection Frequency	Units	Exposure Point Concentration		CBR[b]		Hazard Quotient[c] Maximum		Hazard Quotient[c] Average	
			MAX[a]	AVG[a]	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Pesticides										
4,4'-DDD	3/3	UG/G	0.0037	0.0019	0.008	0.6	4.6E-01	6.2E-03	2.3E-01	3.1E-03
4,4'-DDE	3/3	UG/G	0.0069	0.0030	0.042	0.29	1.6E-01	2.4E-02	7.1E-02	1.0E-02
4,4'-DDT	2/3	UG/G	0.00017	0.000079	0.13	0.15	1.3E-03	1.2E-03	6.1E-04	5.3E-04
Dieldrin	3/3	UG/G	0.011	0.0040	0.01	0.08	**1.1E+00**	1.4E-01	4.0E-01	5.0E-02
Lindane	1/3	UG/G	0.00030	0.00012	2	0.072	1.5E-04	4.2E-03	6.1E-05	1.7E-03
						Total Pesticides	**1.7E+00**	1.7E-01	7.1E-01	6.6E-02
PCBs										
TOTAL AROCLOR	3/3	UG/G	0.39	0.16						
Aroclor 1254	2/3	UG/G	0.38	0.15	10.4	8.1	3.6E-02	4.7E-02	1.4E-02	1.8E-02
Aroclor 1268	1/3	UG/G	0.013	0.0052		0.45		2.9E-02		1.2E-02
						Total PCBs	3.6E-02	7.6E-02	1.4E-02	3.0E-02
Inorganics/Metals										
Antimony	4/4	UG/G	1.5	1	5	9	2.9E-01	1.6E-01	1.3E-01	7.0E-02
Arsenic	4/4	UG/G	0.43	0.18	1.0	4.2	4.2E-01	1.0E-01	1.7E-01	4.3E-02
Barium	4/4	UG/G	36	21		0.41		**8.9E+01**		**5.2E+01**
Beryllium	4/4	UG/G	0.34	0.21	5.1		6.7E-02		4.1E-02	
Cadmium	4/4	UG/G	9.9	4.8	1.1	0.093	**8.9E+00**	**1.1E+02**	**4.3E+00**	**5.2E+01**
Chromium	4/4	UG/G	2.6	1.8						
Cobalt	4/4	UG/G	0.79	0.57						
Copper	4/4	UG/G	11	3.6	3.4	4.4	**3.1E+00**	**2.4E+00**	**1.0E+00**	8.1E-01
Lead	4/4	UG/G	80	25	2.3	5.8	**3.5E+01**	**1.4E+01**	**1.1E+01**	**4.3E+00**
Manganese	4/4	UG/G	52	50	18.4		**2.8E+00**		**2.7E+00**	
Molybdenum	4/4	UG/G	0.42	0.20						
Selenium	3/4	UG/G	1.2	0.74	2.9	0.2	3.9E-01	**5.8E+00**	2.5E-01	**3.7E+00**
Thallium	4/4	UG/G	0.055	0.038	2.7		2.0E-02		1.4E-02	
Vanadium	4/4	UG/G	1.7	1.4	0.8	0.41	**2.1E+00**	**4.2E+00**	**1.8E+00**	**3.5E+00**
Zinc	4/4	UG/G	345	119	13	20	**2.7E+01**	**1.8E+01**	**9.4E+00**	**6.1E+00**
						Total Inorganics/Metals	**8.0E+01**	**2.4E+02**	**3.1E+01**	**1.2E+02**
Dioxins										
2,3,7,8-TCDD	7/7	UG/G	0.0003	0.0001	0.0003	0.003	**1.1E+00**	1.1E-01	4.4E-01	4.4E-02
						Total	**8.3E+01**	**2.4E+02**	**3.2E+01**	**1.2E+02**

Notes:

a. Estimated earthworm EPCs presented in Table 3.

b. Critical Body Residues (CBRs) are obtained from summary of tissue effects data presented in the BERA (MACTEC, 2004; Table G-1).

c. Hazard Quotient is the ratio of the Average and Maximum concentration to the NOAEL or LOAEL CBR.

Shaded cells indicate a hazard quotient greater than 1.

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TABLE 6
INCREMENTAL RISK SUMMARY FOR OXBOW AREA FLOODPLAIN SOIL

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]	
	Oxbow[a]		Greystone[b]			
Analyte	MAX	AVG	MAX	AVG	MAX	AVG
HI	**4.8E+02**	**2.8E+02**	**1.1E+03**	**8.5E+02**		
Dieldrin	1.3E+02	4.6E+01	1.9E+01	1.3E+01	1.1E+02	3.4E+01
Lindane	1.5E+01	6.2E+00			1.5E+01	6.2E+00
Zinc	1.9E+01	6.4E+00	5.0E+00	2.9E+00	1.4E+01	3.6E+00
4,4'-DDE	1.7E+01	7.3E+00	8.2E+00	5.3E+00	8.7E+00	2.0E+00
4,4'-DDD	1.1E+01	5.3E+00	6.1E+00	3.3E+00	4.6E+00	2.0E+00
Beryllium	7.2E+00	4.4E+00	4.1E+00	2.8E+00	3.1E+00	1.6E+00
Lead	3.7E+00	1.1E+00	1.2E+00	9.0E-01	2.5E+00	2.5E-01
Antimony	2.0E+00	8.6E-01	2.8E-01	1.8E-01	1.7E+00	6.9E-01

Notes:

a. Risk estimates as calculated and presented in Table 4.

b. Risk estimates as calculated and presented Table 71 in the BERA (MACTEC, 2004). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with RME-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceeds the corresponding reference risk estimate.

Incremental risks for individual analytes are derived by subtracting the upgradient/reference HQs from the exposure area HQ.

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TABLE 7
INCREMENTAL RISK SUMMARY FOR ESTIMATED OXBOW STUDY AREA EARTHWORM TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]	
	Oxbow[a]		Greystone[b]			
Analyte	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
HI	**3.2E+01**	**1.2E+02**	**2.7E+03**	**4.9E+02**		
Cadmium	4.3E+00	5.2E+01		3.2E+01	4.3E+00	2.0E+01
Zinc	9.4E+00	6.1E+00	6.7E+00	4.4E+00	2.7E+00	1.7E+00

Notes:

a. Risk estimates as calculated and presented in Table 5.

b. Risk estimates as calculated and presented Table 74 in the BERA (MACTEC, 2004). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with RME-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceeds the corresponding reference risk estimate.

Incremental risks for individual analytes are derived by subtracting the upgradient/reference HQs from the exposure area HQ.

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TABLE 8. EXPOSURE ASSUMPTIONS FOR THE AMERICAN WOODCOCK.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Parameter	Symbol	Value	Units	Reference
Soil concentration	C_{soil}	COPEC-specific	ug/g_{dw}	Table 1
Percentage of earthworms in diet	$P_{earthworms}$	100	%	Assumption
Earthworm concentration[a]	$C_{earthworm}$	COPEC-specific	ug/g_{ww}	Table 2
Ingestion Rate[b]	IR_{food}	0.082	kg/day	USEPA, 1993
Incidental Soil Ingestion Rate[c]	IR_{soil}	0.012	kg/day	Assumption
Site Foraging Factor[d]	SFF	100	%	Gregg, 1984
Body Weight	BW	0.20	kg	USEPA, 1993

Notes:

a. Earthworm tissue concentrations estimated using site-specific BSAFs as discussed in 3.1.1.
b. Calculated using regression equation for non-passerines: IR_{food} (g/day) = 0.301 * BW 0.751 (g) and converted to kg/day.
c. Assume 15% of daily food ingestion rate.
d. Assumed 100% for initial calculations using maximum exposure estimates; also 100% for evaluation of average conditions based on average home range (5 hectares) of females with broods in Wisconsin woods (Gregg, 1984) relative to estimated available habitat in Oxbow Area (11.12 hectares).

TABLE 9. EXPOSURE ASSUMPTIONS FOR THE SHORT-TAILED SHREW.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Parameter	Symbol	Value	Units	Reference
Soil concentration	C_{soil}	COPEC-specific	ug/g_{dw}	Table 1
Percentage of plants in diet	P_{plants}	15	%	USEPA, 1993; Whittaker and Feraro, 1963
Plant concentration	C_{plant}	COPEC-specific	ug/g_{ww}	Tables C.2-1, D.2-1
Percentage of earthworms in diet	$P_{earthworms}$	85	%	USEPA, 1993; Whittaker and Feraro, 1963
Earthworm concentration[a]	$C_{earthworm}$	COPEC-specific	ug/g_{ww}	Table 2
Ingestion Rate[b]	IR_{food}	0.013	kg/day	USEPA, 1993
Incidental Soil Ingestion Rate[c]	IR_{soil}	0.00064	kg/day	Assumption
Site Foraging Factor[d]	SFF	100	%	Buckner, 1966
Body Weight	BW	0.017	kg	Guilday, 1957

Notes:

a. Earthworm tissue concentrations estimated using site-specific BSAFs as discussed in 3.1.1.
b. Calculated using regression equation for mammals: IR_{food} (g/day) = 0.235 * BW 0.822 (g) and converted to kg/day.
c. Assume 5% of daily food ingestion rate.
d. Assumed 100% for initial calculations using maximum exposure estimates; also 100% for evaluation of average conditions based on average home ranges (0.390 hectares) in southern Manitoba/tamarack bog habitat relative to estimated available habitat in Oxbow Area (11.12 hectares).

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TABLE 10
CBR-BASED HAZARD QUOTIENTS FOR ESTIMATED VERMIVOROUS AVIAN EGG TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Chemical	Estimated Earthworm Tissue Concentration[a]		Units	Avian BMF[b] (lipid basis)	TEF	Estimated Egg Tissue Concentration[c]		CBR[d]		Hazard Quotients[e] Maximum		Average	
	MAX	AVG				MAX	AVG	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Pesticides/PCBs													
4,4'-DDD	0.0037	0.013	UG/G	-	na				0.009				
4,4'-DDE	0.0069	0.0030	UG/G	13.3	na	2.7E-01	1.1E-01		0.10		**2.7E+00**		**1.1E+00**
4,4'-DDT	0.0002	0.000079	UG/G	0.69	na	3.5E-04	1.6E-04						
Dieldrin	0.011	0.0040	UG/G	2.82	na	9.0E-02	3.3E-02		0.059		**1.5E+00**		5.6E-01
Lindane	0.00076	0.00031	UG/G	#N/A	na								
									Total Pesticides/PCBs		**4.2E+00**		**1.7E+00**
Dioxins/Furans													
2,3,7,8-TCDD	0.00032	0.00013	UG/G	6.99	1	6.5E-03	2.7E-03						
1,2,3,7,8-PeCDD	0.000016	0.0000034	UG/G	3.35	1	1.6E-04	3.3E-05						
2,3,4,7,8-PeCDF	0.000016	0.0000029	UG/G	1.57	1	7.1E-05	1.3E-05						
1,2,3,6,7,8-HxCDD	#N/A	#N/A	UG/G	5.98	0.01								
1,2,3,4,6,7,8-HpCDD	0.00022	0.000040	UG/G		0.001								
OCDD	0.00027	0.00010	UG/G		0.0001								
1,2,3,4,7,8-HxCDF	0.000005	0.0000011	UG/G		0.1								
1,2,3,6,7,8-HxCDF	0.000013	0.0000026	UG/G		0.1								
2,3,7,8-TCDF	0.000001	0.00000044	UG/G	-	1								
1,2,3,4,7,8-HxCDD	0.000012	0.0000024	UG/G	#N/A	0.05								
1,2,3,7,8,9-HxCDD	0.000013	0.0000021	UG/G	#N/A	0.1								
2,3,4,6,7,8-HxCDF	0.000032	0.0000055	UG/G	#N/A	0.1								
1,2,3,4,6,7,8-HpCDF	0.00020	0.000032	UG/G	#N/A	0.01								
1,2,3,4,7,8,9-HpCDF	0.0000070	0.0000012	UG/G	#N/A	0.01								
OCDF	0.00012	0.000022	UG/G	#N/A	0.0001								
					TCDD Toxic Equivalency (Birds)	6.7E-03	2.7E-03	7.0E-05	1.2E-03	**9.6E+01**	**5.6E+00**	**3.9E+01**	**2.3E+00**
									Total	**9.6E+01**	**9.8E+00**	**3.9E+01**	**4.0E+00**

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TABLE 10
CBR-BASED HAZARD QUOTIENTS FOR ESTIMATED VERMIVOROUS AVIAN EGG TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Notes:

a. EPCs for earthworm tissue (Table 3); only analytes with BMFs presented.

b. Biomagnification Factors (BMFs - expressed in units of g (lipid % fish)/g (lipid % gull egg) presented in the BERA (MACTEC, 2004; Table J-12).

c. Egg concentration for avian insectivore receptor (mg/kg wet weight) estimated by multiplying the earthworm tissue concentration by the BMF and the ratio of the egg to earthworm percent lipid. The following lipid contents were assumed:

2.7	Average earthworm lipid percent in Lyman Mill Pond.
7.7	Average gull egg lipid percentage (Braune and Norstrom, 1989)

d. Critical Body Residues (CBRs) are obtained from summary of tissue effects data presented in the BERA (MACTEC, 2004; Table G-1); TCDD CBRs presented in Table 130 (MACTEC, 2004).

e. Hazard Quotient is the ratio of the estimated tissue concentration to the NOAEL or LOAEL CBR.

na - Not available/applicable.

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TABLE 11
CBR-BASED HAZARD QUOTIENTS FOR ESTIMATED VERMIVOROUS MAMMALIAN TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

										Hazard Quotients[e]			
	Estimated Earthworm Tissue Concentration[a]		Units	Mammal BMF[b] (lipid basis)	TEF	Estimated Tissue Concentration[c]		CBR[d]		Maximum		Average	
Chemical	MAX	AVG				MAX	AVG	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Pesticides/PCBs													
4,4'-DDD	0.0037	0.0019	UG/G	-	na			8.0E-03	0.6				
Aroclor, Total	0.39	0.158	UG/G	14	na	9.1E+00	3.7E+00						
Pesticides/PCBs													
Dioxins/Furans													
2,3,7,8-TCDD	0.00032	0.00013	UG/G	11	1	6.0E-03	2.5E-03						
1,2,3,4,6,7,8-HpCDD	0.000225	0.000040	UG/G	36	0.01	1.3E-04	2.4E-05						
1,2,3,6,7,8-HxCDD	#N/A	#N/A	UG/G	30	0.1								
1,2,3,4,7,8-HxCDF	0.000005	0.0000011	UG/G	57	0.1	4.8E-05	1.1E-05						
2,3,4,7,8-PeCDF	0.000016	0.0000029	UG/G	54	0.5	7.0E-04	1.3E-04						
1,2,3,4,7,8-HxCDD	0.000012	0.0000024	UG/G	9.3	0.1	1.9E-05	3.7E-06						
2,3,7,8-TCDF	0.000001	0.0000004	UG/G	0.40	0.1	5.9E-08	2.9E-08						
1,2,3,7,8-PeCDD	0.000016	0.000003	UG/G	#N/A	1								
1,2,3,7,8,9-HxCDD	0.000013	0.000002	UG/G	#N/A	0.1								
OCDD	0.00027	0.000096	UG/G	#N/A	0.0001								
1,2,3,6,7,8-HxCDF	0.000013	0.0000026	UG/G	#N/A	0.1								
2,3,4,6,7,8-HxCDF	0.000032	0.0000055	UG/G	#N/A	0.1								
1,2,3,4,6,7,8-HpCDF	0.00020	0.000032	UG/G	#N/A	0.01								
1,2,3,4,7,8,9-HpCDF	0.0000070	0.0000012	UG/G	#N/A	0.01								
OCDF	0.00012	0.000022	UG/G	#N/A	0.0001								
TCDD Toxic Equivalency (Mammals)						6.9E-03	2.6E-03	1.5E-04	2.3E-04	**4.6E+01**	**3.0E+01**	**1.7E+01**	**1.1E+01**
TEQ (D/F)										**4.6E+01**	**3.0E+01**	**1.7E+01**	**1.1E+01**
TEQ (PCBs)										0.0E+00	0.0E+00	0.0E+00	0.0E+00
Total TCDD TEQ										**4.6E+01**	**3.0E+01**	**1.7E+01**	**1.1E+01**
Total										**4.6E+01**	**3.0E+01**	**1.7E+01**	**1.1E+01**

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TABLE 11
CBR-BASED HAZARD QUOTIENTS FOR ESTIMATED VERMIVOROUS MAMMALIAN TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Notes:

a. EPCs for earthworm tissue (Table 3); only analytes with BMFs presented.

b. Biomagnification Factors (BMFs - expressed in units of g (lipid % fish)/g (lipid % otter liver tissue) presented in the BERA (MACTEC, 2004; Table J-12).

c. Mammalian tissue concentration (mg/kg wet weight) estimated by multiplying the earthworm tissue concentration by the BMF and the ratio of the otter to earthworm percent lipid. The following lipid contents were assumed:

2.7	Average earthworm lipid percent in Lyman Mill Pond.
4.4	Average lipid percentage in five otter liver samples (Leonards et al., 1997).

d. Critical Body Residues (CBRs) are obtained from summary of tissue effects data presented in the BERA (MACTEC, 2004; Table G-1).

e. Hazard Quotient is the ratio of the estimated tissue concentration to the NOAEL or LOAEL CBR.

na - Not available/applicable.

TABLE 12
INCREMENTAL RISK SUMMARY FOR WILDLIFE RECEPTORS - American Woodcock

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]	
	Oxbow[a]		Greystone[b]			
Analyte	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
HI	**4.6E+01**	**6.1E+00**	**4.1E+01**	**6.7E+00**		
TEQ-BIRD	1.3E+01	1.3E+00	5.1E-01	5.1E-02	1.3E+01	1.3E+00
Zinc	6.0E+00	6.6E-01	3.6E+00	3.9E-01	2.4E+00	2.7E-01
Lead	1.2E+01	1.2E+00	1.0E+01	1.0E+00	1.6E+00	1.6E-01
TOTAL AROCLOR	1.4E+00	5.4E-01	1.8E-01	7.3E-02	1.2E+00	4.7E-01

Notes:

a. Oxbow risk estimates as calculated and presented in Appendix D.1.

b. Risk estimates as calculated and presented in the BERA (MACTEC, 2004; Appendix L). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with NOAEL-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceeds the corresponding reference risk estimate.

Incremental risks for individual analytes are derived by subtracting the upgradient background HQs from the Oxbow HQ.

TABLE 13
INCREMENTAL RISK SUMMARY FOR WILDLIFE RECEPTORS - Short-tailed Shrew

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]	
	Oxbow[a]		Greystone[b]			
Analyte	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
HI	**2.6E+02**	**2.9E+01**	**1.3E+02**	**1.6E+01**		
TEQ-MAMMAL	1.9E+02	1.9E+01	4.2E+00	4.2E-01	1.8E+02	1.8E+01
Antimony	2.0E+01	2.0E+00	6.3E+00	6.3E-01	1.3E+01	1.3E+00
TOTAL AROCLOR	2.2E+00	2.2E-01	4.7E-01	4.7E-02	1.8E+00	1.8E-01
Aroclor 1254	2.2E+00	2.2E-01	6.4E-01	6.4E-02	1.5E+00	1.5E-01
Cadmium	3.2E+00	3.2E-01	1.9E+00	1.9E-01	1.3E+00	1.3E-01

Notes:

a. Oxbow risk estimates as calculated and presented in Appendix D.2.

b. Risk estimates as calculated and presented in the BERA (MACTEC, 2004; Appendix L). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with NOAEL-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceeds the corresponding reference risk estimate.

Incremental risks for individual analytes are derived by subtracting the upgradient/reference HQs from the exposure area HQ.

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TABLE 14. EXPOSURE ASSUMPTIONS FOR THE RACCOON.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Parameter	Symbol	Value	Units	Reference
Soil concentration	C_{soil}	COPEC-specific	ug/g_{dw}	Table 1
Percentage of plants in diet	P_{plants}	71	%	Llewellyn and Uhler, 1952 as cited in USEPA, 1993
Plant concentration	C_{plant}	COPEC-specific	ug/g_{ww}	Tables C.3-1, D.3-1
Percentage of earthworms in diet	$P_{earthworms}$	29	%	Llewellyn and Uhler, 1952 as cited in USEPA, 1993
Earthworm concentration[a]	$C_{earthworm}$	COPEC-specific	ug/g_{ww}	Table 2
Ingestion Rate[b]	IR_{food}	1.7	kg/day	USEPA, 1993
Incidental Soil Ingestion Rate[c]	IR_{soil}	0.087	kg/day	Assumption
Site Foraging Factor[d]	SFF	5	%	Stuewer, 1943, as cited in USEPA, 1993
Body Weight	BW	6.2	kg	Sanderson, 1984, as cited in USEPA, 1993

Notes:

a. Earthworm tissue concentrations estimated using site-specific BSAFs as discussed in 3.1.1.

b. Calculated using regression equation for mammals: IR_{food} (g/day) = 0.235 * BW 0.822 (g) and converted to kg/day.

c. Assume 5% of daily food ingestion rate.

d. Assumed 100% for initial calculations using maximum exposure estimates; 10% selected for evaluation of average conditions based on average adult female home range size from May to December in riparian habitat in Michigan (Stuewer, 1943) (108 hectares) relative to estimated available habitat in Oxbow Area (11.12 hectares). Also assumed that raccoons forage in floodplain habitat for 50% of the year and exposure to terrestrial prey limited primarily to late summer and fall (USEPA, 1993). This resulted in an overall SFF of 0.1 * 0.5 or 5%.

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TABLE 15
INCREMENTAL RISK SUMMARY FOR WILDLIFE RECEPTORS - Raccoon: floodplain

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]	
	Oxbow[a]		Greystone[b]			
Analyte	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
HI	**3.6E+00**	**5.1E-01**	**1.4E+01**	**2.3E+00**		
TEQ-MAMMAL	**2.1E+00**	2.1E-01	5.3E-01	5.3E-02	**1.6E+00**	1.6E-01

Notes:

a. Oxbow risk estimates as calculated and presented in Appendix D.3.

b. Greystone risk estimates presented in the BERA (MACTEC, 2004; Appendix N). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with NOAEL-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceeds the corresponding reference risk estimate.

Incremental risks for individual analytes are derived by subtracting the upgradient/reference HQs from the exposure area HQ.

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TABLE 16. SUMMARY OF UNCERTAINTIES.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under-estimation (-) of Risk	Rationale
Problem Formulation		
Selection of Receptors of Concern	+	The urbanized and industrialized nature of the landscape in the vicinity of the Oxbow Area may limit habitat suitability for sensitive receptors such as the American woodcock
	-	Plants were not specifically evaluated in the Addendum. Although inorganic analytes were generally consistent with upgradient background concentrations, reported levels in floodplain soils could adversely affect these receptors.
	-	The Oxbow Area was considered to provide primarily floodplain (i.e., terrestrial) habitat for ecological receptors. However, seasonal ponding could result in exposures to aquatic invertebrates and amphibians. These exposures were not evaluated because surface water data are not available.
	+	The availability of soil invertebrates as a forage base for vermivorous wildlife was assumed but not verified. Depositional regions of the Oxbow Area may contain saturated hydric soils for sufficient periods of time to exclude or reduce the numbers of soil invertebrates. In these areas, the bioaccumulation hazard to vermivorous wildlife would be eliminated.
Identification and Selection of COPECs	-	HCX, PAHs, and coplanar PCBs were not included in the analytical parameters for soil samples collected at the Oxbow Area. Although this may result in exposures (and hazards) being under-estimated, the potential risks are anticipated to be considerably lower than those identified in the Addendum.
Area Boundary Delineation	+	The analytical chemistry results for the sample from location LPX-SD-4404 are distinctive and may not be within the normal flooding zone (and therefore not historically impacted by the site source area).
Exposure Assessment		
Exposure Parameters	+/-	Uncertainty is inherent in the use of literature-derived exposure parameters because they were not empirically measured at the site. The general use of conservative values likely resulted in wildlife hazards being over-estimated.

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TABLE 16. SUMMARY OF UNCERTAINTIES. (continued)

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under-estimation (-) of Risk	Rationale
Exposure Concentrations	+	Earthworm tissue concentrations were estimated using BSAFs that were normalized based on the minimum organic carbon concentration detected in the 2004 Oxbow Area floodplain soils. Floodplain soil carbon content is variable (8 - >30%); the average (of three soil samples) was almost 2.5 times the minimum value and use of the average TOC would have resulted in estimated earthworm tissue concentrations being reduced by this same factor.
Contaminant Distribution with Soil Depth	+/-	Floodplain soil samples were collected from 0-6 inches in depth only; data is lacking for other depth intervals where ecological exposure is possible.
Bioaccumulation Factors	-	The lack of soil/plant uptake factors for TCDD may have resulted in an underestimation of dietary exposures to omnivorous wildlife (raccoon).
	-	The lack of BMFs necessary to estimate wildlife tissue concentrations for certain COPECs may have resulted in an underestimation of risks.
Effects Assessment		
Toxicity Reference Values	+	The use of conservative application factors to derive benchmark doses may have resulted in risks being over-estimated for some COPECs.
	-	Avian toxicological data for antimony and cobalt were not available and, as a result, potential risks for these COPECs could not be quantified.
	+/-	CBRs were not available for all COPECs. In addition, the relatively high percentage of studies reporting unbounded results contributed significant uncertainty to the residue-based analysis. The general methodology employed likely resulted in the selection of conservative measures of effect.
Dioxin, Furan, and PCB Congeners	-	The TEQ approach does not explicitly account for antagonistic or synergistic interactions between congeners and may underestimate risk to wildlife; however, because TCDD was the primary risk driver this uncertainty is likely of little consequence.
Risk Characterization		
Hazard Quotients/ Hazard Indices	+/-	Uncertainty exists regarding the interpretation of the HQ or HI value of one as a definitive indicator of population level impacts to wildlife. The assessment is believed to be sufficiently conservative and the relationship between the assessment and measurement endpoints is not direct, resulting in a gray area for HQ or HI values in the vicinity of one.

TABLE 17. SUMMARY OF ECOLOGICAL RISK AT THE OXBOW AREA.

Receptor	Contaminant Group	Hazard Index[a] NOAEL	LOAEL
Soil invertebrates (soil screen)			
	Pesticides	66	
	PCBs	-	
	Metals	212	
	TEQ/TCDD	-	
	Total	278	
Soil invertebrates (tissue screen)			
	Pesticides	-	-
	PCBs	-	-
	Metals	31	122
	TEQ/TCDD	-	-
	Total	32	122
Short-tailed shrew	Pesticides	-	-
	PCBs	44	-
	Metals	69	8.2
	TEQ/TCDD	187	19
	Total	264	29
American woodcock	Pesticides	-	-
	PCBs	1.4	-
	Metals	27	2.2
	TEQ/TCDD	13	1.3
	Total	46	6.1
Raccoon	Pesticides	-	-
	PCBs	-	-
	Metals	-	-
	TEQ/TCDD	2.1	-
	Total	3.6	-

a. Hazard indices (HI) based on average COPEC concentrations at the Oxbow Area.

- Indicates that the HI was below 1.

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Appendix A

APPENDIX A
SITE PHOTOGRAPHS

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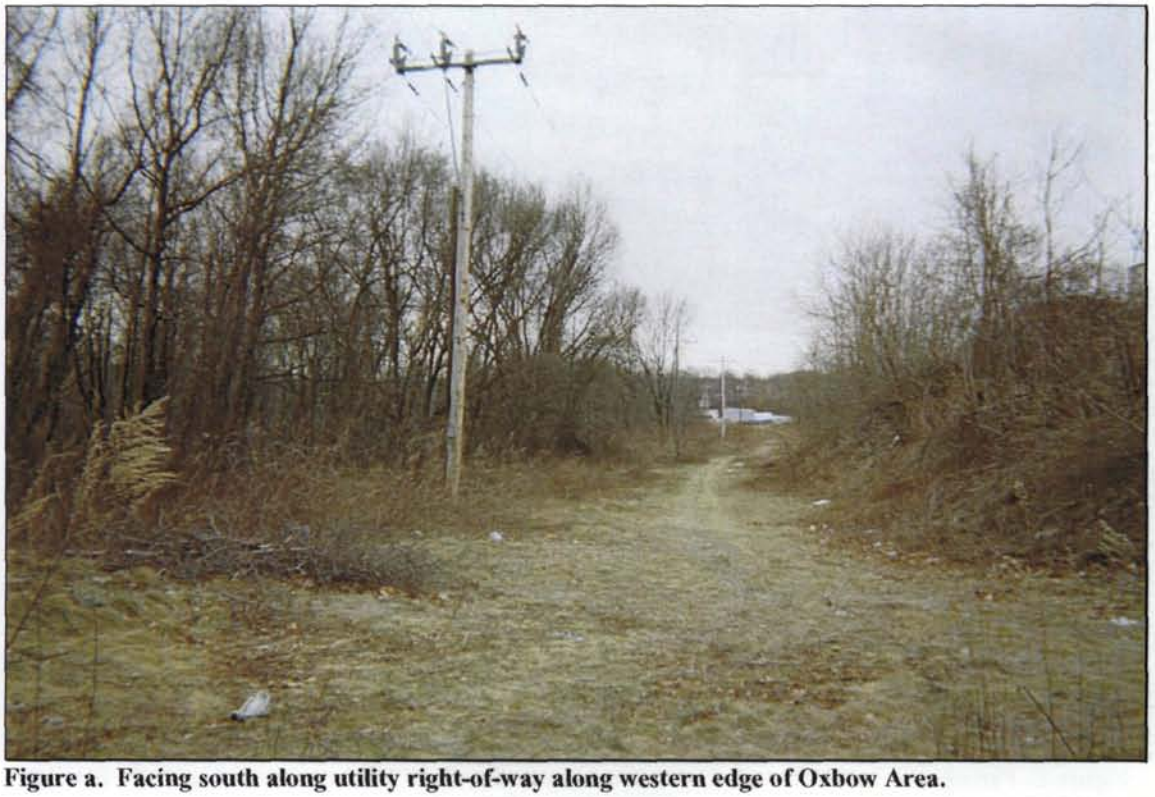

Figure a. Facing south along utility right-of-way along western edge of Oxbow Area.

Figure b. Facing west-south-west near center of Oxbow Area adjacent to former river channel.

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Figure c. Facing west in a forest opening located approximately 100 feet north of Figure b. Small ponded area in foreground may be one of several vernal pools located within the Oxbow Area

Figure d. Facing west in northwestern portion of Oxbow Area; note yellow-stained leaves along recent wet channel.

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Figure e. Disturbed borrow and fill topography typical of south central portion of the Oxbow Area across the Woonasquatucket River from the Lee Romano Baseball Field.

Figure f. Across Woonasquatucket River from the former Allendale Pond mill building complex. Allendale Dam is approximately 500 feet upstream around bend to the left. Note cut in bank in the center of the photo where floodwaters can flow into the Oxbow Area.

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Figure g. Topographically elevated oak-hardwood hammock in south-central portion of the Oxbow Area.

Figure h. Facing south from southern end of oak hammock area and looking into the scrub-shrub habitat that fringes the upper portion of Lyman Mill Pond.

Appendix B

APPENDIX B
SPECIES OF CONCERN – RESPONSES FROM TRUSTEE AGENCIES

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RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
235 Promenade Street, Providence, RI 02908-5767 TDD 401-222-4462

Melissa A. Beauchemin
Battelle
397 Washington Street
Duxbury, MA 02332

June 1, 2006

RE: Centredale Manor Restoration Project, North Providence, RI.

Dear Ms. Beauchemin:

Thank you for contacting the RI Natural Heritage Program for information regarding the presence of rare, threatened, or endangered species, or exemplary natural communities within the vicinity of the above-referenced project as outlined in your letter and map received at this office by fax on May 8, 2006.

Review of the Program database indicates there are no rare, threatened, or endangered species, or exemplary natural communities within the vicinity of this site. As our inventory is ongoing, more information may become available concerning this area in the future. If you have any questions regarding this review, please contact me at 277-2776, extension 4308.

Sincerely,

Richard W. Enser

Richard W. Enser, Coordinator
RI Natural Heritage Program

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

June 14, 2006

Reference:	Project	Location
	Site assessment	Johnston, RI

Melissa Beauchemin
Battelle
397 Washington St.
Duxbury, MA 02332

Dear Ms. Beauchemin:

This responds to your recent correspondence requesting information on the presence of federally-listed and/or proposed endangered or threatened species in relation to the proposed activity(ies) referenced above.

Based on information currently available to us, no federally-listed or proposed, threatened or endangered species or critical habitat under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area(s). Preparation of a Biological Assessment or further consultation with us under Section 7 of the Endangered Species Act is not required.

This concludes our review of listed species and critical habitat in the project location(s) and environs referenced above. No further Endangered Species Act coordination of this type is necessary for a period of one year from the date of this letter, unless additional information on listed or proposed species becomes available.

Thank you for your coordination. Please contact us at 603-223-2541 if we can be of further assistance.

Sincerely yours,

Michael J. Amaral

Michael J. Amaral
Endangered Species Specialist
New England Field Office

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Appendix C

APPENDIX C
FOOD WEB EXPOSURE MODELS USING MAXIMUM SITE CONCENTRATIONS

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TABLE C.1-1
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surface Soil (0-2 feet) / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Woodcock

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		SOIL INTAKE-INGESTION
	C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
	IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.012	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Gregg, 1984	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.20	USEPA, 1993	

REFERENCES

Gregg, L., 1984. Population ecology of woodcock in Wisconsin; Wis. Dept. Nat. Resour. Tech. Bull. No. 144; 51 pp.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE C.1-2
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surface Soil (0-2 feet) / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Woodcock

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	7.0E+00	mg/kg	4.2E-01	mg/kg-d					
Arsenic	1.3E+01	mg/kg	7.7E-01	mg/kg-d	5.1E+00	1.3E+01	mg/kg-d	1.5E-01	6.0E-02
Barium	5.1E+02	mg/kg	3.1E+01	mg/kg-d	4.2E+01	8.3E+01	mg/kg-d	7.4E-01	3.7E-01
Beryllium	7.9E+00	mg/kg	4.7E-01	mg/kg-d	1.5E-01	1.5E+00	mg/kg-d	**3.2E+00**	3.2E-01
Cadmium	8.3E+00	mg/kg	5.0E-01	mg/kg-d	1.5E+00	2.0E+01	mg/kg-d	3.4E-01	2.5E-02
Chromium	1.0E+02	mg/kg	6.2E+00	mg/kg-d	1.0E+00	5.0E+00	mg/kg-d	**6.2E+00**	**1.2E+00**
Cobalt	2.2E+01	mg/kg	1.3E+00	mg/kg-d					
Copper	3.6E+02	mg/kg	2.1E+01	mg/kg-d	4.7E+01	6.2E+01	mg/kg-d	4.6E-01	3.5E-01
Lead	1.8E+03	mg/kg	1.1E+02	mg/kg-d	3.9E+00	3.9E+01	mg/kg-d	**2.9E+01**	**2.9E+00**
Manganese	8.6E+02	mg/kg	5.2E+01	mg/kg-d	9.8E+02	9.8E+03	mg/kg-d	5.3E-02	5.3E-03
Molybdenum	1.7E+01	mg/kg	1.0E+00	mg/kg-d	3.5E+00	3.5E+01	mg/kg-d	2.9E-01	2.9E-02
Selenium	2.2E+00	mg/kg	1.3E-01	mg/kg-d	4.4E-01	1.5E+00	mg/kg-d	3.0E-01	8.9E-02
Thallium	1.0E+00	mg/kg	6.2E-02	mg/kg-d	3.5E+00	5.0E+00	mg/kg-d	1.8E-02	1.2E-02
Vanadium	7.1E+01	mg/kg	4.3E+00	mg/kg-d	1.1E+01	1.1E+02	mg/kg-d	3.7E-01	3.7E-02
Zinc	1.9E+03	mg/kg	1.1E+02	mg/kg-d	1.5E+01	1.3E+02	mg/kg-d	**7.7E+00**	8.6E-01
4,4'-DDD	2.7E-02	mg/kg	1.6E-03	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	5.7E-01	5.7E-02
4,4'-DDE	4.2E-02	mg/kg	2.5E-03	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	9.1E-01	9.1E-02
4,4'-DDT	2.8E-03	mg/kg	1.7E-04	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	5.9E-02	5.9E-03
Dieldrin	6.3E-02	mg/kg	3.8E-03	mg/kg-d	7.7E-02	7.7E-01	mg/kg-d	4.9E-02	4.9E-03
Lindane	7.6E-04	mg/kg	4.6E-05	mg/kg-d	2.0E+00	2.0E+01	mg/kg-d	2.3E-05	2.3E-06
TOTAL AROCLOR	3.6E+00	mg/kg	2.2E-01	mg/kg-d	1.1E-01	2.8E-01	mg/kg-d	**1.9E+00**	7.8E-01
Aroclor 1254	3.6E+00	mg/kg	2.2E-01	mg/kg-d	1.8E-01	1.8E+00	mg/kg-d	**1.2E+00**	1.2E-01
Aroclor 1268	1.0E-01	mg/kg	6.2E-03	mg/kg-d	1.1E+00	1.1E+01	mg/kg-d	5.6E-03	5.6E-04
TEQ-BIRD	4.3E-03	mg/kg	2.6E-04	mg/kg-d	1.4E-05	1.4E-04	mg/kg-d	**1.8E+01**	**1.8E+00**
TEQ-MAMMAL	4.3E-03	mg/kg	2.6E-04	mg/kg-d					
							HAZARD INDICES:	7.2E+01	9.2E+00

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table C.1-1.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE C.1-3
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Soil Invertebrates / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Woodcock

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.082	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	100%	USEPA, 1993; Krohn, 1970.	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{soil} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Gregg, 1984	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.20	USEPA, 1993	

REFERENCES

Gregg, L., 1984. Population ecology of woodcock in Wisconsin; Wis. Dept. Nat. Resour. Tech. Bull. No. 144; 51 pp.

Krohn, W.B., 1970. Woodcock feeding habits as related to summer field usage in central Maine; J. Widl. Manage. 34:769-775.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE C.1-4
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Soil Invertebrates / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Woodcock

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	1.5E+00	mg/kg	5.9E-01	mg/kg-d					
Arsenic	4.3E-01	mg/kg	1.7E-01	mg/kg-d	5.1E+00	1.3E+01	mg/kg-d	3.3E-02	1.3E-02
Barium	3.6E+01	mg/kg	1.5E+01	mg/kg-d	4.2E+01	8.3E+01	mg/kg-d	3.5E-01	1.7E-01
Beryllium	3.4E-01	mg/kg	1.4E-01	mg/kg-d	1.5E-01	1.5E+00	mg/kg-d	9.2E-01	9.2E-02
Cadmium	9.9E+00	mg/kg	4.0E+00	mg/kg-d	1.5E+00	2.0E+01	mg/kg-d	**2.7E+00**	2.0E-01
Chromium	2.6E+00	mg/kg	1.0E+00	mg/kg-d	1.0E+00	5.0E+00	mg/kg-d	**1.0E+00**	2.1E-01
Cobalt	7.9E-01	mg/kg	3.2E-01	mg/kg-d					
Copper	1.1E+01	mg/kg	4.2E+00	mg/kg-d	4.7E+01	6.2E+01	mg/kg-d	9.0E-02	6.8E-02
Lead	8.0E+01	mg/kg	3.2E+01	mg/kg-d	3.9E+00	3.9E+01	mg/kg-d	**8.3E+00**	8.3E-01
Manganese	5.2E+01	mg/kg	2.1E+01	mg/kg-d	9.8E+02	9.8E+03	mg/kg-d	2.1E-02	2.1E-03
Molybdenum	4.2E-01	mg/kg	1.7E-01	mg/kg-d	3.5E+00	3.5E+01	mg/kg-d	4.8E-02	4.8E-03
Selenium	1.2E+00	mg/kg	4.6E-01	mg/kg-d	4.4E-01	1.5E+00	mg/kg-d	**1.0E+00**	3.1E-01
Thallium	5.5E-02	mg/kg	2.2E-02	mg/kg-d	3.5E+00	5.0E+00	mg/kg-d	6.2E-03	4.4E-03
Vanadium	1.7E+00	mg/kg	6.8E-01	mg/kg-d	1.1E+01	1.1E+02	mg/kg-d	6.0E-02	6.0E-03
Zinc	3.5E+02	mg/kg	1.4E+02	mg/kg-d	1.5E+01	1.3E+02	mg/kg-d	**9.5E+00**	**1.1E+00**
4,4'-DDD	3.7E-03	mg/kg	1.5E-03	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	5.3E-01	5.3E-02
4,4'-DDE	6.9E-03	mg/kg	2.8E-03	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	9.9E-01	9.9E-02
4,4'-DDT	1.7E-04	mg/kg	6.9E-05	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	2.5E-02	2.5E-03
Dieldrin	1.1E-02	mg/kg	4.4E-03	mg/kg-d	7.7E-02	7.7E-01	mg/kg-d	5.7E-02	5.7E-03
Lindane	3.0E-04	mg/kg	1.2E-04	mg/kg-d	2.0E+00	2.0E+01	mg/kg-d	6.1E-05	6.1E-06
TOTAL AROCLOR	3.9E-01	mg/kg	1.6E-01	mg/kg-d	1.1E-01	2.8E-01	mg/kg-d	**1.4E+00**	5.7E-01
Aroclor 1254	3.8E-01	mg/kg	1.5E-01	mg/kg-d	1.8E-01	1.8E+00	mg/kg-d	8.4E-01	8.4E-02
Aroclor 1268	1.3E-02	mg/kg	5.3E-03	mg/kg-d	1.1E+00	1.1E+01	mg/kg-d	4.8E-03	4.8E-04
TEQ-BIRD	4.4E-04	mg/kg	1.7E-04	mg/kg-d	1.4E-05	1.4E-04	mg/kg-d	**1.2E+01**	**1.2E+00**
TEQ-MAMMAL	4.5E-04	mg/kg	1.8E-04	mg/kg-d					
							HAZARD INDICES:	**4.1E+01**	**5.0E+00**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table C.1-3.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE C.1-5
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED RTVs : Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Woodcock
TOTAL RISK (HI): 1.1E+02

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
Lead		2.9E+01	-	8.3E+00	-	-	***3.7E+01***	***33%***
TEQ-BIRD		1.8E+01	-	1.2E+01	-	-	***3.1E+01***	***28%***
Zinc		7.7E+00	-	9.5E+00	-	-	***1.7E+01***	***15%***
Chromium		6.2E+00	-	1.0E+00	-	-	***7.3E+00***	6%
Beryllium		3.2E+00	-	9.2E-01	-	-	***4.1E+00***	4%
TOTAL AROCLOR		1.9E+00	-	1.4E+00	-	-	***3.4E+00***	3%
Cadmium		3.4E-01	-	2.7E+00	-	-	***3.1E+00***	3%
Aroclor 1254		1.2E+00	-	8.4E-01	-	-	***2.0E+00***	2%
4,4'-DDE		9.1E-01	-	9.9E-01	-	-	***1.9E+00***	2%
Selenium		3.0E-01	-	1.0E+00	-	-	***1.3E+00***	1%
4,4'-DDD		5.7E-01	-	5.3E-01	-	-	***1.1E+00***	1%
Barium		7.4E-01	-	3.5E-01	-	-	***1.1E+00***	1%
Copper		4.6E-01	-	9.0E-02	-	-	5.5E-01	0%
Vanadium		3.7E-01	-	6.0E-02	-	-	4.3E-01	0%
Molybdenum		2.9E-01	-	4.8E-02	-	-	3.4E-01	0%
Arsenic		1.5E-01	-	3.3E-02	-	-	1.8E-01	0%
Dieldrin		4.9E-02	-	5.7E-02	-	-	1.1E-01	0%
4,4'-DDT		5.9E-02	-	2.5E-02	-	-	8.4E-02	0%
Manganese		5.3E-02	-	2.1E-02	-	-	7.4E-02	0%
Thallium		1.8E-02	-	6.2E-03	-	-	2.4E-02	0%
Aroclor 1268		5.6E-03	-	4.8E-03	-	-	1.0E-02	0%
Lindane		2.3E-05	-	6.1E-05	-	-	8.3E-05	0%
Antimony								
Cobalt								
TEQ-MAMMAL								
TOTAL MEDIUM-SPECIFIC RISK	**-**	**7.2E+01**	**-**	**4.1E+01**	**-**	**-**	**1.1E+02**	
PERCENTAGE OF TOTAL RISK		**64%**		**36%**			**100%**	

Footnotes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE C.1-6
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED RTVs : Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Woodcock
TOTAL RISK (HI): 1.4E+01

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
Lead		2.9E+00	-	8.3E-01	-	-	***3.7E+00***	***26%***
TEQ-BIRD		1.8E+00	-	1.2E+00	-	-	***3.1E+00***	***22%***
Zinc		8.6E-01	-	1.1E+00	-	-	***1.9E+00***	***13%***
Chromium		1.2E+00	-	2.1E-01	-	-	***1.5E+00***	***10%***
TOTAL AROCLOR		7.8E-01	-	5.7E-01	-	-	***1.3E+00***	9%
Barium		3.7E-01	-	1.7E-01	-	-	5.4E-01	4%
Copper		3.5E-01	-	6.8E-02	-	-	4.2E-01	3%
Beryllium		3.2E-01	-	9.2E-02	-	-	4.1E-01	3%
Selenium		8.9E-02	-	3.1E-01	-	-	4.0E-01	3%
Cadmium		2.5E-02	-	2.0E-01	-	-	2.2E-01	2%
Aroclor 1254		1.2E-01	-	8.4E-02	-	-	2.0E-01	1%
4,4'-DDE		9.1E-02	-	9.9E-02	-	-	1.9E-01	1%
4,4'-DDD		5.7E-02	-	5.3E-02	-	-	1.1E-01	1%
Arsenic		6.0E-02	-	1.3E-02	-	-	7.3E-02	1%
Vanadium		3.7E-02	-	6.0E-03	-	-	4.3E-02	0%
Molybdenum		2.9E-02	-	4.8E-03	-	-	3.4E-02	0%
Thallium		1.2E-02	-	4.4E-03	-	-	1.7E-02	0%
Dieldrin		4.9E-03	-	5.7E-03	-	-	1.1E-02	0%
4,4'-DDT		5.9E-03	-	2.5E-03	-	-	8.4E-03	0%
Manganese		5.3E-03	-	2.1E-03	-	-	7.4E-03	0%
Aroclor 1268		5.6E-04	-	4.8E-04	-	-	1.0E-03	0%
Lindane		2.3E-06	-	6.1E-06	-	-	8.3E-06	0%
Antimony								
Cobalt								
TEQ-MAMMAL								
TOTAL MEDIUM-SPECIFIC RISK	**-**	**9.2E+00**	**-**	**5.0E+00**	**-**	**-**	**1.4E+01**	
PERCENTAGE OF TOTAL RISK		**65%**		**35%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE C.2-1
ESTIMATED TERRESTRIAL PREY TISSUE CONCENTRATIONS DERIVED USING LITERATURE-BASED BAFs

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: All
EXPOSURE POINT: Oxbow Area Floodplain - Maximum

Analyte	Medium EPC Value	Literature-based BAFs[a]		Estimated Tissue Concentration	
		Terrestial Plants	Terrestrial Inverts	Terrestial Plants[b]	Terrestrial Inverts[b]
Antimony	7.0E+00	2.0E-03	-	**1.4E-02**	0.0E+00
Arsenic	1.3E+01	1.0E-02	2.5E-02	**1.3E-01**	3.1E-01
Barium	5.1E+02	3.1E-02	1.8E-02	**1.6E+01**	9.4E+00
Beryllium	7.9E+00	2.0E-03	9.0E-03	**1.6E-02**	7.1E-02
Cadmium	8.3E+00	4.4E-02	1.0E+00	**3.6E-01**	8.5E+00
Chromium	1.0E+02	8.2E-03	6.1E-02	**8.5E-01**	6.4E+00
Cobalt	2.2E+01	1.5E-03	2.4E-02	**3.3E-02**	5.4E-01
Copper	3.6E+02	9.7E-02	2.0E-01	**3.5E+01**	7.0E+01
Lead	1.8E+03	1.9E-02	1.0E-01	**3.5E+01**	1.9E+02
Manganese	8.6E+02	1.6E-02	4.3E-02	**1.4E+01**	3.7E+01
Molybdenum	1.7E+01	5.0E-02	1.9E-01	**8.7E-01**	3.3E+00
Selenium	2.2E+00	1.3E-01	1.0E-01	**2.9E-01**	2.2E-01
Thallium	1.0E+00	8.0E-04	-	**8.3E-04**	0.0E+00
Vanadium	7.1E+01	9.7E-04	8.4E-03	**6.9E-02**	6.0E-01
Zinc	1.9E+03	3.5E-01	3.6E+00	**6.5E+02**	6.8E+03
4,4'-DDD	2.7E-02	2.4E-03	1.1E+00	**6.5E-05**	2.9E-02
4,4'-DDE	4.2E-02	9.6E-04	1.1E+00	**4.1E-05**	4.6E-02
4,4'-DDT	2.8E-03	1.4E-03	1.1E+00	**4.0E-06**	3.0E-03
Dieldrin	6.3E-02	6.7E-03	1.1E+00	**4.2E-04**	6.7E-02
Lindane	7.6E-04	5.9E-02	1.0E+00	**4.5E-05**	7.8E-04
TOTAL AROCLOR	3.6E+00	6.1E-04	1.1E+00	**2.2E-03**	4.0E+00
Aroclor 1254	3.6E+00	1.4E-03	1.1E+00	**4.9E-03**	3.9E+00
Aroclor 1268	1.0E-01	3.4E-04	1.1E+00	**3.5E-05**	1.2E-01
TEQ-BIRD	4.3E-03			**0.0E+00**	0.0E+00
TEQ-MAMMAL	4.3E-03			**0.0E+00**	0.0E+00

Footnotes:

a. Literature-derived BAFs are summarized in Table J-1 in the BERA (MACTEC, 2004).

b. Estimated plant and invertebrate concentrations calculated by multiplying the soil EPC concentration (mg/kg[dw] by the tissue-specific BAF (mg/kg[ww]). Estimated tissue concentrations reported in units of mg/kg [wet weight tissue].

c. Estimated small bird prey concentrations calculated by multiplying the estimated tissue concentration of soil invertebrates by the small bird BAF (I.e., assumes vermivorous species).

d. Estimated small mammal prey concentrations calculated assuming that plants and invertebrates each comprise 50% of the prey species diet (i.e., omnivore); the sum of 50% times the estimated tissue concentrations of plants and invertebrates was multiplied by the small mammal BAF.

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TABLE C.2-2
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surface Soil (0-2 feet) / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Short-tailed Shrew

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		SOIL INTAKE-INGESTION
	C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
	IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.00064	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Buckner, 1966	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.017	Guilday, 1957	

REFERENCES

Buckner, C.H., 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba; J. Mammal. 47:181-194.

Guilday, J.E., 1957, Individual an dgeographic variation in Blarina brevicauda from Pennsylvania; Ann. Carnegie Mus. 35:41-68.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE C.2-3
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surface Soil (0-2 feet) / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Short-tailed Shrew

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	7.0E+00	mg/kg	2.6E-01	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	**9.9E+00**	9.9E-01
Arsenic	1.3E+01	mg/kg	4.7E-01	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	**3.7E+00**	3.7E-01
Barium	5.1E+02	mg/kg	1.9E+01	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	2.5E-01	1.2E-01
Beryllium	7.9E+00	mg/kg	2.9E-01	mg/kg-d	6.6E-01	6.6E+00	mg/kg-d	4.4E-01	4.4E-02
Cadmium	8.3E+00	mg/kg	3.0E-01	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	3.0E-01	3.0E-02
Chromium	1.0E+02	mg/kg	3.8E+00	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	2.6E-03	2.6E-04
Cobalt	2.2E+01	mg/kg	8.1E-01	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	**1.1E+01**	**1.1E+00**
Copper	3.6E+02	mg/kg	1.3E+01	mg/kg-d	4.2E-01	4.2E+00	mg/kg-d	**3.1E+01**	**3.1E+00**
Lead	1.8E+03	mg/kg	6.8E+01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	5.4E-01	1.8E-01
Manganese	8.6E+02	mg/kg	3.2E+01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	3.6E-01	1.1E-01
Molybdenum	1.7E+01	mg/kg	6.4E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	**3.4E+00**	3.4E-01
Selenium	2.2E+00	mg/kg	8.2E-02	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	4.1E-01	2.5E-01
Thallium	1.0E+00	mg/kg	3.8E-02	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	2.7E-01	2.7E-02
Vanadium	7.1E+01	mg/kg	2.6E+00	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	**6.2E+00**	**1.2E+00**
Zinc	1.9E+03	mg/kg	6.9E+01	mg/kg-d	1.6E+02	3.2E+02	mg/kg-d	4.3E-01	2.2E-01
4,4'-DDD	2.7E-02	mg/kg	9.8E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.2E-03	2.5E-04
4,4'-DDE	4.2E-02	mg/kg	1.6E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.0E-03	3.9E-04
4,4'-DDT	2.8E-03	mg/kg	1.0E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.3E-04	2.5E-05
Dieldrin	6.3E-02	mg/kg	2.3E-03	mg/kg-d	2.8E-02	2.8E-01	mg/kg-d	8.5E-02	8.5E-03
Lindane	7.6E-04	mg/kg	2.8E-05	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	1.8E-05	8.8E-06
TOTAL AROCLOR	3.6E+00	mg/kg	1.3E-01	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	**1.9E+00**	1.9E-01
Aroclor 1254	3.6E+00	mg/kg	1.3E-01	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	**1.9E+00**	1.9E-01
Aroclor 1268	1.0E-01	mg/kg	3.8E-03	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	5.6E-02	5.6E-03
TEQ-BIRD	4.3E-03	mg/kg	1.6E-04	mg/kg-d					
TEQ-MAMMAL	4.3E-03	mg/kg	1.6E-04	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	**1.6E+02**	**1.6E+01**
							HAZARD INDICES:	**2.3E+02**	**2.4E+01**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table C.2-2.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE C.2-4
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Terrestrial Plants / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: *Oxbow Area Floodplain - Maximum*
RECEPTOR: Short-tailed Shrew

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{plant}	ESTIMATED DAILY INTAKE VIA PLANT INGESTION	*mg/kg-d*	*calculated*		PLANT INTAKE-INGESTION
	C_{plant}	CHEMICAL CONCENTRATION IN PLANTS	mg/kg	chemical-specific		$EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.013	USEPA, 1993	
	P_{plant}	PERCENT PLANTS IN DIET	unitless	14%	Whitaker and	Where C_{plant} is estimated using site-specific
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Buckner, 1966	$C_{plant} = C_{soil} * BAF_{plant}$
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.017	Guilday, 1957	

REFERENCES

Buckner, C.H., 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba; J. Mammal. 47:181-194.

Guilday, J.E., 1957, Individual an dgeographic variation in Blarina brevicauda from Pennsylvania; Ann. Carnegie Mus. 35:41-68.

EPA/600/R-93/187a; December 1993; Washington, D.C.

Whitaker, J.O., Jr., and M.G. Ferraro, 1963. Summer food of 220 short-tailed shrews from Ithica, New York; J. Mammal. 44:419.

TABLE C.2-5
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Terrestrial Plants / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Short-tailed Shrew

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	1.4E-02	mg/kg	1.5E-03	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	5.7E-02	5.7E-03
Arsenic	1.3E-01	mg/kg	1.3E-02	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	1.1E-01	1.1E-02
Barium	1.6E+01	mg/kg	1.7E+00	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	2.2E-02	1.1E-02
Beryllium	1.6E-02	mg/kg	1.7E-03	mg/kg-d	6.6E-01	6.6E+00	mg/kg-d	2.5E-03	2.5E-04
Cadmium	3.6E-01	mg/kg	3.8E-02	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	3.8E-02	3.8E-03
Chromium	8.5E-01	mg/kg	9.0E-02	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	6.1E-05	6.1E-06
Cobalt	3.3E-02	mg/kg	3.4E-03	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	4.5E-02	4.5E-03
Copper	3.5E+01	mg/kg	3.6E+00	mg/kg-d	4.2E-01	4.2E+00	mg/kg-d	**8.6E+00**	8.6E-01
Lead	3.5E+01	mg/kg	3.7E+00	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	3.0E-02	9.9E-03
Manganese	1.4E+01	mg/kg	1.4E+00	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	1.6E-02	5.0E-03
Molybdenum	8.7E-01	mg/kg	9.1E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	4.8E-01	4.8E-02
Selenium	2.9E-01	mg/kg	3.0E-02	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	1.5E-01	9.1E-02
Thallium	8.3E-04	mg/kg	8.7E-05	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	6.2E-04	6.2E-05
Vanadium	6.9E-02	mg/kg	7.2E-03	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	1.7E-02	3.5E-03
Zinc	6.5E+02	mg/kg	6.8E+01	mg/kg-d	1.6E+02	3.2E+02	mg/kg-d	4.3E-01	2.1E-01
4,4'-DDD	6.5E-05	mg/kg	6.8E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	8.5E-06	1.7E-06
4,4'-DDE	4.1E-05	mg/kg	4.3E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.3E-06	1.1E-06
4,4'-DDT	4.0E-06	mg/kg	4.2E-07	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.3E-07	1.1E-07
Dieldrin	4.2E-04	mg/kg	4.5E-05	mg/kg-d	2.8E-02	2.8E-01	mg/kg-d	1.6E-03	1.6E-04
Lindane	4.5E-05	mg/kg	4.7E-06	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	2.9E-06	1.5E-06
TOTAL AROCLOR	2.2E-03	mg/kg	2.3E-04	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	3.4E-03	3.4E-04
Aroclor 1254	4.9E-03	mg/kg	5.1E-04	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	7.5E-03	7.5E-04
Aroclor 1268	3.5E-05	mg/kg	3.6E-06	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	5.3E-05	5.3E-06
TEQ-BIRD	0.0E+00	mg/kg	0.0E+00	mg/kg-d					
TEQ-MAMMAL	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	**1.0E+01**	**1.3E+00**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table C.2-4.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

US EPA ARCHIVE DOCUMENT

TABLE C.2-6
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Soil Invertebrates / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Short-tailed Shrew

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.013	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	85%	USEPA, 1993; Whitaker and Feraro, 1963	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{soil} * BAF_{invert}$
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Buckner, 1966	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.017	Guilday, 1957	

REFERENCES

Buckner, C.H., 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba; J. Mammal. 47:181-194.

Guilday, J.E., 1957, Individual an dgeographic variation in Blarina brevicauda from Pennsylvania; Ann. Carnegie Mus. 35:41-68.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

Whitaker, J.O., Jr., and M.G. Ferraro, 1963. Summer food of 220 short-tailed shrews from Ithica, New York; J. Mammal. 44:419.

TABLE C.2-7
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Soil Invertebrates / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Short-tailed Shrew

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	1.5E+00	mg/kg	9.3E-01	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	**3.5E+01**	**3.5E+00**
Arsenic	4.3E-01	mg/kg	2.7E-01	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	**2.1E+00**	2.1E-01
Barium	3.6E+01	mg/kg	2.3E+01	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	3.1E-01	1.4E-01
Beryllium	3.4E-01	mg/kg	2.2E-01	mg/kg-d	6.6E-01	6.6E+00	mg/kg-d	3.3E-01	3.3E-02
Cadmium	9.9E+00	mg/kg	6.3E+00	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	**6.3E+00**	6.3E-01
Chromium	2.6E+00	mg/kg	1.6E+00	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	1.1E-03	1.1E-04
Cobalt	7.9E-01	mg/kg	5.0E-01	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	**6.6E+00**	6.6E-01
Copper	1.1E+01	mg/kg	6.6E+00	mg/kg-d	4.2E-01	4.2E+00	mg/kg-d	**1.6E+01**	**1.6E+00**
Lead	8.0E+01	mg/kg	5.0E+01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	4.0E-01	1.3E-01
Manganese	5.2E+01	mg/kg	3.3E+01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	3.7E-01	1.1E-01
Molybdenum	4.2E-01	mg/kg	2.7E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	**1.4E+00**	1.4E-01
Selenium	1.2E+00	mg/kg	7.3E-01	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	**3.6E+00**	**2.2E+00**
Thallium	5.5E-02	mg/kg	3.4E-02	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	2.5E-01	2.5E-02
Vanadium	1.7E+00	mg/kg	1.1E+00	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	**2.6E+00**	5.1E-01
Zinc	3.5E+02	mg/kg	2.2E+02	mg/kg-d	1.6E+02	3.2E+02	mg/kg-d	**1.4E+00**	6.8E-01
4,4'-DDD	3.7E-03	mg/kg	2.3E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.9E-03	5.8E-04
4,4'-DDE	6.9E-03	mg/kg	4.4E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.5E-03	1.1E-03
4,4'-DDT	1.7E-04	mg/kg	1.1E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.4E-04	2.7E-05
Dieldrin	1.1E-02	mg/kg	7.0E-03	mg/kg-d	2.8E-02	2.8E-01	mg/kg-d	2.5E-01	2.5E-02
Lindane	3.0E-04	mg/kg	1.9E-04	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	1.2E-04	6.0E-05
TOTAL AROCLOR	3.9E-01	mg/kg	2.5E-01	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	**3.6E+00**	3.6E-01
Aroclor 1254	3.8E-01	mg/kg	2.4E-01	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	**3.5E+00**	3.5E-01
Aroclor 1268	1.3E-02	mg/kg	8.3E-03	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	1.2E-01	1.2E-02
TEQ-BIRD	4.4E-04	mg/kg	2.8E-04	mg/kg-d					
TEQ-MAMMAL	4.5E-04	mg/kg	2.9E-04	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	**2.9E+02**	**2.9E+01**
							HAZARD INDICES:	**3.7E+02**	**4.0E+01**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table C.2-6.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE D.2-8
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED RTVs : Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Short-tailed Shrew
TOTAL RISK (HI): 2.6E+02

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-MAMMAL		6.7E+01	-	1.2E+02			***1.9E+02***	***71%***
Antimony		4.3E+00	2.5E-02	1.5E+01			***2.0E+01***	7%
Copper		1.1E+01	2.9E+00	5.4E+00			***1.9E+01***	7%
Cobalt		7.8E+00	3.3E-02	4.8E+00			***1.3E+01***	5%
Vanadium		5.2E+00	1.4E-02	2.1E+00			***7.4E+00***	3%
Cadmium		1.5E-01	1.8E-02	3.0E+00			***3.2E+00***	1%
Selenium		2.6E-01	9.7E-02	2.3E+00			***2.7E+00***	1%
Molybdenum		1.6E+00	2.3E-01	6.8E-01			***2.5E+00***	1%
Arsenic		1.6E+00	4.5E-02	9.0E-01			***2.5E+00***	1%
TOTAL AROCLOR		7.8E-01	1.4E-03	1.5E+00			***2.2E+00***	1%
Aroclor 1254		7.6E-01	3.0E-03	1.4E+00			***2.2E+00***	1%
Zinc		1.5E-01	1.5E-01	4.7E-01			7.7E-01	0%
Manganese		3.5E-01	1.6E-02	3.6E-01			7.2E-01	0%
Beryllium		2.7E-01	1.6E-03	2.0E-01			4.8E-01	0%
Thallium		1.9E-01	4.3E-04	1.7E-01			3.6E-01	0%
Barium		1.5E-01	1.3E-02	1.8E-01			3.4E-01	0%
Lead		1.7E-01	9.2E-03	1.2E-01			3.0E-01	0%
Dieldrin		3.1E-02	5.9E-04	9.2E-02			1.2E-01	0%
Aroclor 1268		2.2E-02	2.1E-05	4.8E-02			7.0E-02	0%
4,4'-DDE		8.4E-04	2.3E-06	2.3E-03			3.2E-03	0%
Chromium		1.8E-03	4.3E-05	7.9E-04			2.7E-03	0%
4,4'-DDD		6.1E-04	4.3E-06	1.5E-03			2.1E-03	0%
4,4'-DDT		5.8E-05	2.4E-07	6.3E-05			1.2E-04	0%
Lindane		7.1E-06	1.2E-06	4.8E-05			5.7E-05	0%
TEQ-BIRD								
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.0E+02**	**3.6E+00**	**1.6E+02**	**-**	**-**	**2.6E+02**	
PERCENTAGE OF TOTAL RISK		**38%**	**1%**	**60%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE C.2-9
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED RTVs : Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Short-tailed Shrew
TOTAL RISK (HI): 6.6E+01

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-MAMMAL		1.6E+01	-	2.9E+01			***4.4E+01***	***68%***
Copper		3.1E+00	8.6E-01	1.6E+00			***5.6E+00***	9%
Antimony		9.9E-01	5.7E-03	3.5E+00			***4.5E+00***	7%
Selenium		2.5E-01	9.1E-02	2.2E+00			***2.5E+00***	4%
Vanadium		1.2E+00	3.5E-03	5.1E-01			***1.8E+00***	3%
Cobalt		1.1E+00	4.5E-03	6.6E-01			***1.7E+00***	3%
Zinc		2.2E-01	2.1E-01	6.8E-01			***1.1E+00***	2%
Cadmium		3.0E-02	3.8E-03	6.3E-01			6.6E-01	1%
Arsenic		3.7E-01	1.1E-02	2.1E-01			6.0E-01	1%
TOTAL AROCLOR		1.9E-01	3.4E-04	3.6E-01			5.6E-01	1%
Aroclor 1254		1.9E-01	7.5E-04	3.5E-01			5.5E-01	1%
Molybdenum		3.4E-01	4.8E-02	1.4E-01			5.2E-01	1%
Lead		1.8E-01	9.9E-03	1.3E-01			3.2E-01	0%
Barium		1.2E-01	1.1E-02	1.4E-01			2.7E-01	0%
Manganese		1.1E-01	5.0E-03	1.1E-01			2.3E-01	0%
Beryllium		4.4E-02	2.5E-04	3.3E-02			7.7E-02	0%
Thallium		2.7E-02	6.2E-05	2.5E-02			5.2E-02	0%
Dieldrin		8.5E-03	1.6E-04	2.5E-02			3.4E-02	0%
Aroclor 1268		5.6E-03	5.3E-06	1.2E-02			1.8E-02	0%
4,4'-DDE		3.9E-04	1.1E-06	1.1E-03			1.5E-03	0%
4,4'-DDD		2.5E-04	1.7E-06	5.8E-04			8.3E-04	0%
Chromium		2.6E-04	6.1E-06	1.1E-04			3.8E-04	0%
Lindane		8.8E-06	1.5E-06	6.0E-05			7.0E-05	0%
4,4'-DDT		2.5E-05	1.1E-07	2.7E-05			5.3E-05	0%
TEQ-BIRD								
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.4E+01**	**1.3E+00**	**4.0E+01**	**-**	**-**	**6.6E+01**	
PERCENTAGE OF TOTAL RISK		**37%**	**2%**	**61%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE C.3-1
ESTIMATED TERRESTRIAL PREY TISSUE CONCENTRATIONS DERIVED USING LITERATURE-BASED BAFs

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: All
EXPOSURE POINT: Oxbow Area Floodplain - Maximum

Analyte	Medium EPC Value	Literature-based BAFs[a]		Estimated Tissue Concentration	
		Terrestial Plants	Terrestrial Inverts	Terrestial Plants[b]	Terrestrial Inverts[b]
Antimony	7.0E+00	2.0E-03	-	**1.4E-02**	0.0E+00
Arsenic	1.3E+01	1.0E-02	2.5E-02	**1.3E-01**	3.1E-01
Barium	5.1E+02	3.1E-02	1.8E-02	**1.6E+01**	9.4E+00
Beryllium	7.9E+00	2.0E-03	9.0E-03	**1.6E-02**	7.1E-02
Cadmium	8.3E+00	4.4E-02	1.0E+00	**3.6E-01**	8.5E+00
Chromium	1.0E+02	8.2E-03	6.1E-02	**8.5E-01**	6.4E+00
Cobalt	2.2E+01	1.5E-03	2.4E-02	**3.3E-02**	5.4E-01
Copper	3.6E+02	9.7E-02	2.0E-01	**3.5E+01**	7.0E+01
Lead	1.8E+03	1.9E-02	1.0E-01	**3.5E+01**	1.9E+02
Manganese	8.6E+02	1.6E-02	4.3E-02	**1.4E+01**	3.7E+01
Molybdenum	1.7E+01	5.0E-02	1.9E-01	**8.7E-01**	3.3E+00
Selenium	2.2E+00	1.3E-01	1.0E-01	**2.9E-01**	2.2E-01
Thallium	1.0E+00	8.0E-04	-	**8.3E-04**	0.0E+00
Vanadium	7.1E+01	9.7E-04	8.4E-03	**6.9E-02**	6.0E-01
Zinc	1.9E+03	3.5E-01	3.6E+00	**6.5E+02**	6.8E+03
4,4'-DDD	2.7E-02	2.4E-03	1.1E+00	**6.5E-05**	2.9E-02
4,4'-DDE	4.2E-02	9.6E-04	1.1E+00	**4.1E-05**	4.6E-02
4,4'-DDT	2.8E-03	1.4E-03	1.1E+00	**4.0E-06**	3.0E-03
Dieldrin	6.3E-02	6.7E-03	1.1E+00	**4.2E-04**	6.7E-02
Lindane	7.6E-04	5.9E-02	1.0E+00	**4.5E-05**	7.8E-04
TOTAL AROCLOR	3.6E+00	6.1E-04	1.1E+00	**2.2E-03**	4.0E+00
Aroclor 1254	3.6E+00	1.4E-03	1.1E+00	**4.9E-03**	3.9E+00
Aroclor 1268	1.0E-01	3.4E-04	1.1E+00	**3.5E-05**	1.2E-01
TEQ-BIRD	4.3E-03			**0.0E+00**	0.0E+00
TEQ-MAMMAL	4.3E-03			**0.0E+00**	0.0E+00

Footnotes:

a. Literature-derived BAFs are summarized in Table J-1 in the BERA (MACTEC, 2004).

b. Estimated plant and invertebrate concentrations calculated by multiplying the soil EPC concentration (mg/kg[dw] by the tissue-specific BAF (mg/kg[ww]). Estimated tissue concentrations reported in units of mg/kg [wet weight tissue].

c. Estimated small bird prey concentrations calculated by multiplying the estimated tissue concentration of soil invertebrates by the small bird BAF (I.e., assumes vermivorous species).

d. Estimated small mammal prey concentrations calculated assuming that plants and invertebrates each comprise 50% of the prey species diet (i.e., omnivore); the sum of 50% times the estimated tissue concentrations of plants and invertebrates was multiplied by the small mammal BAF.

US EPA ARCHIVE DOCUMENT

TABLE C.3-2
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surface Soil (0-2 feet) / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Raccoon

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		SOIL INTAKE-INGESTION
	C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
	IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.087	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Stuewer, 1943	
	EF	EXPOSURE FREQUENCY	unitless	50%	USEPA, 1993	
	BW	BODY WEIGHT	kg	6.2	Sanderson, 1984	

REFERENCES

Sanderson, G.C., 1984. Cooperative raccoon collections; Ill. Nat. Hist. Survey Div.; Pittman-Robertson Proj. W-49-31.

Stuewer, R.W., 1943. Raccoons: their habits and management in Michigan; Ecol. Monogr. 13:203-257.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

US EPA ARCHIVE DOCUMENT

TABLE C.3-3
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surface Soil (0-2 feet) / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Raccoon

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	7.0E+00	mg/kg	4.9E-02	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	**1.9E+00**	1.9E-01
Arsenic	1.3E+01	mg/kg	9.0E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	**1.9E+00**	1.9E-01
Barium	5.1E+02	mg/kg	3.6E+00	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	4.8E-02	2.3E-02
Beryllium	7.9E+00	mg/kg	5.6E-02	mg/kg-d	1.2E+00	1.2E+01	mg/kg-d	4.6E-02	4.6E-03
Cadmium	8.3E+00	mg/kg	5.8E-02	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	5.8E-02	5.8E-03
Chromium	1.0E+02	mg/kg	7.3E-01	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	5.0E-04	5.0E-05
Cobalt	2.2E+01	mg/kg	1.6E-01	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	**2.0E+00**	2.0E-01
Copper	3.6E+02	mg/kg	2.5E+00	mg/kg-d	1.2E+01	1.5E+01	mg/kg-d	2.2E-01	1.7E-01
Lead	1.8E+03	mg/kg	1.3E+01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	1.0E-01	3.4E-02
Manganese	8.6E+02	mg/kg	6.1E+00	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	6.9E-02	2.1E-02
Molybdenum	1.7E+01	mg/kg	1.2E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	6.4E-01	6.4E-02
Selenium	2.2E+00	mg/kg	1.6E-02	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	7.8E-02	4.7E-02
Thallium	1.0E+00	mg/kg	7.3E-03	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	5.2E-02	5.2E-03
Vanadium	7.1E+01	mg/kg	5.0E-01	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	**1.2E+00**	2.4E-01
Zinc	1.9E+03	mg/kg	1.3E+01	mg/kg-d	2.0E+02	3.9E+02	mg/kg-d	6.8E-02	3.4E-02
4,4'-DDD	2.7E-02	mg/kg	1.9E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.3E-04	4.7E-05
4,4'-DDE	4.2E-02	mg/kg	3.0E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	3.7E-04	7.5E-05
4,4'-DDT	2.8E-03	mg/kg	1.9E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.4E-05	4.9E-06
Dieldrin	6.3E-02	mg/kg	4.5E-04	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	3.0E-02	3.0E-03
Lindane	7.6E-04	mg/kg	5.4E-06	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	3.4E-06	1.7E-06
TOTAL AROCLOR	3.6E+00	mg/kg	2.5E-02	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	**5.1E+00**	**1.3E+00**
Aroclor 1254	3.6E+00	mg/kg	2.5E-02	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	**5.1E+00**	**1.3E+00**
Aroclor 1268	1.0E-01	mg/kg	7.3E-04	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.5E-01	3.6E-02
TEQ-BIRD	4.3E-03	mg/kg	3.0E-05	mg/kg-d					
TEQ-MAMMAL	4.3E-03	mg/kg	3.0E-05	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	**3.0E+01**	**3.0E+00**
							HAZARD INDICES:	**4.9E+01**	**6.8E+00**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table C.3-2.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE C.3-4
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Terrestrial Plants / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Raccoon

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{plant}	ESTIMATED DAILY INTAKE VIA PLANT INGESTION	mg/kg-d	calculated		PLANT INTAKE-INGESTION $EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF * 1/BW$
	C_{plant}	CHEMICAL CONCENTRATION IN PLANTS	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	1.7	USEPA, 1993	
	P_{plant}	PERCENT PLANTS IN DIET	unitless	71%	USEPA, 1993; Llewllyn and Uhler, 1952	Where C_{plant} is estimated using site-specific tissue data or calculated using the following equation: $C_{plant} = C_{soil} * BAF_{plant}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Stuewer, 1943	
	EF	EXPOSURE FREQUENCY	unitless	50%	USEPA, 1993	
	BW	BODY WEIGHT	kg	6.2	Sanderson, 1984	

REFERENCES

Llewellyn, L.M., and F.M. Uhler, 1952. The foods of fur animals of the Patuxent Research Refuge, Maryland; Am. Midl. Nat. 48:193-203.

Sanderson, G.C., 1984. Cooperative raccoon collections; Ill. Nat. Hist. Survey Div.; Pittman-Robertson Proj. W-49-31.

Stuewer, R.W., 1943. Raccoons: their habits and management in Michigan; Ecol. Monogr. 13:203-257.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE C.3-5
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Terrestrial Plants / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Raccoon

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	1.4E-02	mg/kg	1.4E-03	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	5.5E-02	5.5E-03
Arsenic	1.3E-01	mg/kg	1.3E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	2.7E-01	2.7E-02
Barium	1.6E+01	mg/kg	1.6E+00	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	2.2E-02	1.0E-02
Beryllium	1.6E-02	mg/kg	1.6E-03	mg/kg-d	1.2E+00	1.2E+01	mg/kg-d	1.3E-03	1.3E-04
Cadmium	3.6E-01	mg/kg	3.6E-02	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	3.6E-02	3.6E-03
Chromium	8.5E-01	mg/kg	8.6E-02	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	5.9E-05	5.9E-06
Cobalt	3.3E-02	mg/kg	3.3E-03	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	4.4E-02	4.4E-03
Copper	3.5E+01	mg/kg	3.5E+00	mg/kg-d	1.2E+01	1.5E+01	mg/kg-d	3.0E-01	2.3E-01
Lead	3.5E+01	mg/kg	3.6E+00	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	2.8E-02	9.5E-03
Manganese	1.4E+01	mg/kg	1.4E+00	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	1.6E-02	4.8E-03
Molybdenum	8.7E-01	mg/kg	8.7E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	4.6E-01	4.6E-02
Selenium	2.9E-01	mg/kg	2.9E-02	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	1.4E-01	8.7E-02
Thallium	8.3E-04	mg/kg	8.4E-05	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	6.0E-04	6.0E-05
Vanadium	6.9E-02	mg/kg	7.0E-03	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	1.7E-02	3.3E-03
Zinc	6.5E+02	mg/kg	6.5E+01	mg/kg-d	2.0E+02	3.9E+02	mg/kg-d	3.3E-01	1.7E-01
4,4'-DDD	6.5E-05	mg/kg	6.5E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	8.2E-06	1.6E-0
4,4'-DDE	4.1E-05	mg/kg	4.1E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.1E-06	1.0E-06
4,4'-DDT	4.0E-06	mg/kg	4.0E-07	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.0E-07	1.0E-07
Dieldrin	4.2E-04	mg/kg	4.3E-05	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	2.9E-03	2.9E-04
Lindane	4.5E-05	mg/kg	4.5E-06	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	2.8E-06	1.4E-06
TOTAL AROCLOR	2.2E-03	mg/kg	2.2E-04	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	4.4E-02	1.1E-02
Aroclor 1254	4.9E-03	mg/kg	4.9E-04	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	9.8E-02	2.4E-02
Aroclor 1268	3.5E-05	mg/kg	3.5E-06	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	7.0E-04	1.7E-04
TEQ-BIRD	0.0E+00	mg/kg	0.0E+00	mg/kg-d					
TEQ-MAMMAL	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	**1.9E+00**	6.3E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table C.3-4.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE C.3-6
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Soil Invertebrates / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Raccoon

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	1.7	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	29%	USEPA, 1993; Llewllyn and Uhler, 1952	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{soil} * BAF_{invert}$
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Stuewer, 1943	
	EF	EXPOSURE FREQUENCY	unitless	50%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	6.2	Sanderson, 1984	

REFERENCES
Llewellyn, L.M., and F.M. Uhler, 1952. The foods of fur animals of the Patuxent Research Refuge, Maryland; Am. Midl. Nat. 48:193-203.
Sanderson, G.C., 1984. Cooperative raccoon collections; Ill. Nat. Hist. Survey Div.; Pittman-Robertson Proj. W-49-31.
Stuewer, R.W., 1943. Raccoons: their habits and management in Michigan; Ecol. Monogr. 13:203-257.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE C.3-7
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Soil Invertebrates / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Raccoon

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	1.5E+00	mg/kg	5.9E-02	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	**2.3E+00**	2.3E-01
Arsenic	4.3E-01	mg/kg	1.7E-02	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.6E-01	3.6E-02
Barium	3.6E+01	mg/kg	1.5E+00	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	2.0E-02	9.2E-03
Beryllium	3.4E-01	mg/kg	1.4E-02	mg/kg-d	1.2E+00	1.2E+01	mg/kg-d	1.1E-02	1.1E-03
Cadmium	9.9E+00	mg/kg	4.0E-01	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	4.0E-01	4.0E-02
Chromium	2.6E+00	mg/kg	1.0E-01	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	7.1E-05	7.1E-06
Cobalt	7.9E-01	mg/kg	3.2E-02	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	4.2E-01	4.2E-02
Copper	1.1E+01	mg/kg	4.2E-01	mg/kg-d	1.2E+01	1.5E+01	mg/kg-d	3.6E-02	2.8E-02
Lead	8.0E+01	mg/kg	3.2E+00	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	2.5E-02	8.5E-03
Manganese	5.2E+01	mg/kg	2.1E+00	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	2.4E-02	7.3E-03
Molybdenum	4.2E-01	mg/kg	1.7E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	9.0E-02	9.0E-03
Selenium	1.2E+00	mg/kg	4.6E-02	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	2.3E-01	1.4E-01
Thallium	5.5E-02	mg/kg	2.2E-03	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	1.6E-02	1.6E-03
Vanadium	1.7E+00	mg/kg	6.9E-02	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	1.6E-01	3.3E-02
Zinc	3.5E+02	mg/kg	1.4E+01	mg/kg-d	2.0E+02	3.9E+02	mg/kg-d	7.1E-02	3.6E-02
4,4'-DDD	3.7E-03	mg/kg	1.5E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.9E-04	3.7E-05
4,4'-DDE	6.9E-03	mg/kg	2.8E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	3.5E-04	7.0E-05
4,4'-DDT	1.7E-04	mg/kg	7.0E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	8.7E-06	1.7E-06
Dieldrin	1.1E-02	mg/kg	4.5E-04	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	3.0E-02	3.0E-03
Lindane	3.0E-04	mg/kg	1.2E-05	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	7.6E-06	3.8E-06
TOTAL AROCLOR	3.9E-01	mg/kg	1.6E-02	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	**3.2E+00**	7.9E-01
Aroclor 1254	3.8E-01	mg/kg	1.5E-02	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	**3.1E+00**	7.7E-01
Aroclor 1268	1.3E-02	mg/kg	5.3E-04	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.1E-01	2.7E-02
TEQ-BIRD	4.4E-04	mg/kg	1.8E-05	mg/kg-d					
TEQ-MAMMAL	4.5E-04	mg/kg	1.8E-05	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	**1.8E+01**	**1.8E+00**
							HAZARD INDICES:	**2.9E+01**	**4.0E+00**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table C.3-6.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE C.3-8
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED RTVs : Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Raccoon
TOTAL RISK (HI): 8.0E+01

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-MAMMAL		3.0E+01	-	1.8E+01	-	-	***4.9E+01***	***61%***
TOTAL AROCLOR		5.1E+00	4.4E-02	3.2E+00	-	-	***8.3E+00***	***10%***
Aroclor 1254		5.1E+00	9.8E-02	3.1E+00	-	-	***8.2E+00***	***10%***
Antimony		1.9E+00	5.5E-02	2.3E+00	-	-	***4.2E+00***	5%
Cobalt		2.0E+00	4.4E-02	4.2E-01	-	-	***2.5E+00***	3%
Arsenic		1.9E+00	2.7E-01	3.6E-01	-	-	***2.5E+00***	3%
Vanadium		1.2E+00	1.7E-02	1.6E-01	-	-	***1.4E+00***	2%
Molybdenum		6.4E-01	4.6E-01	9.0E-02	-	-	***1.2E+00***	1%
Copper		2.2E-01	3.0E-01	3.6E-02	-	-	5.5E-01	1%
Cadmium		5.8E-02	3.6E-02	4.0E-01	-	-	4.9E-01	1%
Zinc		6.8E-02	3.3E-01	7.1E-02	-	-	4.7E-01	1%
Selenium		7.8E-02	1.4E-01	2.3E-01	-	-	4.5E-01	1%
Aroclor 1268		1.5E-01	7.0E-04	1.1E-01	-	-	2.5E-01	0%
Lead		1.0E-01	2.8E-02	2.5E-02	-	-	1.6E-01	0%
Manganese		6.9E-02	1.6E-02	2.4E-02	-	-	1.1E-01	0%
Barium		4.8E-02	2.2E-02	2.0E-02	-	-	8.9E-02	0%
Thallium		5.2E-02	6.0E-04	1.6E-02	-	-	6.9E-02	0%
Dieldrin		3.0E-02	2.9E-03	3.0E-02	-	-	6.2E-02	0%
Beryllium		4.6E-02	1.3E-03	1.1E-02	-	-	5.9E-02	0%
4,4'-DDE		3.7E-04	5.1E-06	3.5E-04	-	-	7.3E-04	0%
Chromium		5.0E-04	5.9E-05	7.1E-05	-	-	6.3E-04	0%
4,4'-DDD		2.3E-04	8.2E-06	1.9E-04	-	-	4.3E-04	0%
4,4'-DDT		2.4E-05	5.0E-07	8.7E-06	-	-	3.4E-05	0%
Lindane		3.4E-06	2.8E-06	7.6E-06	-	-	1.4E-05	0%
TEQ-BIRD								
TOTAL MEDIUM-SPECIFIC RISK	**-**	**4.9E+01**	**1.9E+00**	**2.9E+01**	**-**	**-**	**8.0E+01**	
PERCENTAGE OF TOTAL RISK		**61%**	**2%**	**36%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE C.3-9
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED RTVs : Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Maximum
RECEPTOR: Raccoon
TOTAL RISK (HI): 1.1E+01

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-MAMMAL		3.0E+00	-	1.8E+00	-	-	***4.9E+00***	***42%***
TOTAL AROCLOR		1.3E+00	1.1E-02	7.9E-01	-	-	***2.1E+00***	***18%***
Aroclor 1254		1.3E+00	2.4E-02	7.7E-01	-	-	***2.1E+00***	***18%***
Copper		1.7E-01	2.3E-01	2.8E-02	-	-	4.2E-01	4%
Antimony		1.9E-01	5.5E-03	2.3E-01	-	-	4.2E-01	4%
Selenium		4.7E-02	8.7E-02	1.4E-01	-	-	2.8E-01	2%
Vanadium		2.4E-01	3.3E-03	3.3E-02	-	-	2.8E-01	2%
Cobalt		2.0E-01	4.4E-03	4.2E-02	-	-	2.5E-01	2%
Arsenic		1.9E-01	2.7E-02	3.6E-02	-	-	2.5E-01	2%
Zinc		3.4E-02	1.7E-01	3.6E-02	-	-	2.4E-01	2%
Molybdenum		6.4E-02	4.6E-02	9.0E-03	-	-	1.2E-01	1%
Aroclor 1268		3.6E-02	1.7E-04	2.7E-02	-	-	6.3E-02	1%
Lead		3.4E-02	9.5E-03	8.5E-03	-	-	5.2E-02	0%
Cadmium		5.8E-03	3.6E-03	4.0E-02	-	-	4.9E-02	0%
Barium		2.3E-02	1.0E-02	9.2E-03	-	-	4.2E-02	0%
Manganese		2.1E-02	4.8E-03	7.3E-03	-	-	3.3E-02	0%
Thallium		5.2E-03	6.0E-05	1.6E-03	-	-	6.9E-03	0%
Dieldrin		3.0E-03	2.9E-04	3.0E-03	-	-	6.2E-03	0%
Beryllium		4.6E-03	1.3E-04	1.1E-03	-	-	5.9E-03	0%
4,4'-DDE		7.5E-05	1.0E-06	7.0E-05	-	-	1.5E-04	0%
4,4'-DDD		4.7E-05	1.6E-06	3.7E-05	-	-	8.6E-05	0%
Chromium		5.0E-05	5.9E-06	7.1E-06	-	-	6.3E-05	0%
Lindane		1.7E-06	1.4E-06	3.8E-06	-	-	6.9E-06	0%
4,4'-DDT		4.9E-06	1.0E-07	1.7E-06	-	-	6.7E-06	0%
TEQ-BIRD								
TOTAL MEDIUM-SPECIFIC RISK	**-**	**6.8E+00**	**6.3E-01**	**4.0E+00**	**-**	**-**	**1.1E+01**	
PERCENTAGE OF TOTAL RISK		**59%**	**6%**	**35%**			**100%**	

Footnotes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

Appendix D

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APPENDIX D
FOOD WEB EXPOSURE MODELS USING AVERAGE SITE CONCENTRATIONS

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TABLE D.1-1
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surface Soil (0-2 feet) / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Woodcock

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		SOIL INTAKE-INGESTION
	C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
	IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.012	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Gregg, 1984	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.20	USEPA, 1993	

REFERENCES

Gregg, L., 1984. Population ecology of woodcock in Wisconsin; Wis. Dept. Nat. Resour. Tech. Bull. No. 144; 51 pp.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE D.1-2
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surface Soil (0-2 feet) / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Woodcock

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	3.0E+00	mg/kg	1.8E-01	mg/kg-d					
Arsenic	5.4E+00	mg/kg	3.2E-01	mg/kg-d	5.1E+00	1.3E+01	mg/kg-d	6.3E-02	2.5E-02
Barium	3.0E+02	mg/kg	1.8E+01	mg/kg-d	4.2E+01	8.3E+01	mg/kg-d	4.3E-01	2.2E-01
Beryllium	4.9E+00	mg/kg	2.9E-01	mg/kg-d	1.5E-01	1.5E+00	mg/kg-d	**2.0E+00**	2.0E-01
Cadmium	4.0E+00	mg/kg	2.4E-01	mg/kg-d	1.5E+00	2.0E+01	mg/kg-d	1.7E-01	1.2E-02
Chromium	7.4E+01	mg/kg	4.4E+00	mg/kg-d	1.0E+00	5.0E+00	mg/kg-d	**4.4E+00**	8.8E-01
Cobalt	1.6E+01	mg/kg	9.6E-01	mg/kg-d					
Copper	1.2E+02	mg/kg	7.3E+00	mg/kg-d	4.7E+01	6.2E+01	mg/kg-d	1.5E-01	1.2E-01
Lead	5.7E+02	mg/kg	3.4E+01	mg/kg-d	3.9E+00	3.9E+01	mg/kg-d	**9.0E+00**	9.0E-01
Manganese	8.3E+02	mg/kg	5.0E+01	mg/kg-d	9.8E+02	9.8E+03	mg/kg-d	5.1E-02	5.1E-03
Molybdenum	8.4E+00	mg/kg	5.0E-01	mg/kg-d	3.5E+00	3.5E+01	mg/kg-d	1.4E-01	1.4E-02
Selenium	1.4E+00	mg/kg	8.6E-02	mg/kg-d	4.4E-01	1.5E+00	mg/kg-d	2.0E-01	5.7E-02
Thallium	7.1E-01	mg/kg	4.3E-02	mg/kg-d	3.5E+00	5.0E+00	mg/kg-d	1.2E-02	8.6E-03
Vanadium	5.9E+01	mg/kg	3.6E+00	mg/kg-d	1.1E+01	1.1E+02	mg/kg-d	3.1E-01	3.1E-02
Zinc	6.4E+02	mg/kg	3.9E+01	mg/kg-d	1.5E+01	1.3E+02	mg/kg-d	**2.7E+00**	3.0E-01
4,4'-DDD	1.3E-02	mg/kg	8.0E-04	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	2.9E-01	2.9E-02
4,4'-DDE	1.8E-02	mg/kg	1.1E-03	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	3.9E-01	3.9E-02
4,4'-DDT	1.3E-03	mg/kg	7.6E-05	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	2.7E-02	2.7E-03
Dieldrin	2.3E-02	mg/kg	1.4E-03	mg/kg-d	7.7E-02	7.7E-01	mg/kg-d	1.8E-02	1.8E-03
Lindane	3.1E-04	mg/kg	1.9E-05	mg/kg-d	2.0E+00	2.0E+01	mg/kg-d	9.3E-06	9.3E-07
TOTAL AROCLOR	1.4E+00	mg/kg	8.6E-02	mg/kg-d	1.1E-01	2.8E-01	mg/kg-d	7.8E-01	3.1E-01
Aroclor 1254	1.4E+00	mg/kg	8.5E-02	mg/kg-d	1.8E-01	1.8E+00	mg/kg-d	4.7E-01	4.7E-02
Aroclor 1268	4.0E-02	mg/kg	2.4E-03	mg/kg-d	1.1E+00	1.1E+01	mg/kg-d	2.2E-03	2.2E-04
TEQ-BIRD	1.8E-03	mg/kg	1.1E-04	mg/kg-d	1.4E-05	1.4E-04	mg/kg-d	**7.8E+00**	7.8E-01
TEQ-MAMMAL	1.8E-03	mg/kg	1.1E-04	mg/kg-d					
							HAZARD INDICES:	**2.9E+01**	**4.0E+00**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table D.1-1.
b. Reference Dose Values presented in Table D-4 in BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE D.1-3
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Soil Invertebrates / Woodcock

Screening Level Ecological Risk Assessment
***Centredale Manor River* Restoration Superfund Site**
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Woodcock

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.082	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	100%	USEPA, 1993; Krohn, 1970.	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{soil} * BAF_{invert}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Gregg, 1984	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.20	USEPA, 1993	

REFERENCES

Gregg, L., 1984. Population ecology of woodcock in Wisconsin; Wis. Dept. Nat. Resour. Tech. Bull. No. 144; 51 pp.

Krohn, W.B., 1970. Woodcock feeding habits as related to summer field usage in central Maine; J. Widl. Manage. 34:769-775.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE D.1-4
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Soil Invertebrates / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Woodcock

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	6.3E-01	mg/kg	2.5E-01	mg/kg-d					
Arsenic	1.8E-01	mg/kg	7.2E-02	mg/kg-d	5.1E+00	1.3E+01	mg/kg-d	1.4E-02	5.6E-03
Barium	2.1E+01	mg/kg	8.5E+00	mg/kg-d	4.2E+01	8.3E+01	mg/kg-d	2.0E-01	1.0E-01
Beryllium	2.1E-01	mg/kg	8.4E-02	mg/kg-d	1.5E-01	1.5E+00	mg/kg-d	5.7E-01	5.7E-02
Cadmium	4.8E+00	mg/kg	1.9E+00	mg/kg-d	1.5E+00	2.0E+01	mg/kg-d	**1.3E+00**	9.7E-02
Chromium	1.8E+00	mg/kg	7.3E-01	mg/kg-d	1.0E+00	5.0E+00	mg/kg-d	7.3E-01	1.5E-01
Cobalt	5.7E-01	mg/kg	2.3E-01	mg/kg-d					
Copper	3.6E+00	mg/kg	1.4E+00	mg/kg-d	4.7E+01	6.2E+01	mg/kg-d	3.0E-02	2.3E-02
Lead	2.5E+01	mg/kg	1.0E+01	mg/kg-d	3.9E+00	3.9E+01	mg/kg-d	**2.6E+00**	2.6E-01
Manganese	5.0E+01	mg/kg	2.0E+01	mg/kg-d	9.8E+02	9.8E+03	mg/kg-d	2.0E-02	2.0E-03
Molybdenum	2.0E-01	mg/kg	8.2E-02	mg/kg-d	3.5E+00	3.5E+01	mg/kg-d	2.3E-02	2.3E-03
Selenium	7.4E-01	mg/kg	3.0E-01	mg/kg-d	4.4E-01	1.5E+00	mg/kg-d	6.7E-01	2.0E-01
Thallium	3.8E-02	mg/kg	1.5E-02	mg/kg-d	3.5E+00	5.0E+00	mg/kg-d	4.3E-03	3.0E-03
Vanadium	1.4E+00	mg/kg	5.7E-01	mg/kg-d	1.1E+01	1.1E+02	mg/kg-d	5.0E-02	5.0E-03
Zinc	1.2E+02	mg/kg	4.8E+01	mg/kg-d	1.5E+01	1.3E+02	mg/kg-d	**3.3E+00**	3.6E-01
4,4'-DDD	1.9E-03	mg/kg	7.4E-04	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	2.7E-01	2.7E-02
4,4'-DDE	3.0E-03	mg/kg	1.2E-03	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	4.3E-01	4.3E-02
4,4'-DDT	7.9E-05	mg/kg	3.2E-05	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	1.1E-02	1.1E-03
Dieldrin	4.0E-03	mg/kg	1.6E-03	mg/kg-d	7.7E-02	7.7E-01	mg/kg-d	2.1E-02	2.1E-03
Lindane	1.2E-04	mg/kg	4.9E-05	mg/kg-d	2.0E+00	2.0E+01	mg/kg-d	2.5E-05	2.5E-06
TOTAL AROCLOR	1.6E-01	mg/kg	6.3E-02	mg/kg-d	1.1E-01	2.8E-01	mg/kg-d	5.7E-01	2.3E-01
Aroclor 1254	1.5E-01	mg/kg	6.0E-02	mg/kg-d	1.8E-01	1.8E+00	mg/kg-d	3.3E-01	3.3E-02
Aroclor 1268	5.2E-03	mg/kg	2.1E-03	mg/kg-d	1.1E+00	1.1E+01	mg/kg-d	1.9E-03	1.9E-04
TEQ-BIRD	1.9E-04	mg/kg	7.4E-05	mg/kg-d	1.4E-05	1.4E-04	mg/kg-d	**5.3E+00**	5.3E-01
TEQ-MAMMAL	1.9E-04	mg/kg	7.7E-05	mg/kg-d					
							HAZARD INDICES:	**1.6E+01**	**2.1E+00**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table D.1-3.
b. Reference Dose Values presented in Table D-4 in BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE D.1-5
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED RTVs : Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Woodcock
TOTAL RISK (HI): 4.6E+01

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-BIRD		7.8E+00	-	5.3E+00	-	-	***1.3E+01***	***29%***
Lead		9.0E+00	-	2.6E+00	-	-	***1.2E+01***	***25%***
Zinc		2.7E+00	-	3.3E+00	-	-	***6.0E+00***	***13%***
Chromium		4.4E+00	-	7.3E-01	-	-	***5.1E+00***	***11%***
Beryllium		2.0E+00	-	5.7E-01	-	-	***2.5E+00***	6%
Cadmium		1.7E-01	-	1.3E+00	-	-	***1.5E+00***	3%
TOTAL AROCLOR		7.8E-01	-	5.7E-01	-	-	***1.4E+00***	3%
Selenium		2.0E-01	-	6.7E-01	-	-	8.7E-01	2%
4,4'-DDE		3.9E-01	-	4.3E-01	-	-	8.2E-01	2%
Aroclor 1254		4.7E-01	-	3.3E-01	-	-	8.0E-01	2%
Barium		4.3E-01	-	2.0E-01	-	-	6.4E-01	1%
4,4'-DDD		2.9E-01	-	2.7E-01	-	-	5.5E-01	1%
Vanadium		3.1E-01	-	5.0E-02	-	-	3.6E-01	1%
Copper		1.5E-01	-	3.0E-02	-	-	1.8E-01	0%
Molybdenum		1.4E-01	-	2.3E-02	-	-	1.7E-01	0%
Arsenic		6.3E-02	-	1.4E-02	-	-	7.7E-02	0%
Manganese		5.1E-02	-	2.0E-02	-	-	7.1E-02	0%
Dieldrin		1.8E-02	-	2.1E-02	-	-	3.9E-02	0%
4,4'-DDT		2.7E-02	-	1.1E-02	-	-	3.8E-02	0%
Thallium		1.2E-02	-	4.3E-03	-	-	1.7E-02	0%
Aroclor 1268		2.2E-03	-	1.9E-03	-	-	4.1E-03	0%
Lindane		9.3E-06	-	2.5E-05	-	-	3.4E-05	0%
Antimony								
Cobalt								
TEQ-MAMMAL								
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.9E+01**	**-**	**1.6E+01**	**-**	**-**	**4.6E+01**	
PERCENTAGE OF TOTAL RISK		**64%**		**36%**			**100%**	

Footnotes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE D.1-6
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED RTVs : Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Woodcock
TOTAL RISK (HI): 6.1E+00

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-BIRD		7.8E-01	-	5.3E-01	-	-	***1.3E+00***	***21%***
Lead		9.0E-01	-	2.6E-01	-	-	***1.2E+00***	***19%***
Chromium		8.8E-01	-	1.5E-01	-	-	***1.0E+00***	***17%***
Zinc		3.0E-01	-	3.6E-01	-	-	6.6E-01	***11%***
TOTAL AROCLOR		3.1E-01	-	2.3E-01	-	-	5.4E-01	9%
Barium		2.2E-01	-	1.0E-01	-	-	3.2E-01	5%
Selenium		5.7E-02	-	2.0E-01	-	-	2.6E-01	4%
Beryllium		2.0E-01	-	5.7E-02	-	-	2.5E-01	4%
Copper		1.2E-01	-	2.3E-02	-	-	1.4E-01	2%
Cadmium		1.2E-02	-	9.7E-02	-	-	1.1E-01	2%
4,4'-DDE		3.9E-02	-	4.3E-02	-	-	8.2E-02	1%
Aroclor 1254		4.7E-02	-	3.3E-02	-	-	8.0E-02	1%
4,4'-DDD		2.9E-02	-	2.7E-02	-	-	5.5E-02	1%
Vanadium		3.1E-02	-	5.0E-03	-	-	3.6E-02	1%
Arsenic		2.5E-02	-	5.6E-03	-	-	3.1E-02	1%
Molybdenum		1.4E-02	-	2.3E-03	-	-	1.7E-02	0%
Thallium		8.6E-03	-	3.0E-03	-	-	1.2E-02	0%
Manganese		5.1E-03	-	2.0E-03	-	-	7.1E-03	0%
Dieldrin		1.8E-03	-	2.1E-03	-	-	3.9E-03	0%
4,4'-DDT		2.7E-03	-	1.1E-03	-	-	3.8E-03	0%
Aroclor 1268		2.2E-04	-	1.9E-04	-	-	4.1E-04	0%
Lindane		9.3E-07	-	2.5E-06	-	-	3.4E-06	0%
Antimony								
Cobalt								
TEQ-MAMMAL								
TOTAL MEDIUM-SPECIFIC RISK	-	**4.0E+00**	-	**2.1E+00**	-	-	**6.1E+00**	
PERCENTAGE OF TOTAL RISK		**65%**		**35%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE D.2-1
ESTIMATED TERRESTRIAL PREY TISSUE CONCENTRATIONS DERIVED USING LITERATURE-BASED BAFs

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: All
EXPOSURE POINT: Oxbow Area Floodplain - Average

Analyte	Medium EPC Value	Literature-based BAFs[a]		Estimated Tissue Concentration	
		Terrestrial Plants	Terrestrial Inverts	Terrestrial Plants[b]	Terrestrial Inverts[b]
Antimony	3.0E+00	2.0E-03	-	**6.2E-03**	0.0E+00
Arsenic	5.4E+00	1.0E-02	2.5E-02	**5.4E-02**	1.3E-01
Barium	3.0E+02	3.1E-02	1.8E-02	**9.4E+00**	5.5E+00
Beryllium	4.9E+00	2.0E-03	9.0E-03	**9.8E-03**	4.4E-02
Cadmium	4.0E+00	4.4E-02	1.0E+00	**1.8E-01**	4.2E+00
Chromium	7.4E+01	8.2E-03	6.1E-02	**6.0E-01**	4.5E+00
Cobalt	1.6E+01	1.5E-03	2.4E-02	**2.4E-02**	3.9E-01
Copper	1.2E+02	9.7E-02	2.0E-01	**1.2E+01**	2.4E+01
Lead	5.7E+02	1.9E-02	1.0E-01	**1.1E+01**	5.9E+01
Manganese	8.3E+02	1.6E-02	4.3E-02	**1.3E+01**	3.5E+01
Molybdenum	8.4E+00	5.0E-02	1.9E-01	**4.2E-01**	1.6E+00
Selenium	1.4E+00	1.3E-01	1.0E-01	**1.8E-01**	1.4E-01
Thallium	7.1E-01	8.0E-04	-	**5.7E-04**	0.0E+00
Vanadium	5.9E+01	9.7E-04	8.4E-03	**5.8E-02**	5.0E-01
Zinc	6.4E+02	3.5E-01	3.6E+00	**2.2E+02**	2.3E+03
4,4'-DDD	1.3E-02	2.4E-03	1.1E+00	**3.2E-05**	1.4E-02
4,4'-DDE	1.8E-02	9.6E-04	1.1E+00	**1.7E-05**	2.0E-02
4,4'-DDT	1.3E-03	1.4E-03	1.1E+00	**1.8E-06**	1.4E-03
Dieldrin	2.3E-02	6.7E-03	1.1E+00	**1.5E-04**	2.4E-02
Lindane	3.1E-04	5.9E-02	1.0E+00	**1.8E-05**	3.2E-04
TOTAL AROCLOR	1.4E+00	6.1E-04	1.1E+00	**8.8E-04**	1.6E+00
Aroclor 1254	1.4E+00	1.4E-03	1.1E+00	**1.9E-03**	1.5E+00
Aroclor 1268	4.0E-02	3.4E-04	1.1E+00	**1.4E-05**	4.5E-02
TEQ-BIRD	1.8E-03			**0.0E+00**	0.0E+00
TEQ-MAMMAL	1.8E-03			**0.0E+00**	0.0E+00

Footnotes:

a. Literature-derived BAFs are summarized in Table J-1 in the BERA (MACTEC, 2004).

b. Estimated plant and invertebrate concentrations calculated by multiplying the soil EPC concentration (mg/kg[dw] by the tissue-specific BAF (mg/kg[ww]). Estimated tissue concentrations reported in units of mg/kg [wet weight tissue].

c. Estimated small bird prey concentrations calculated by multiplying the estimated tissue concentration of soil invertebrates by the small bird BAF (I.e., assumes vermivorous species).

d. Estimated small mammal prey concentrations calculated assuming that plants and invertebrates each comprise 50% of the prey species diet (i.e., omnivore); the sum of 50% times the estimated tissue concentrations of plants and invertebrates was multiplied by the small mammal BAF.

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TABLE D.2-2
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surface Soil (0-2 feet) / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Short-tailed Shrew

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		SOIL INTAKE-INGESTION
	C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
	IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.00064	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Buckner, 1966	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.017	Guilday, 1957	

REFERENCES

Buckner, C.H., 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba; J. Mammal. 47:181-194.

Guilday, J.E., 1957, Individual an dgeographic variation in Blarina brevicauda from Pennsylvania; Ann. Carnegie Mus. 35:41-68.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE D.2-3
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surface Soil (0-2 feet) / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Short-tailed Shrew

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	3.0E+00	mg/kg	1.1E-01	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	**4.3E+00**	4.3E-01
Arsenic	5.4E+00	mg/kg	2.0E-01	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	**1.6E+00**	1.6E-01
Barium	3.0E+02	mg/kg	1.1E+01	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	1.5E-01	6.9E-02
Beryllium	4.9E+00	mg/kg	1.8E-01	mg/kg-d	6.6E-01	6.6E+00	mg/kg-d	2.7E-01	2.7E-02
Cadmium	4.0E+00	mg/kg	1.5E-01	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	1.5E-01	1.5E-02
Chromium	7.4E+01	mg/kg	2.7E+00	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	1.8E-03	1.8E-04
Cobalt	1.6E+01	mg/kg	5.9E-01	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	**7.8E+00**	7.8E-01
Copper	1.2E+02	mg/kg	4.5E+00	mg/kg-d	4.2E-01	4.2E+00	mg/kg-d	**1.1E+01**	**1.1E+00**
Lead	5.7E+02	mg/kg	2.1E+01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	1.7E-01	5.6E-02
Manganese	8.3E+02	mg/kg	3.0E+01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	3.5E-01	1.1E-01
Molybdenum	8.4E+00	mg/kg	3.1E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	**1.6E+00**	1.6E-01
Selenium	1.4E+00	mg/kg	5.3E-02	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	2.6E-01	1.6E-01
Thallium	7.1E-01	mg/kg	2.6E-02	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	1.9E-01	1.9E-02
Vanadium	5.9E+01	mg/kg	2.2E+00	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	**5.2E+00**	**1.0E+00**
Zinc	6.4E+02	mg/kg	2.4E+01	mg/kg-d	1.6E+02	3.2E+02	mg/kg-d	1.5E-01	7.4E-02
4,4'-DDD	1.3E-02	mg/kg	4.9E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	6.1E-04	1.2E-04
4,4'-DDE	1.8E-02	mg/kg	6.7E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	8.4E-04	1.7E-04
4,4'-DDT	1.3E-03	mg/kg	4.7E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.8E-05	1.2E-05
Dieldrin	2.3E-02	mg/kg	8.5E-04	mg/kg-d	2.8E-02	2.8E-01	mg/kg-d	3.1E-02	3.1E-03
Lindane	3.1E-04	mg/kg	1.1E-05	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	7.1E-06	3.6E-06
TOTAL AROCLOR	1.4E+00	mg/kg	5.3E-02	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	7.8E-01	7.8E-02
Aroclor 1254	1.4E+00	mg/kg	5.2E-02	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	7.6E-01	7.6E-02
Aroclor 1268	4.0E-02	mg/kg	1.5E-03	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	2.2E-02	2.2E-03
TEQ-BIRD	1.8E-03	mg/kg	6.7E-05	mg/kg-d					
TEQ-MAMMAL	1.8E-03	mg/kg	6.7E-05	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	**6.7E+01**	**6.7E+00**
							HAZARD INDICES:	**1.0E+02**	**1.1E+01**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table D.2-2.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE D.2-4
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Terrestrial Plants / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Short-tailed Shrew

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{plant}	ESTIMATED DAILY INTAKE VIA PLANT INGESTION	mg/kg-d	calculated		PLANT INTAKE-INGESTION
	C_{plant}	CHEMICAL CONCENTRATION IN PLANTS	mg/kg	chemical-specific		$EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.013	USEPA, 1993	
	P_{plant}	PERCENT PLANTS IN DIET	unitless	14%	Whitaker and	Where C_{plant} is estimated using site-specific
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Buckner, 1966	$C_{plant} = C_{soil} * BAF_{plant}$
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.017	Guilday, 1957	

REFERENCES

Buckner, C.H., 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba; J. Mammal. 47:181-194.

Guilday, J.E., 1957. Individual an dgeographic variation in Blarina brevicauda from Pennsylvania; Ann. Carnegie Mus. 35:41-68.

EPA/600/R-93/187a; December 1993; Washington, D.C.

Whitaker, J.O., Jr., and M.G. Ferraro, 1963. Summer food of 220 short-tailed shrews from Ithica, New York; J. Mammal. 44:419.

TABLE D.2-5
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Terrestrial Plants / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Short-tailed Shrew

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	6.2E-03	mg/kg	6.5E-04	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	2.5E-02	2.5E-03
Arsenic	5.4E-02	mg/kg	5.7E-03	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	4.5E-02	4.5E-03
Barium	9.4E+00	mg/kg	9.8E-01	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	1.3E-02	6.1E-03
Beryllium	9.8E-03	mg/kg	1.0E-03	mg/kg-d	6.6E-01	6.6E+00	mg/kg-d	1.6E-03	1.6E-04
Cadmium	1.8E-01	mg/kg	1.8E-02	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	1.8E-02	1.8E-03
Chromium	6.0E-01	mg/kg	6.3E-02	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	4.3E-05	4.3E-06
Cobalt	2.4E-02	mg/kg	2.5E-03	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	3.3E-02	3.3E-03
Copper	1.2E+01	mg/kg	1.2E+00	mg/kg-d	4.2E-01	4.2E+00	mg/kg-d	**2.9E+00**	2.9E-01
Lead	1.1E+01	mg/kg	1.2E+00	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	9.2E-03	3.1E-03
Manganese	1.3E+01	mg/kg	1.4E+00	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	1.6E-02	4.8E-03
Molybdenum	4.2E-01	mg/kg	4.4E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.3E-01	2.3E-02
Selenium	1.8E-01	mg/kg	1.9E-02	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	9.7E-02	5.9E-02
Thallium	5.7E-04	mg/kg	6.0E-05	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	4.3E-04	4.3E-05
Vanadium	5.8E-02	mg/kg	6.0E-03	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	1.4E-02	2.9E-03
Zinc	2.2E+02	mg/kg	2.3E+01	mg/kg-d	1.6E+02	3.2E+02	mg/kg-d	1.5E-01	7.3E-02
4,4'-DDD	3.2E-05	mg/kg	3.4E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	4.3E-06	8.5E-07
4,4'-DDE	1.7E-05	mg/kg	1.8E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.3E-06	4.6E-07
4,4'-DDT	1.8E-06	mg/kg	1.9E-07	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.4E-07	4.8E-08
Dieldrin	1.5E-04	mg/kg	1.6E-05	mg/kg-d	2.8E-02	2.8E-01	mg/kg-d	5.9E-04	5.9E-05
Lindane	1.8E-05	mg/kg	1.9E-06	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	1.2E-06	5.9E-07
TOTAL AROCLOR	8.8E-04	mg/kg	9.2E-05	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	1.4E-03	1.4E-04
Aroclor 1254	1.9E-03	mg/kg	2.0E-04	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	3.0E-03	3.0E-04
Aroclor 1268	1.4E-05	mg/kg	1.4E-06	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	2.1E-05	2.1E-06
TEQ-BIRD	0.0E+00	mg/kg	0.0E+00	mg/kg-d					
TEQ-MAMMAL	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	**3.6E+00**	4.8E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table D.2-4.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE D.2-6
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Soil Invertebrates / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Short-tailed Shrew

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.013	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	85%	USEPA, 1993; Whitaker and Feraro, 1963	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{soil} * BAF_{invert}$
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Buckner, 1966	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.017	Guilday, 1957	

REFERENCES
Buckner, C.H., 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba; J. Mammal. 47:181-194.
Guilday, J.E., 1957, Individual an dgeographic variation in Blarina brevicauda from Pennsylvania; Ann. Carnegie Mus. 35:41-68.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.
Whitaker, J.O., Jr., and M.G. Ferraro, 1963. Summer food of 220 short-tailed shrews from Ithica, New York; J. Mammal. 44:419.

TABLE D.2-7
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Soil Invertebrates / Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Short-tailed Shrew

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	6.3E-01	mg/kg	4.0E-01	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	**1.5E+01**	**1.5E+00**
Arsenic	1.8E-01	mg/kg	1.1E-01	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	9.0E-01	9.0E-02
Barium	2.1E+01	mg/kg	1.3E+01	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	1.8E-01	8.4E-02
Beryllium	2.1E-01	mg/kg	1.3E-01	mg/kg-d	6.6E-01	6.6E+00	mg/kg-d	2.0E-01	2.0E-02
Cadmium	4.8E+00	mg/kg	3.0E+00	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	**3.0E+00**	3.0E-01
Chromium	1.8E+00	mg/kg	1.2E+00	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	7.9E-04	7.9E-05
Cobalt	5.7E-01	mg/kg	3.6E-01	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	**4.8E+00**	4.8E-01
Copper	3.6E+00	mg/kg	2.2E+00	mg/kg-d	4.2E-01	4.2E+00	mg/kg-d	**5.4E+00**	5.4E-01
Lead	2.5E+01	mg/kg	1.6E+01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	1.2E-01	4.2E-02
Manganese	5.0E+01	mg/kg	3.1E+01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	3.6E-01	1.1E-01
Molybdenum	2.0E-01	mg/kg	1.3E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	6.8E-01	6.8E-02
Selenium	7.4E-01	mg/kg	4.7E-01	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	**2.3E+00**	**1.4E+00**
Thallium	3.8E-02	mg/kg	2.4E-02	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	1.7E-01	1.7E-02
Vanadium	1.4E+00	mg/kg	9.0E-01	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	**2.1E+00**	4.3E-01
Zinc	1.2E+02	mg/kg	7.5E+01	mg/kg-d	1.6E+02	3.2E+02	mg/kg-d	4.7E-01	2.3E-01
4,4'-DDD	1.9E-03	mg/kg	1.2E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.5E-03	2.9E-04
4,4'-DDE	3.0E-03	mg/kg	1.9E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.3E-03	4.7E-04
4,4'-DDT	7.9E-05	mg/kg	5.0E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	6.3E-05	1.3E-05
Dieldrin	4.0E-03	mg/kg	2.5E-03	mg/kg-d	2.8E-02	2.8E-01	mg/kg-d	9.2E-02	9.2E-03
Lindane	1.2E-04	mg/kg	7.7E-05	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	4.8E-05	2.4E-05
TOTAL AROCLOR	1.6E-01	mg/kg	1.0E-01	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	**1.5E+00**	1.5E-01
Aroclor 1254	1.5E-01	mg/kg	9.4E-02	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	**1.4E+00**	1.4E-01
Aroclor 1268	5.2E-03	mg/kg	3.3E-03	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	4.8E-02	4.8E-03
TEQ-BIRD	1.9E-04	mg/kg	1.2E-04	mg/kg-d					
TEQ-MAMMAL	1.9E-04	mg/kg	1.2E-04	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	**1.2E+02**	**1.2E+01**
							HAZARD INDICES:	**1.6E+02**	**1.8E+01**

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table D.2-6.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE D.2-8
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED RTVs : Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Short-tailed Shrew
TOTAL RISK (HI): 2.6E+02

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-MAMMAL		6.7E+01	-	1.2E+02			***1.9E+02***	***71%***
Antimony		4.3E+00	2.5E-02	1.5E+01			***2.0E+01***	7%
Copper		1.1E+01	2.9E+00	5.4E+00			***1.9E+01***	7%
Cobalt		7.8E+00	3.3E-02	4.8E+00			***1.3E+01***	5%
Vanadium		5.2E+00	1.4E-02	2.1E+00			***7.4E+00***	3%
Cadmium		1.5E-01	1.8E-02	3.0E+00			***3.2E+00***	1%
Selenium		2.6E-01	9.7E-02	2.3E+00			***2.7E+00***	1%
Molybdenum		1.6E+00	2.3E-01	6.8E-01			***2.5E+00***	1%
Arsenic		1.6E+00	4.5E-02	9.0E-01			***2.5E+00***	1%
TOTAL AROCLOR		7.8E-01	1.4E-03	1.5E+00			***2.2E+00***	1%
Aroclor 1254		7.6E-01	3.0E-03	1.4E+00			***2.2E+00***	1%
Zinc		1.5E-01	1.5E-01	4.7E-01			7.7E-01	0%
Manganese		3.5E-01	1.6E-02	3.6E-01			7.2E-01	0%
Beryllium		2.7E-01	1.6E-03	2.0E-01			4.8E-01	0%
Thallium		1.9E-01	4.3E-04	1.7E-01			3.6E-01	0%
Barium		1.5E-01	1.3E-02	1.8E-01			3.4E-01	0%
Lead		1.7E-01	9.2E-03	1.2E-01			3.0E-01	0%
Dieldrin		3.1E-02	5.9E-04	9.2E-02			1.2E-01	0%
Aroclor 1268		2.2E-02	2.1E-05	4.8E-02			7.0E-02	0%
4,4'-DDE		8.4E-04	2.3E-06	2.3E-03			3.2E-03	0%
Chromium		1.8E-03	4.3E-05	7.9E-04			2.7E-03	0%
4,4'-DDD		6.1E-04	4.3E-06	1.5E-03			2.1E-03	0%
4,4'-DDT		5.8E-05	2.4E-07	6.3E-05			1.2E-04	0%
Lindane		7.1E-06	1.2E-06	4.8E-05			5.7E-05	0%
TEQ-BIRD								
TOTAL MEDIUM-SPECIFIC RISK	-	**1.0E+02**	**3.6E+00**	**1.6E+02**	-	-	**2.6E+02**	
PERCENTAGE OF TOTAL RISK		**38%**	**1%**	**60%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE D.2-9
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED RTVs : Short-tailed Shrew

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Short-tailed Shrew
TOTAL RISK (HI): 2.9E+01

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-MAMMAL		6.7E+00	-	1.2E+01			***1.9E+01***	***64%***
Antimony		4.3E-01	2.5E-03	1.5E+00			***2.0E+00***	7%
Copper		1.1E+00	2.9E-01	5.4E-01			***1.9E+00***	6%
Selenium		1.6E-01	5.9E-02	1.4E+00			***1.6E+00***	6%
Vanadium		1.0E+00	2.9E-03	4.3E-01			***1.5E+00***	5%
Cobalt		7.8E-01	3.3E-03	4.8E-01			***1.3E+00***	4%
Zinc		7.4E-02	7.3E-02	2.3E-01			3.8E-01	1%
Cadmium		1.5E-02	1.8E-03	3.0E-01			3.2E-01	1%
Arsenic		1.6E-01	4.5E-03	9.0E-02			2.5E-01	1%
TOTAL AROCLOR		7.8E-02	1.4E-04	1.5E-01			2.2E-01	1%
Manganese		1.1E-01	4.8E-03	1.1E-01			2.2E-01	1%
Aroclor 1254		7.6E-02	3.0E-04	1.4E-01			2.2E-01	1%
Molybdenum		1.6E-01	2.3E-02	6.8E-02			2.5E-01	1%
Barium		6.9E-02	6.1E-03	8.4E-02			1.6E-01	1%
Lead		5.6E-02	3.1E-03	4.2E-02			1.0E-01	0%
Beryllium		2.7E-02	1.6E-04	2.0E-02			4.8E-02	0%
Thallium		1.9E-02	4.3E-05	1.7E-02			3.6E-02	0%
Dieldrin		3.1E-03	5.9E-05	9.2E-03			1.2E-02	0%
Aroclor 1268		2.2E-03	2.1E-06	4.8E-03			7.0E-03	0%
4,4'-DDE		1.7E-04	4.6E-07	4.7E-04			6.4E-04	0%
4,4'-DDD		1.2E-04	8.5E-07	2.9E-04			4.2E-04	0%
Chromium		1.8E-04	4.3E-06	7.9E-05			2.7E-04	0%
Lindane		3.6E-06	5.9E-07	2.4E-05			2.8E-05	0%
4,4'-DDT		1.2E-05	4.8E-08	1.3E-05			2.4E-05	0%
TEQ-BIRD								
TOTAL MEDIUM-SPECIFIC RISK	**-**	**1.1E+01**	**4.8E-01**	**1.8E+01**	**-**	**-**	**2.9E+01**	
PERCENTAGE OF TOTAL RISK		**38%**	**2%**	**61%**			**100%**	

Footnotes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE D.3-1
ESTIMATED TERRESTRIAL PREY TISSUE CONCENTRATIONS DERIVED USING LITERATURE-BASED BAFs

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: All
EXPOSURE POINT: Oxbow Area Floodplain - Average

Analyte	Medium EPC Value	Literature-based BAFs[a]		Estimated Tissue Concentration	
		Terrestial Plants	Terrestrial Inverts	Terrestial Plants[b]	Terrestrial Inverts[b]
Antimony	3.0E+00	2.0E-03	-	**6.2E-03**	0.0E+00
Arsenic	5.4E+00	1.0E-02	2.5E-02	**5.4E-02**	1.3E-01
Barium	3.0E+02	3.1E-02	1.8E-02	**9.4E+00**	5.5E+00
Beryllium	4.9E+00	2.0E-03	9.0E-03	**9.8E-03**	4.4E-02
Cadmium	4.0E+00	4.4E-02	1.0E+00	**1.8E-01**	4.2E+00
Chromium	7.4E+01	8.2E-03	6.1E-02	**6.0E-01**	4.5E+00
Cobalt	1.6E+01	1.5E-03	2.4E-02	**2.4E-02**	3.9E-01
Copper	1.2E+02	9.7E-02	2.0E-01	**1.2E+01**	2.4E+01
Lead	5.7E+02	1.9E-02	1.0E-01	**1.1E+01**	5.9E+01
Manganese	8.3E+02	1.6E-02	4.3E-02	**1.3E+01**	3.5E+01
Molybdenum	8.4E+00	5.0E-02	1.9E-01	**4.2E-01**	1.6E+00
Selenium	1.4E+00	1.3E-01	1.0E-01	**1.8E-01**	1.4E-01
Thallium	7.1E-01	8.0E-04	-	**5.7E-04**	0.0E+00
Vanadium	5.9E+01	9.7E-04	8.4E-03	**5.8E-02**	5.0E-01
Zinc	6.4E+02	3.5E-01	3.6E+00	**2.2E+02**	2.3E+03
4,4'-DDD	1.3E-02	2.4E-03	1.1E+00	**3.2E-05**	1.4E-02
4,4'-DDE	1.8E-02	9.6E-04	1.1E+00	**1.7E-05**	2.0E-02
4,4'-DDT	1.3E-03	1.4E-03	1.1E+00	**1.8E-06**	1.4E-03
Dieldrin	2.3E-02	6.7E-03	1.1E+00	**1.5E-04**	2.4E-02
Lindane	3.1E-04	5.9E-02	1.0E+00	**1.8E-05**	3.2E-04
TOTAL AROCLOR	1.4E+00	6.1E-04	1.1E+00	**8.8E-04**	1.6E+00
Aroclor 1254	1.4E+00	1.4E-03	1.1E+00	**1.9E-03**	1.5E+00
Aroclor 1268	4.0E-02	3.4E-04	1.1E+00	**1.4E-05**	4.5E-02
TEQ-BIRD	1.8E-03			**0.0E+00**	0.0E+00
TEQ-MAMMAL	1.8E-03			**0.0E+00**	0.0E+00

Footnotes:

a. Literature-derived BAFs are summarized in Table J-1 in the BERA (MACTEC, 2004).

b. Estimated plant and invertebrate concentrations calculated by multiplying the soil EPC concentration (mg/kg[dw] by the tissue-specific BAF (mg/kg[ww]). Estimated tissue concentrations reported in units of mg/kg [wet weight tissue].

c. Estimated small bird prey concentrations calculated by multiplying the estimated tissue concentration of soil invertebrates by the small bird BAF (I.e., assumes vermivorous species).

d. Estimated small mammal prey concentrations calculated assuming that plants and invertebrates each comprise 50% of the prey species diet (i.e., omnivore); the sum of 50% times the estimated tissue concentrations of plants and invertebrates was multiplied by the small mammal BAF.

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TABLE D.3-2
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surface Soil (0-2 feet) / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Raccoon

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		SOIL INTAKE-INGESTION
	C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
	IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.087	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	10%	Stuewer, 1943	
	EF	EXPOSURE FREQUENCY	unitless	50%	USEPA, 1993	
	BW	BODY WEIGHT	kg	6.2	Sanderson, 1984	

REFERENCES

Sanderson, G.C., 1984. Cooperative raccoon collections; Ill. Nat. Hist. Survey Div.; Pittman-Robertson Proj. W-49-31.

Stuewer, R.W., 1943. Raccoons: their habits and management in Michigan; Ecol. Monogr. 13:203-257.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

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TABLE D.3-3
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surface Soil (0-2 feet) / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Raccoon

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	3.0E+00	mg/kg	2.2E-03	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	8.4E-02	8.4E-03
Arsenic	5.4E+00	mg/kg	3.9E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	8.2E-02	8.2E-03
Barium	3.0E+02	mg/kg	2.2E-01	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	2.9E-03	1.4E-03
Beryllium	4.9E+00	mg/kg	3.6E-03	mg/kg-d	1.2E+00	1.2E+01	mg/kg-d	3.0E-03	3.0E-04
Cadmium	4.0E+00	mg/kg	2.9E-03	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	2.9E-03	2.9E-04
Chromium	7.4E+01	mg/kg	5.4E-02	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	3.6E-05	3.6E-06
Cobalt	1.6E+01	mg/kg	1.2E-02	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	1.5E-01	1.5E-02
Copper	1.2E+02	mg/kg	8.8E-02	mg/kg-d	1.2E+01	1.5E+01	mg/kg-d	7.5E-03	5.8E-03
Lead	5.7E+02	mg/kg	4.2E-01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	3.3E-03	1.1E-03
Manganese	8.3E+02	mg/kg	6.0E-01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	6.8E-03	2.1E-03
Molybdenum	8.4E+00	mg/kg	6.1E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.2E-02	3.2E-03
Selenium	1.4E+00	mg/kg	1.0E-03	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	5.2E-03	3.2E-03
Thallium	7.1E-01	mg/kg	5.2E-04	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	3.7E-03	3.7E-04
Vanadium	5.9E+01	mg/kg	4.3E-02	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	1.0E-01	2.1E-02
Zinc	6.4E+02	mg/kg	4.7E-01	mg/kg-d	2.0E+02	3.9E+02	mg/kg-d	2.4E-03	1.2E-03
4,4'-DDD	1.3E-02	mg/kg	9.7E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.2E-05	2.4E-0
4,4'-DDE	1.8E-02	mg/kg	1.3E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.7E-05	3.3E-06
4,4'-DDT	1.3E-03	mg/kg	9.2E-07	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.2E-06	2.3E-07
Dieldrin	2.3E-02	mg/kg	1.7E-05	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	1.1E-03	1.1E-04
Lindane	3.1E-04	mg/kg	2.2E-07	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	1.4E-07	7.0E-08
TOTAL AROCLOR	1.4E+00	mg/kg	1.0E-03	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	2.1E-01	5.2E-02
Aroclor 1254	1.4E+00	mg/kg	1.0E-03	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	2.1E-01	5.1E-02
Aroclor 1268	4.0E-02	mg/kg	2.9E-05	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	5.9E-03	1.5E-03
TEQ-BIRD	1.8E-03	mg/kg	1.3E-06	mg/kg-d					
TEQ-MAMMAL	1.8E-03	mg/kg	1.3E-06	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	**1.3E+00**	1.3E-01
							HAZARD INDICES:	**2.2E+00**	3.1E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table D.3-2.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE D.3-4
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Terrestrial Plants / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Raccoon

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{plant}	ESTIMATED DAILY INTAKE VIA PLANT INGESTION	mg/kg-d	calculated		PLANT INTAKE-INGESTION $EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF * 1/BW$
	C_{plant}	CHEMICAL CONCENTRATION IN PLANTS	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	1.7	USEPA, 1993	
	P_{plant}	PERCENT PLANTS IN DIET	unitless	71%	USEPA, 1993; Llewllyn and Uhler, 1952	Where C_{plant} is estimated using site-specific tissue data or calculated using the following equation: $C_{plant} = C_{soil} * BAF_{plant}$ Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	SFF	SITE FORAGING FREQUENCY	unitless	10%	Stuewer, 1943	
	EF	EXPOSURE FREQUENCY	unitless	50%	USEPA, 1993	
	BW	BODY WEIGHT	kg	6.2	Sanderson, 1984	

REFERENCES

Llewellyn, L.M., and F.M. Uhler, 1952. The foods of fur animals of the Patuxent Research Refuge, Maryland; Am. Midl. Nat. 48:193-203.

Sanderson, G.C., 1984. Cooperative raccoon collections; Ill. Nat. Hist. Survey Div.; Pittman-Robertson Proj. W-49-31.

Stuewer, R.W., 1943. Raccoons: their habits and management in Michigan; Ecol. Monogr. 13:203-257.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE D.3-5
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Terrestrial Plants / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Raccoon

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	6.2E-03	mg/kg	6.4E-05	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	2.5E-03	2.5E-04
Arsenic	5.4E-02	mg/kg	5.6E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.2E-02	1.2E-03
Barium	9.4E+00	mg/kg	9.7E-02	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	1.3E-03	6.1E-04
Beryllium	9.8E-03	mg/kg	1.0E-04	mg/kg-d	1.2E+00	1.2E+01	mg/kg-d	8.5E-05	8.5E-06
Cadmium	1.8E-01	mg/kg	1.8E-03	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	1.8E-03	1.8E-04
Chromium	6.0E-01	mg/kg	6.3E-03	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	4.3E-06	4.3E-07
Cobalt	2.4E-02	mg/kg	2.5E-04	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	3.3E-03	3.3E-04
Copper	1.2E+01	mg/kg	1.2E-01	mg/kg-d	1.2E+01	1.5E+01	mg/kg-d	1.0E-02	8.0E-03
Lead	1.1E+01	mg/kg	1.2E-01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	9.2E-04	3.1E-04
Manganese	1.3E+01	mg/kg	1.4E-01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	1.5E-03	4.8E-04
Molybdenum	4.2E-01	mg/kg	4.3E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.3E-02	2.3E-03
Selenium	1.8E-01	mg/kg	1.9E-03	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	9.6E-03	5.8E-03
Thallium	5.7E-04	mg/kg	6.0E-06	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	4.3E-05	4.3E-06
Vanadium	5.8E-02	mg/kg	6.0E-04	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	1.4E-03	2.9E-04
Zinc	2.2E+02	mg/kg	2.3E+00	mg/kg-d	2.0E+02	3.9E+02	mg/kg-d	1.2E-02	6.0E-03
4,4'-DDD	3.2E-05	mg/kg	3.4E-07	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	4.2E-07	8.4E-0
4,4'-DDE	1.7E-05	mg/kg	1.8E-07	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.3E-07	4.6E-0
4,4'-DDT	1.8E-06	mg/kg	1.9E-08	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.4E-08	4.8E-09
Dieldrin	1.5E-04	mg/kg	1.6E-06	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	1.1E-04	1.1E-05
Lindane	1.8E-05	mg/kg	1.9E-07	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	1.2E-07	5.9E-08
TOTAL AROCLOR	8.8E-04	mg/kg	9.1E-06	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.8E-03	4.6E-04
Aroclor 1254	1.9E-03	mg/kg	2.0E-05	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	4.0E-03	9.9E-04
Aroclor 1268	1.4E-05	mg/kg	1.4E-07	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	2.8E-05	7.1E-06
TEQ-BIRD	0.0E+00	mg/kg	0.0E+00	mg/kg-d					
TEQ-MAMMAL	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	8.5E-02	2.7E-02

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table D.3-4.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

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TABLE D.3-6
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Soil Invertebrates / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Raccoon

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	1.7	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	29%	USEPA, 1993; Llewllyn and Uhler, 1952	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{soil} * BAF_{invert}$
	SFF	SITE FORAGING FREQUENCY	unitless	10%	Stuewer, 1943	
	EF	EXPOSURE FREQUENCY	unitless	50%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	6.2	Sanderson, 1984	

REFERENCES
Llewellyn, L.M., and F.M. Uhler, 1952. The foods of fur animals of the Patuxent Research Refuge, Maryland; Am. Midl. Nat. 48:193-203.
Sanderson, G.C., 1984. Cooperative raccoon collections; Ill. Nat. Hist. Survey Div.; Pittman-Robertson Proj. W-49-31.
Stuewer, R.W., 1943. Raccoons: their habits and management in Michigan; Ecol. Monogr. 13:203-257.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE D.3-7
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Soil Invertebrates / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Raccoon

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	6.3E-01	mg/kg	2.6E-03	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	1.0E-01	1.0E-02
Arsenic	1.8E-01	mg/kg	7.5E-04	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.6E-02	1.6E-03
Barium	2.1E+01	mg/kg	8.8E-02	mg/kg-d	7.5E+01	1.6E+02	mg/kg-d	1.2E-03	5.5E-04
Beryllium	2.1E-01	mg/kg	8.8E-04	mg/kg-d	1.2E+00	1.2E+01	mg/kg-d	7.3E-04	7.3E-05
Cadmium	4.8E+00	mg/kg	2.0E-02	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	2.0E-02	2.0E-03
Chromium	1.8E+00	mg/kg	7.6E-03	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	5.2E-06	5.2E-07
Cobalt	5.7E-01	mg/kg	2.4E-03	mg/kg-d	7.6E-02	7.6E-01	mg/kg-d	3.1E-02	3.1E-03
Copper	3.6E+00	mg/kg	1.5E-02	mg/kg-d	1.2E+01	1.5E+01	mg/kg-d	1.3E-03	9.8E-04
Lead	2.5E+01	mg/kg	1.0E-01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	8.2E-04	2.8E-04
Manganese	5.0E+01	mg/kg	2.1E-01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	2.3E-03	7.3E-04
Molybdenum	2.0E-01	mg/kg	8.5E-04	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	4.5E-03	4.5E-04
Selenium	7.4E-01	mg/kg	3.1E-03	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	1.5E-02	9.4E-03
Thallium	3.8E-02	mg/kg	1.6E-04	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	1.1E-03	1.1E-04
Vanadium	1.4E+00	mg/kg	5.9E-03	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	1.4E-02	2.8E-03
Zinc	1.2E+02	mg/kg	5.0E-01	mg/kg-d	2.0E+02	3.9E+02	mg/kg-d	2.5E-03	1.3E-03
4,4'-DDD	1.9E-03	mg/kg	7.7E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	9.7E-06	1.9E-06
4,4'-DDE	3.0E-03	mg/kg	1.2E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.6E-05	3.1E-06
4,4'-DDT	7.9E-05	mg/kg	3.3E-07	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	4.1E-07	8.3E-08
Dieldrin	4.0E-03	mg/kg	1.7E-05	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	1.1E-03	1.1E-04
Lindane	1.2E-04	mg/kg	5.1E-07	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	3.2E-07	1.6E-07
TOTAL AROCLOR	1.6E-01	mg/kg	6.6E-04	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.3E-01	3.3E-02
Aroclor 1254	1.5E-01	mg/kg	6.2E-04	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.2E-01	3.1E-02
Aroclor 1268	5.2E-03	mg/kg	2.2E-05	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	4.3E-03	1.1E-03
TEQ-BIRD	1.9E-04	mg/kg	7.7E-07	mg/kg-d					
TEQ-MAMMAL	1.9E-04	mg/kg	8.0E-07	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	8.0E-01	8.0E-02
							HAZARD INDICES:	1.3E+00	1.8E-01

Notes:
a. Estimated Daily Intake (EDI) calculated using parameters presented in Table D.3-6.
b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).
c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE D.3-8
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED RTVs : Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Raccoon
TOTAL RISK (HI): 3.6E+00

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-MAMMAL		1.3E+00	-	8.0E-01	-	-	***2.1E+00***	***59%***
TOTAL AROCLOR		2.1E-01	1.8E-03	1.3E-01	-	-	3.4E-01	10%
Aroclor 1254		2.1E-01	4.0E-03	1.2E-01	-	-	3.3E-01	9%
Cobalt		1.5E-01	3.3E-03	3.1E-02	-	-	1.9E-01	5%
Antimony		8.4E-02	2.5E-03	1.0E-01	-	-	1.9E-01	5%
Vanadium		1.0E-01	1.4E-03	1.4E-02	-	-	1.2E-01	3%
Arsenic		8.2E-02	1.2E-02	1.6E-02	-	-	1.1E-01	3%
Molybdenum		3.2E-02	2.3E-02	4.5E-03	-	-	5.9E-02	2%
Selenium		5.2E-03	9.6E-03	1.5E-02	-	-	3.0E-02	1%
Cadmium		2.9E-03	1.8E-03	2.0E-02	-	-	2.5E-02	1%
Copper		7.5E-03	1.0E-02	1.3E-03	-	-	1.9E-02	1%
Zinc		2.4E-03	1.2E-02	2.5E-03	-	-	1.7E-02	0%
Manganese		6.8E-03	1.5E-03	2.3E-03	-	-	1.1E-02	0%
Aroclor 1268		5.9E-03	2.8E-05	4.3E-03	-	-	1.0E-02	0%
Barium		2.9E-03	1.3E-03	1.2E-03	-	-	5.4E-03	0%
Lead		3.3E-03	9.2E-04	8.2E-04	-	-	5.1E-03	0%
Thallium		3.7E-03	4.3E-05	1.1E-03	-	-	4.9E-03	0%
Beryllium		3.0E-03	8.5E-05	7.3E-04	-	-	3.8E-03	0%
Dieldrin		1.1E-03	1.1E-04	1.1E-03	-	-	2.3E-03	0%
Chromium		3.6E-05	4.3E-06	5.2E-06	-	-	4.6E-05	0%
4,4'-DDE		1.7E-05	2.3E-07	1.6E-05	-	-	3.2E-05	0%
4,4'-DDD		1.2E-05	4.2E-07	9.7E-06	-	-	2.2E-05	0%
4,4'-DDT		1.2E-06	2.4E-08	4.1E-07	-	-	1.6E-06	0%
Lindane		1.4E-07	1.2E-07	3.2E-07	-	-	5.8E-07	0%
TEQ-BIRD								
TOTAL MEDIUM-SPECIFIC RISK	-	**2.2E+00**	**8.5E-02**	**1.3E+00**	-	-	**3.6E+00**	
PERCENTAGE OF TOTAL RISK		**62%**	**2%**	**35%**			**100%**	

Footnotes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE D.3-9
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED RTVs : Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current/Future
EXPOSURE POINT: Oxbow Area Floodplain - Average
RECEPTOR: Raccoon
TOTAL RISK (HI): 5.1E-01

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
TEQ-MAMMAL		1.3E-01	-	8.0E-02	-	-	2.1E-01	***41%***
TOTAL AROCLOR		5.2E-02	4.6E-04	3.3E-02	-	-	8.6E-02	***17%***
Aroclor 1254		5.1E-02	9.9E-04	3.1E-02	-	-	8.3E-02	***16%***
Vanadium		2.1E-02	2.9E-04	2.8E-03	-	-	2.4E-02	5%
Cobalt		1.5E-02	3.3E-04	3.1E-03	-	-	1.9E-02	4%
Antimony		8.4E-03	2.5E-04	1.0E-02	-	-	1.9E-02	4%
Selenium		3.2E-03	5.8E-03	9.4E-03	-	-	1.8E-02	4%
Copper		5.8E-03	8.0E-03	9.8E-04	-	-	1.5E-02	3%
Arsenic		8.2E-03	1.2E-03	1.6E-03	-	-	1.1E-02	2%
Zinc		1.2E-03	6.0E-03	1.3E-03	-	-	8.4E-03	2%
Molybdenum		3.2E-03	2.3E-03	4.5E-04	-	-	5.9E-03	1%
Manganese		2.1E-03	4.8E-04	7.3E-04	-	-	3.3E-03	1%
Aroclor 1268		1.5E-03	7.1E-06	1.1E-03	-	-	2.6E-03	0%
Barium		1.4E-03	6.1E-04	5.5E-04	-	-	2.5E-03	0%
Cadmium		2.9E-04	1.8E-04	2.0E-03	-	-	2.5E-03	0%
Lead		1.1E-03	3.1E-04	2.8E-04	-	-	1.7E-03	0%
Thallium		3.7E-04	4.3E-06	1.1E-04	-	-	4.9E-04	0%
Beryllium		3.0E-04	8.5E-06	7.3E-05	-	-	3.8E-04	0%
Dieldrin		1.1E-04	1.1E-05	1.1E-04	-	-	2.3E-04	0%
4,4'-DDE		3.3E-06	4.6E-08	3.1E-06	-	-	6.5E-06	0%
Chromium		3.6E-06	4.3E-07	5.2E-07	-	-	4.6E-06	0%
4,4'-DDD		2.4E-06	8.4E-08	1.9E-06	-	-	4.4E-06	0%
4,4'-DDT		2.3E-07	4.8E-09	8.3E-08	-	-	3.2E-07	0%
Lindane		7.0E-08	5.9E-08	1.6E-07	-	-	2.9E-07	0%
TEQ-BIRD								
TOTAL MEDIUM-SPECIFIC RISK	**-**	**3.1E-01**	**2.7E-02**	**1.8E-01**	**-**	**-**	**5.1E-01**	
PERCENTAGE OF TOTAL RISK		**60%**	**5%**	**35%**			**100%**	

Footnotes:
a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.