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Via Electronic and Regular Mail

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Re: Comments on U.S. EPA's Interim-Final Supplemental Baseline Human Health Risk and Ecological Risk Assessment: Oxbow Area Floodplain Soil and Sediment – Centredale Manor Restoration Project Superfund Site, North Providence, Rhode Island.

For Inclusion in the Administrative Record

Dear Eve and Anna:

On behalf of Emhart Industries, Inc., we enclose for your consideration the comments of Integral Consulting, Inc. ("Integral") that address the above-referenced risk assessment released by EPA in June of 2011 ("Supplemental Oxbow BHHRA/BERA").

In their comments, Integral has identified shortcomings in the Supplemental Oxbow BHHRA/BERA, the most significant of which involve: (1) definition of exposure areas; (2) data representativeness; (3) receptor identification; and (4) exposure parameter quantification. Expressed in lay terms, the Supplemental Oxbow BHHRA/BERA treats as a single exposure area for risk assessment purposes the disparate, non-contiguous portions of the Oxbow and the floodplain areas around Lyman Mill Pond, resulting in an improper, aggregate analysis of the data. As Integral points out, correcting these shortcomings would significantly improve the quality of the risk assessment analysis, enabling a more granular assessment of risks and a determination of whether remediation is needed in specific floodplain areas.

To address these deficiencies in the Supplemental Oxbow BHHRA/BERA, Integral has prepared an independent human health risk assessment and streamlined ecological risk analysis, which are attached to the comments in Appendices A and B.

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We urge your careful consideration of Integral's Comments. As you know, USEPA guidance requires that potential risks to plausible receptor groups at a site be assessed individually for each exposure area. For example, USEPA Region 1 guidance stipulates that "[t]he exposure area is the area of soil, sediment, etc. which an individual may come in contact with."[1] However, only to the extent that "the data from different exposure areas are homogeneous" should the data be combined.[2] Since, as discussed in the comments, the data for the different floodplain areas is not homogenous, separate evaluation of the risk in each area is required. Additionally, the data represent distinct exposure areas, which warrant individual assessment rather than in aggregate.

Should you have any questions regarding the enclosed comments, we and/or Integral would be pleased to discuss them with you. Thank you for your consideration.

Sincerely,

Jeffrey M. Karp

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Enclosure
cc: Mr. Patrick Gwinn (Integral)
Dr. Russell Keenan (Integral)

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[1] USEPA *Supplemental Guidance for Risk Assessment for the Superfund Program, EPA New England Risk Update*, Number 2, August 1994, at 2.

[2] *Id.* ("To the extent that data from different exposure areas are homogeneous the data may be combined to calculate the 95% UCL.")

COMMENTS ON U.S. EPA'S INTERIM-FINAL SUPPLEMENTAL BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS: OXBOW AREA FLOODPLAIN SOIL AND SEDIMENT CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE NORTH PROVIDENCE, RHODE ISLAND

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1 INTRODUCTION

In June 2011, U.S. Environmental Protection Agency (USEPA) Region I released the *Interim-Final Supplemental Baseline Human Health Risk and Ecological Risk Assessment: Oxbow Area Floodplain Soil and Sediment* (herein referred to collectively as the "Supplemental Oxbow BHHRA/BERA" or individually as the "Supplemental Oxbow BHHRA" and "Supplemental Oxbow BERA") for the Centredale Manor Restoration Project Superfund Site (MACTEC, 2011). The Supplemental Oxbow BHHRA /BERA were prepared by MACTEC Engineering and Consulting, Inc., under contract to Battelle Corporation, and were submitted to the Department of the Army, U.S. Army Corps of Engineers, New England Division under Contract No. DACW33-03-D-0004, Delivery Order No. 26.

At the request of Emhart Industries, Inc. (Emhart), Integral Consulting, Inc. (Integral) prepared these comments on the Supplemental Oxbow BHHRA/BERA.

Integral also prepared for USEPA's consideration a human health risk assessment (HHRA) and streamlined ecological risk analysis consistent with the comments provided herein.

Section 2 of the document provides comments on USEPA's Supplemental Oxbow Area BHHRA, while section 3 provides the comments on the Supplemental Oxbow Area BERA.

Section 3 provides a summary of Integral's HHRA and streamlined ecological risk analysis, which are attached as Appendices A and B, respectively.

2 SUPPLEMENTAL OXBOW AREA BHHRA COMMENTS

These comments address USEPA's reevaluation of the baseline human health risk assessment for the Oxbow flood plain soil and sediment. The Agency's reevaluation is appropriate given the extensive soil and sediment sampling data generated from the 2010 Supplemental Investigation of the Lyman Mill Reach Sediment and Flood Plain Soils (Integral, 2011), and the comments submitted regarding USEPA's exposure assessment in the *2006 Addendum to the Interim Final Baseline Risk Assessment: Oxbow Area, Part I Human Health Risk Assessment* (USEPA, 2006).

Using the analytical results of the 2010 Supplemental Investigation together with modified, yet still conservative, human health exposure parameters, USEPA has concluded that current and potential future human health risks associated with routine use of the Oxbow Area are not significant (i.e., the excess lifetime cancer risks and non-cancer hazards do not exceed the USEPA's risk thresholds). Nevertheless, USEPA's Supplemental Oxbow BHHRA has significant shortcomings which, if properly addressed, would appreciably improve the assessment of potential health risks in the Oxbow Area. Moreover, the correction of the shortcomings, as enumerated below, would provide information on potential baseline health risks associated with other identified flood plain areas around Lyman Mill Pond, which could be used to assess whether remediation is required in these other floodplain areas.

The most significant shortcomings of USEPA's Supplemental Oxbow BHHRA are in the following areas:

1. Definition of exposure areas,
2. Data representativeness assessment,
3. Receptor identification, and
4. Exposure parameter quantification.

Detailed comment is provided below for those items that are specific to the USEPA's Supplemental Oxbow Area HHRA. We also reference previously submitted comments on Emhart's behalf, regarding the *2006 Addendum to the Interim Final Baseline Risk Assessment: Oxbow Area, Part I Human Health Risk Assessment* that are pertinent to the Supplemental Oxbow Area HHRA. Such previously submitted comments that are cited herein are incorporated by reference.

2.1 DEFINITION OF EXPOSURE AREAS

In the Supplemental Oxbow BHRRA, USEPA defines non-contiguous floodplain areas as one exposure area. This results in the pooling of data in an inappropriate manner for the purposes of calculating exposure point concentrations. It further limits the ability to use the data to perform a more robust assessment.

For example, the Oxbow Area, located at the far northern extent of Lyman Mill Pond, and the floodplain soils in the southeastern portion of Lyman Mill Pond are distinctly different areas. They are located over a half mile from one another, are separated by water (Lyman Mill Pond), and have distinctly different access points. Nonetheless, USEPA pools the analytical data from these two areas together with data from other areas, to yield a single exposure point concentration for the so-called "general exposure area". This approach is inappropriate because, due to the distance between them, their distinct access points, and their physical differences/attractiveness, the potential long-term users of the Oxbow Area are unlikely to be the same users of the floodplain soils in the southeastern portion of Lyman Mill Pond. Therefore, the exposures for each individual area should be evaluated separately, in which case the pooling of data between areas would not occur.

Moreover, conducting assessments by individual exposure areas yields baseline human health risk assessment results that can be applied more discretely (i.e. to specific flood plain areas). The provision of data in that manner aids in the evaluation of the extent to which remediation may be required for each flood plain area.

Given the physical separation of discrete flood plain areas by both water and distance, the baseline risks associated with the following general areas should be assessed individually, instead of jointly, as done in USEPA's Supplemental Oxbow BHHRA:

1. The flood plain and upland soils in the Oxbow Area,
2. The flood plain soil in the northeastern portion of Lyman Mill Pond, east of the Oxbow Area,
3. The emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond), and
4. The flood plain soil in the southeastern portion of Lyman Mill Pond.

Thus, it is recommended that USEPA individually evaluate potential baseline human health risks for each of the above identified general exposure areas.

Additionally, the manner in which USEPA identified the general exposure area of the Oxbow Area improperly excluded certain samples within the Oxbow Area that plausibly could be accessed by a passive recreational visitor. USEPA excluded data from soil samples that were collected from higher elevation terrain even though the probability of a passive recreational visitor visiting these sampling locations is equal to the probability that they would visit any other general area sampling station within the Oxbow Area. The exclusion of such samples is inconsistent with USEPA Region I guidance, which states that "The exposure area is the soil, sediment, etc., which an individual may come into contact with." (USEPA, 1994).

For example, USEPA's Supplemental Oxbow BHHRA does not include the human health sampling data in the general assessment area even though it is entirely plausible that a visitor could access the so-called "human health concern area". This is not to say that the human health concern area and general area receptors are the same. They are not. The receptor in the

human health concern area is a passive recreational visitor who is likely to travel only on well worn trails that do not require bushwhacking or walking through muddy soil for passage. Thus, the samples used to define the human health concern area are in forested upland areas where passage is relatively easy going. In contrast, the general area receptor is a passive recreational visitor who would be required to undertake bushwhacking techniques to access all portions of the Oxbow Area.

However, the general area passive recreational visitor's use of areas other than the human health concern area does not preclude their use of the human health concern area. In fact, access to many general area sampling locations is made possible by passage through the human health concern area. Therefore, it is likely that the general passive recreational visitor contacts both the general area soils and the human health concern area soils. Consequently, USEPA should include both the general and the human use sampling data when computing the exposure point concentration for the general passive recreational receptor.

Moreover, USEPA should include in the computation of general area exposure point concentrations the areas defined by samples SS_G-01-SS4, SS_G-01-SS10, SS_G-01-SS2, and SS_G-01-SS13 because there is nothing prohibiting a general area passive recreational visitor from visiting the portions of the Oxbow Area where these samples are located. In fact, there is equal probability that a general passive recreational visitor would visit these sampling locations as well as all other general area and human health concern area sampling locations. Therefore, it is recommended that USEPA also use these data in determining exposure point concentrations for the general area.

2.2 DATA REPRESENTATIVENESS ASSESSMENT

USEPA did not follow its own guidance in selecting the data used in the Supplemental Oxbow BHHRA. USEPA Region 1 guidance on human health risk assessment states that the 0-1′ soil depth interval is considered surface soil for assessing incidental ingestion and dermal exposure pathways (USEPA, 1995). Contrary to its own guidance, USEPA used four samples in the general area exposure assessment that were collected from the 0-0.5′ interval[1], which is inconsistent with USEPA's stated preference of 0-1′. All of the samples collected by Integral in 2010 were from the 0-1′ interval in order to be consistent with the 1995 USEPA Region I guidance for conducting a human health risk assessment on the dermal and incidental ingestion exposure pathways. Accordingly, USEPA should have used only data from samples collected in 2010 in its Supplemental Oxbow BHHRA.

In addition, USEPA inappropriately averaged data from several discrete sample locations prior to computing the 95% upper confidence level on the mean (95UCL) for use in the general area risk assessment. The data that were averaged were not duplicate samples. Rather, they were individual sampling locations. It is inappropriate to average data prior to computing the

[1] LPX-FP-4004-0000-01, LPX-SD-4405-0005-01, LPX-SD-4406-0005-01, and LPX-SD-4407-0005-01

95UCL because variability between individual data points is lost when the data are averaged. Once averaged, that inter-sample variability cannot be evaluated by the ProUCL software. It is recommended that USEPA use the data from each discrete sampling location when computing the 95UCLs, and data should not be averaged prior to doing so.

Finally, USEPA uses sample RES-11-419-02, the location of which is described in the Supplemental Oxbow BHHRA as being along the western bank of the Woonasquatucket River within the Oxbow Area. However, the nomenclature used for this sample, collected in 1999, suggests that it actually was collected from a residential location on the eastern shore of Lyman Mill Pond, not from the Oxbow Area as shown in the Supplemental Oxbow BHHRA.

The "RES" portion of the sample ID indicates the sample is from a residential area. The "-11-419" portion of the sample ID indicates that the sample was collected from the property on plat 11, property number 419, which is a residential property at the western end of Zambarano Avenue in North Providence. The final part of the sample ID, "-02," indicates this sample was the second sample collected from the property, with the first sample, RES-11-419-01, having been collected closer to the water's edge and sample RES-11-419-03 having been collected further upland from RES-11-419-02 . Though the geographic coordinates for RES-11-419-02 within the USEPA database places the sample in the Oxbow Area, the sample nomenclature suggests otherwise. Furthermore, the data from RES-11-419-02 is consistent with the sample having been collected in close proximity to samples RES-11-419-01 and RES-11-419-03, with a decreasing concentration gradient with increasing sample elevation. We recommend that USEPA verify the actual location of sample RES-11-419-02 before using it in the Supplemental Oxbow BHHRA.

In light of the foregoing, we further recommend that the exposure areas be assessed using data from the listed sampling locations.

1. Human health exposure area of the Oxbow Area: SS_H-01, SS_H-03, SS_H-06, SS_H-07, SS_H-10, SS_H-13, SS_H-16, SS_H-18, SS_H-19, and SS_H-20.
2. General exposure area of the Oxbow Area: SS_H-01, SS_H-03, SS_H-06, SS_H-07, SS_H-10, SS_H-13, SS_H-16, SS_H-18, SS_H-19, SS_H-20, SS_G-01-SS1, SS_G-01-SS2, SS_G-01-SS3, SS_G-01-SS4, SS_G-01-SS5, SS_G-02, SS_G-03, SS_G-04, SS_G-05, SS_G-06, SS_G-07, SS_G-08, SS_G-09, SS_G-04, SS_G-10, SS_G-12, and SS_G-13.
3. General exposure area in the northeastern portion of Lyman Mill Pond, east of the Oxbow Area: SS_G-23, SS_G-26, SS_G-29-SS1, SS_G-29-SS2, and SS_G-29-SS3.
4. General exposure area in the emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond): SS_G-31 and SS_G-32.
5. General exposure area in the flood plain soil in the southeastern portion of Lyman Mill Pond: SS_G-30 and SS_G-33.

The data from these sampling locations are current, contemporaneous, collected in a manner consistent with the USEPA-defined depth interval for surface soil exposure assessment, and are

consistent with respect to chemicals analyzed. Moreover, as discussed above, using the data in this manner to evaluate individual exposure areas also enables its use to evaluate the need for and extent of any required remediation for each area.

2.3 RECEPTOR IDENTIFICATION

USEPA has identified for both the human use and general areas individuals engaged in passive recreational activities as the most likely receptors. Furthermore, USEPA has assumed that these individuals could be young children (ages 1 to 6 years), adolescents (ages 7 to 18 years) and adults (ages 19 to 30). USEPA's assumption that the receptors are similar for both the human use and the general areas overstates the plausible exposures for the general areas. This occurs because, given the physical nature of the general areas, young children are unlikely to recreate in these areas on a routine basis.

Within the human health concern area, the soils are generally dry, the vegetation is not dense, and reasonably passable foot trails exist. While one can reasonably assume that young children, adolescents and adults might visit this area, access to the general area is limited due to the absence of an easily passable trail system and the presence of dense and potentially hazardous vegetation that includes green briar, poison ivy, and brambles. Also, because the general area is within the floodplain, the soils are not dry, and often are wet. Thus, any paths that might be present within the general area are limited to small game trails, and access through these paths requires the use of a machete. Given the physical hazards, it is unreasonable to assume that young children ages 1 to 6 would visit the general area on a routine basis.

Moreover, this is consistent with the approach taken in the *Interim Final Baseline Human Health Risk Assessment for the Centredale Manor Restoration Project Superfund Site* (USEPA, 2005), in which USEPA states that, for non-residential situations (e.g., the visiting recreational angler), young children would not be involved in recreational activities, such as fishing, or the wading and traversing of bank soils that may occur while fishing. Id at 3-8. Since USEPA assumed that young children would not accompany older children or adults while they fish in non-residential floodplain areas (USEPA, 2005), it is reasonable for USEPA to make the same assumption for other recreational activities that occur in non-residential, floodplain locations, such as the general areas.

Therefore, we recommend that USEPA limit the receptor groups for the general areas to the adolescent and adult passive recreational visitors, thus excluding from the analysis the young children age group.

2.4 EXPOSURE PARAMETER QUANTIFICATION

USEPA relies on numeric exposure parameters to quantify potential receptor exposure to chemicals in soil via direct contact. Due to the nature of the Oxbow Area, many of the exposure

parameters used by USEPA in the Supplemental Oxbow Area BHHRA are based on professional judgment rather than on specific USEPA guidance for similar exposures. However, as discussed below, USEPA has chosen unrealistic or implausible exposure parameters that result in the overstatement of potential risks.

2.4.1 Exposure Frequency

USEPA assumes that a passive recreational visitor spends 78 days per year (3 days per week for 26 weeks per year) in the human health exposure area of the Oxbow Area. Over the course of an assumed 30 year total exposure period, the passive recreational visitor is assumed to spend 6.4 years in the Oxbow Area. As stated in our May 4, 2007 letter to Anna Krasko, this is an excessively high frequency given that the area has limited accessibility[2]. We recommend the use of a more reasonable high-end exposure frequency, such as 39 days per year.

Regarding the general area, USEPA assumed that the passive recreational visitor (including 1-6 year olds) spend 26 days per year (1 day per week for 26 weeks per year) in this portion of the Oxbow Area. The nature of the general area, including the presence of brambles, poison ivy, green briar, and soil that quickly can change from damp to saturated, substantially limits the routine, casual use of this area. Though the general use area may be attractive to some receptors for a short period of time (e.g., adolescence), long-term, routine exposure is unlikely to occur in this area. In our view, a more plausible long-term reasonable maximum exposure (RME) frequency for the general area is 12 days per year, which is twice per month.

2.4.2 Soil Ingestion Rates

In our prior comments provided in the January 25, 2007 letter to Anna Krasko, we detailed the shortcomings of the soil ingestion rates used by USEPA and provided justifiable alternative soil ingestion rates[3]. Nonetheless, USEPA continues to use unsupportable and excessively high soil ingestion rates for all receptors.

We recommend that USEPA use RME incidental soil ingestion rates of 100 mg/d, 50 mg/d, and 50 mg/d, respectively, for children, adolescents and adults.

2.4.3 Fraction Ingested

As stated in our May 4, 2007 letter to Anna Krasko, a1.0 fraction ingested (FI) from the Site unrealistically assumes that the receptor receives from the Oxbow Area an entire day's incidental ingestion of soil. As noted in the USEPA's Supplemental Oxbow HHRA, an assumed FI of 1.0 may be appropriate for a residential exposure scenario, but it should not be applied for

[2] Letter from Russell E. Keenan and Patrick O. Gwinn of AMEC to Anna Krasko of USEPA regarding the CMRP Oxbow Area Risk Assessment, May 4, 2007.
[3] Letter from Jerome C. Muys Jr. of Bingham McCutchen to Anna Krasko of USEPA regarding the CMRP Site, January 25, 2007.

passive recreational visitors to the Oxbow Area. Rather, a FI of 0.5, or 50%, is consistent with the approach taken in the *Interim Final Baseline Human Health Risk Assessment for the Centredale Manor Restoration Project Superfund Site* (USEPA, 2005), in which USEPA states,

> The fraction ingested value of 50% accommodates the likelihood that visiting receptors [non-residential] who do not live immediately near the Site would incur only a portion of their daily exposure to soil or sediment at the Site, and the remainder at off-site locations such as residential yards.

Id. at 3-9.

Whereas here, the receptor is a visiting passive recreational visitor, we recommend that USEPA use a fraction ingested value of 0.5, thus indicating that only a half day's incidentally ingested soil plausibly is from the Oxbow Area.

2.4.4 Relative Bioavailability

USEPA used a relative bioavailability (RBA) of 1.0 for dioxin, specifically 2,3,7,8-TCDD despite the availability of ample data to support an RBA of 0.3. USEPA (2010) identifies six studies that report a total of 17 RBA test results for 2,3,7,8-TCDD in soil. The RBA values for these studies range from <1 percent to 49 percent. An RBA of 30 percent is the 50th percentile RBA value, and the mean of the selected test results is 26 percent.

USEPA (2010) also notes that relative bioavailability appears to be dose-dependent, with higher doses potentially having higher relative bioavailability. However, the doses computed for the Supplemental Oxbow Area BHHRA are at several orders of magnitude lower than the doses reported in USEPA (2010). Therefore, the RBA for dioxin in the Supplemental Oxbow Area BHHRA should not be based on the high-end dosing regiment studies in USEPA (2010). Rather, it certainly would seem appropriate, although perhaps even a bit conservative, to assign a RBA value at the central tendency of the range of the RBAs presented in USEPA (2010). Thus, we recommend the USEPA use an RBA of 30 percent for the exposure assessment to dioxin in the Supplemental Oxbow Area BHHRA.

2.4.5 Exposed Dermal Surface Area

Although, the exposures being assessed in the Supplemental Oxbow Area BHHRA are not consistent with residential exposures, USEPA nonetheless used exposed dermal surface areas that are "for residential exposure"[4]. As indicated in our May 7, 2007 letter to Anna Krasko, it is inappropriate to assume that young children visiting the Oxbow area would only wear shorts and a short-sleeved shirt, and that adolescents and adults would only wear shorts, short-sleeved shirts and shoes. The time frame over which exposure occurs (early spring to fall) and

[4] See USEPA (2011) at Table 4.1, footnote 8.

the physical hazards within the Oxbow Area described above simply would not enable any visitors to wear such minimal apparel, particularly in the general exposure areas.

It is more likely that, at a minimum, a passive recreational visitor to the Oxbow Area's human health exposure area (whether a young child, an adolescent, or an adult) would wear shoes, shorts, and a short sleeved shirt. Moreover, it is unlikely that the entire visitor's head would contact soil, as assumed in USEPA's assessment, although it seems plausible that soil on the visitor's hands could routinely contact the face.

For the general exposure area, USEPA's use of residential exposure assumptions is totally unrealistic for routine, long-term use of the Oxbow Area's general area. Accordingly, we recommend that USEPA modify the exposed surface area estimates in the Supplemental Oxbow Area BHHRA to be consistent with and reflective of the nature of the Oxbow Area and other flood plain areas on Lyman Mill Pond.

3 SUPPLEMENTAL OXBOW AREA BERA COMMENTS

USEPA's Supplemental Oxbow Area BERA suffers from many of the same shortcomings as the HHRA, thus significantly limiting the report's utility. Specifically, USEPA fails to utilize the recently collected soil sampling data (Integral, 2011) in a manner that would enhance the assessment of potential ecological risks. The absence of a more fulsome assessment occurs because USEPA pools the analytical data from non-contiguous potions of the Lyman Mill Reach Sediment and Flood Plain Soil study areas, instead of independently evaluating specific areas of the Lyman Mill flood plain. Evaluation of independent floodplain areas would provide the information needed to determine what, if any, remediation is required in these other floodplain areas.

The most significant shortcomings of USEPA's Supplemental Oxbow BERA are in the following areas:

1. Definition of exposure areas,
2. Data representativeness assessment, and
3. Exposure point concentration calculations.

Each of these areas of deficiency is discussed below.

3.1 DEFINITION OF EXPOSURE AREAS

USEPA's pooling of data for flood plain soils in the Lyman Mill Pond study into a single ecological exposure area minimizes the effectiveness of the Supplemental Oxbow Area BERA because the results of the assessment cannot be used to determine which portions of the flood plain areas may pose a significant risk to ecological receptors. Furthermore, due to the aggregation of the data, USEPA cannot use the results to determine what, if any, remediation may be needed to mitigate the computed potential ecological risks.

The physical configuration of the flood plain areas in the Lyman Mill Sediment and Flood Plain Soil study area allows for the delineation of four ecological exposure areas that each should be evaluated independently, as follows:

1. the flood plain and upland soils in the Oxbow Area;
2. the flood plain soil in the northeastern portion of Lyman Mill Pond, east of the Oxbow area;
3. the emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond); and
4. the flood plain soil in the southeastern portion of Lyman Mill Pond.

Thus, it is recommended that USEPA independently assess the incremental ecological risks at each of these areas.

Moreover, USEPA inexplicably limited the ecological exposure area of the Oxbow Area to the portion identified as forested wetland. Such a limitation is arbitrary; it ignores the fact that the upland portions of the Oxbow Area also provide adequate habitat to the terrestrial receptors evaluated by USEPA in the Supplemental Oxbow Area BERA. Accordingly, we recommend that USEPA include in the assessment all portions of the Oxbow Area.

3.2 DATA REPRESENTATIVENESS ASSESSMENT

Since, the ecological exposure area in the Oxbow Area should include both the forested wetland and upland areas, USEPA should not have limited the data set to just a select group of surface soil samples. Rather, all recently collected surface soil data from the entire Oxbow Area should have been included in the evaluation. The data from all samples collected by Integral in 2010 is the most appropriate set of data upon which to compute the potential ecological risks. Thus, USEPA should include in its assessment of the Oxbow Area all of the general area samples as well as all of the human use area samples. We recommend that the following exposure areas be assessed using data from the following sampling locations.

1. Oxbow Area : SS_H-01, SS_H-03, SS_H-06, SS_H-07, SS_H-10, SS_H-13, SS_H-16, SS_H-18, SS_H-19, SS_H-20, SS_H-01, SS_H-03, SS_H-06, SS_H-07, SS_H-10, SS_H-13, SS_H-16, SS_H-18, SS_H-19, SS_H-20, SS_G-01-SS1, SS_G-01-CR1A, SS_G-01-SS2, SS_G-01-SS3, SS_G-01-SS4, SS_G-01-SS5, SS_G-02, SS_G-03, SS_G-04, SS_G-05, SS_G-05-CR1A, SS_G-06, SS_G-07, SS_G-08, SS_G-09, SS_G-04, SS_G-10, SS_G-12, and SS_G-13.
2. Northeastern portion of Lyman Mill Pond, east of the Oxbow Area: SS_G-23, SS_G-26, SS_G-26-CR1A, SS_G-29-SS1, SS_G-29-SS2, and SS_G-29-SS3.
3. Emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond): SS_G-31 and SS_G-32.
4. Flood plain soil in the southeastern portion of Lyman Mill Pond: SS_G-30 and SS_G-33.

3.3 EXPOSURE POINT CONCENTRATION CALCULATIONS

Even assuming, arguendo, that the exposure areas and data used to represent those areas are correct in the Supplemental Oxbow Area BERA, the exposure point concentrations (EPCs) used in USEPA's calculations are not technically supportable. This results from using the 95UCL as the EPC, and from the data used by USEPA to calculate the EPC.

The EPC represents the average concentration of chemicals in an area where a receptor may reasonably be assumed to move at random and where contact with an environmental medium is equally likely at all locations. The default assumption in human health risk assessments is to calculate the 95UCL of the average concentration without regard to the spatial representativeness of the chemical results. The USEPA's ProUCL software used to calculate the 95UCL values also assumes that the distribution derived for the observed results, or the variability of the results that do not fit into one of the pre-defined distributions (normal,

lognormal, or gamma), would also be applicable to the non-sampled areas. However, that assumption is not realistic for most environmental datasets.

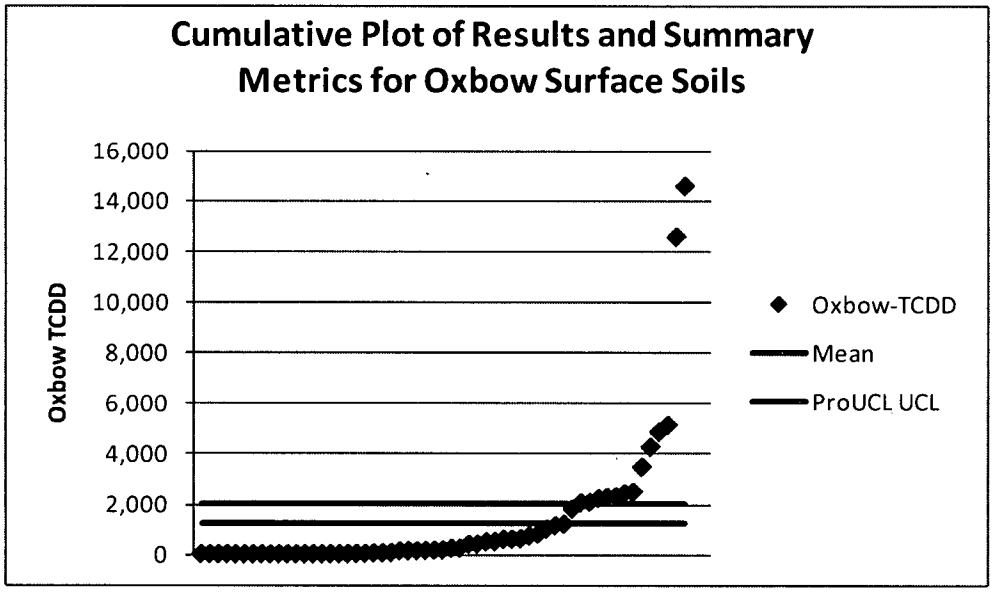
Notwithstanding the issue of the spatial representativeness of the sample results (which is ignored when USEPA's ProUCL software is used), it is also important to visually inspect the data distribution and the calculated EPCs to determine whether the EPC estimates appropriately represent the reasonable central tendency of the dataset. Figure 1a and 1b plot the soil sample results for the 56 samples identified by USEPA in Table 1 of the Supplemental Oxbow Area BERA, the arithmetic mean of those data, and the calculated 95UCL using ProUCL for the 2,3,7,8-TCDD surface soil results from the Oxbow Area.

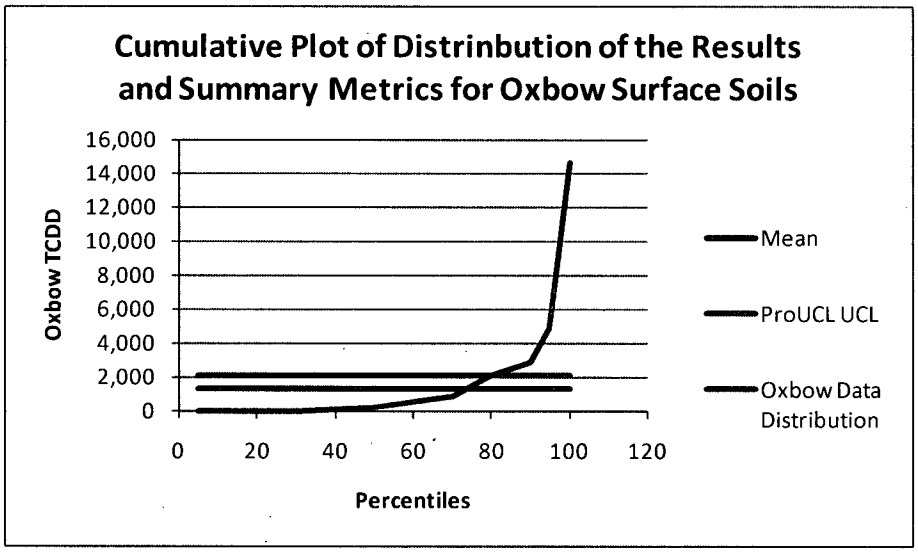
Figure 1a shows the individual soil sample results as discrete points, while Figure 1b shows these same data as percentiles of the distribution. The calculated 95UCL from USEPA's ProUCL software (2,066 pg/g), which is based on the adjusted gamma distribution, is well over the average concentration (1,272 pg/g) of the data, and corresponds to the 80th percentile of the observed dataset. Since, with a few exceptions, the samples were collected using a random location strategy, and have a relatively even spatial distribution across the site, the UCL is clearly not a good representation of the potential average exposure that ecological receptors may encounter throughout the Oxbow Area. In fact, due primarily to the concentration of 2,3,7,8-TCDD in only two soil samples (SS_G-01-SS3 and SS_G-29-SS3), the arithmetic mean is equal to the 72nd percentile of the data distribution shown in Figure 1b. Consequently, assuming equal probability of contact with any soil sampling location, the average concentration represents a conservatively high measure of central tendency exposure potential for this data set.

It is important that EPC values used to estimate exposures for ecological receptors are based on a sound rationale that incorporates both the receptors habit and the representativeness of the sampling that was performed to calculate the EPCs. In this case, the use of the 95UCL as the EPC for dioxin introduces unnecessary bias and conservatism into ecological risk assessment, which, by design, already encompasses conservative exposure estimates.

Based on the foregoing, USEPA should rely on average or mean concentrations for EPCs, rather than the 95UCL. Moreover, regarding the data used in computing the EPC, USEPA should not have calculated a single EPC for each chemical to represent all flood plain soils. Instead, USEPA should compute EPCs for each of the areas defined in Section 3.1, which will provide the input needed to compute potential ecological risks for each area.

Finally, all of the food web exposure tables in USEPA's Supplemental Oxbow Area BERA state that surface soil is defined as the 0-2' interval of soil. Consequently, USEPA should use all data from soil sampling locations with samples from both the 0-1' and the 1'-2' depth intervals.





Figures 1a and b. Comparisons of 2,3,7,8-TCDD in Surface Soil to Different EPCs.

4 SUMMARY OF INTEGRAL'S SITE-SPECIFIC HHRA & STREAMLINED ECOLOGICAL RISK ANALYSIS

Integral has prepared a HHRA and a streamlined ecological risk analysis for the upland and flood plain soil comprising the areas within the Lyman Mill Reach Sediment and Flood Plain Soils. A summary of the findings for each are provided below. The complete HHRA and streamlined ecological risk analysis are attached to the comments as Appendices A and B, respectively.

4.1 INTEGRAL'S HUMAN HEALTH RISK ASSESSMENT

The HHRA's purpose is to quantitatively assess potential human health risks associated with the specific exposure areas and receptors identified below. In addition, Integral's HHRA evaluates plausible receptor populations, using exposure parameters that are indicative of likely uses of the defined exposure areas. The receptors and corresponding exposure parameters were developed based on observations of the physical environ within the exposure areas.

In total, five exposure areas are evaluated:

1. Human health exposure area within the Oxbow area,
2. General area within the Oxbow area,
3. General flood plain soils in the northeastern portion of Lyman Mill Pond, east of the Oxbow area,
4. General emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond), and
5. General flood plain soil in the southeastern portion of Lyman Mill Pond.

The potential receptors that might use the human health exposure area within the Oxbow area for passive recreational activities include children (1-6 yrs), adolescents (7-18 yrs), and adults (19-30 yrs). The human health exposure area is the only area where a young child or older child (7 to 12 years) would regularly visit.

While it is unlikely that the general exposure areas would be routinely accessed by any receptor, for the purposes of this risk assessment, it is assumed that a teenager (13 to 18 years) and an adult (19 to 30 years) might occasionally enter the general areas in the Oxbow, the northeastern and southeastern portions of Lyman Mill Pond, and the area at the confluence of Assapumpset Brook.

Exposures to chemicals of potential concern were estimated assuming dermal contact and incidental ingestion of surface soil. Both central tendency and reasonable maximum exposures were assessed for all receptors, exposure pathways, and exposure areas.

For each exposure area, noncancer hazard indexes were computed for each receptor age group, and potential cancer risks were computed based on an average lifetime exposure. Noncancer hazard indexes for all receptors and exposure areas were less than 1.0. Cancer risks were either below the USEPA acceptable risk range of 10^{-4} to 10^{-6} or at the lower end of this range (between 10^{-5} and 10^{-6}). A summary of noncancer hazards and cancer risks for each receptor and area evaluated by Integral is provided in Table 1.

The results of the HHRA demonstrate that none of the areas evaluated pose a significant (i.e., an unacceptable) health risk to the receptors evaluated. Consequently, upland and flood plain soils within the Lyman Mill Reach Sediment and Flood Plain Soils portion of the Site do not require remediation.

Table 1. Summary of Integral's Human Health Risk Assessment Results

Exposure Area	Receptor	Noncancer Hazard		Cancer Risk	
		RME	CTE	RME	CTE
Oxbow Human Health Area	Child	0.38	0.050	--	--
	Adolescent	0.083	0.0060	--	--
	Adult	0.069	0.0049	--	--
	Lifetime	--	--	4.5E-07	2.3E-08
Oxbow General Area	Adolescent	0.022	0.00064	--	--
	Adult	0.020	0.000544	--	--
	Lifetime	--	--	5.5E-06	6.5E-08
Northeast Lyman Mill Pond Flood Plain General	Adolescent	0.037	0.000354	--	--
	Adult	0.020	0.00030	--	--
	Lifetime	--	--	5.8E-06	1.9E-08
Southeast Lyman Mill Pond Flood Plain General	Adolescent	0.0086	0.00022	--	--
	Adult	0.0096	0.000186	--	--
	Lifetime	--	--	1.3E-07	1.3E-09
Assapumpset Brook Flood Plain General	Adolescent	0.017	0.000386	--	--
	Adult	0.015	0.000326	--	--
	Lifetime	--	--	3.0E-07	2.7E-09

4.2 INTEGRAL'S STREAMLINED ECOLOGICAL RISK ANALYSIS

The purpose of Integral's ecological risk analysis is to provide a focused update of USEPA's 2006 Addendum to the Interim Final Baseline Risk Assessment (BERA): Oxbow Area (Oxbow Addendum) by applying the more robust 2010 soil sampling data to USEPA's risk model for the short-tailed shrew, the most sensitive receptor evaluated by the Agency.

The four ecological exposure areas evaluated in the streamlined ecological risk analysis are:

1. flood plain soils within the Oxbow area;
2. flood plain soils in the northeastern portion of Lyman Mill Pond, east of the Oxbow area;
3. the emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond); and
4. the flood plain soil in the southeastern portion of Lyman Mill Pond.

In the streamlined ecological risk analysis, exposures and potential ecological risks were assessed only for the most sensitive receptor in USEPA's 2006 analysis. Short-tailed shrew exposures to chemicals of potential ecological concern were estimated to occur through incidental ingestion of surface soil, as well as through dietary consumption of plants and soil-borne invertebrates. With the exception of exposure point concentrations, which were based on the 2010 sampling data (Integral, 2011) in this analysis, all exposure assumptions and models used by USEPA in the Oxbow Addendum were applied in this assessment.

For each exposure area, hazard quotients were calculated for each chemical of potential concern and then summed to provide an area-specific hazard index. As in USEPA's assessment, hazard quotients were estimated using both no observable adverse effect level (NOAEL) and lowest observable adverse effect level (LOAEL)-based toxicity reference values. The incremental ecological risk above upstream background risk, computed as a ratio of site-specific risk to upstream risk, was also computed for each area. This ratio is termed the "incremental hazard index." For this assessment, the ecological risk to the short-tailed shrew computed for Greystone Mill Pond flood plain soils as presented in the USEPA BERA (1995) was used to represent upstream background. The LOAEL- and NOAEL-based incremental hazard indices for the short-tailed shrew are summarized in Table 2.

Table 2. Incremental Hazard Index Summary for Short-tailed Shrew - NOAEL- and LOAEL-Based Toxicity Reference Values (TRVs)

	Greystone[a]	General Oxbow HQ (RME)		NE Lyman HQ (RME)		SE Lyman HQ (RME)		Assapumpset Brook HQ (RME)	
Hazard Basis	HI	HI	Inc HI	HI	Inc HI	HI	Inc HI	HI	Inc HI
NOAEL-Based	130	146	1.1	387	3.0	51	0.39	77	0.59
LOAEL-Based	16	16	1.0	40	2.5	6	0.38	13	0.81

a. Greystone risk estimates as calculated and presented in the BERA (MACTEC, 2004; Appendix L). HI is based on summing the hazard quotients (HQs) of all chemicals of potential ecological concern selected in the BERA.
b. Inc HI = Incremental Hazard Index

As shown in Table 2, the LOAEL- and NOAEL- based incremental hazard indices were less than one for the floodplain soil in the southeast Lyman Mill Pond and Assapumpset Brook areas, indicating that the potential risk to the short-tailed shrew computed for these areas are lower than the background risk for this receptor (i.e., the computed risk to the short-tailed shrew is higher in the background area, Greystone Mill, than in these study areas). Thus, these areas pose a lower potential risk to the short-tailed shrew when compared to upstream background.

The LOAEL-based incremental hazard index for the Oxbow area is 1.0, while the NOAEL-based incremental hazard index for the Oxbow area is 1.1. Since the incremental hazard indices are equal to or nearly equal to 1.0, this demonstrates that the theoretical risk to the short-tailed

shrew is not significantly different at the Oxbow area when compared to upstream background, thus indicating that risks to this area are not significantly elevated in comparison to background. Therefore, no mitigation of risk in this area is required. Nonetheless, limited remediation of the northeastern portion of the Oxbow area may still be considered to reduce the potential for redistribution of surface soil contamination, which, due to the topography of this specific area, receives intermittent floodwaters from the Woonasquatucket River.

The LOAEL-based incremental hazard index for the flood plain soil in the northeastern portion of Lyman Mill Pond is 2.5 while the NOAEL-based incremental hazard index for this area is 3.0. These incremental hazard indices suggest that the theoretical risk to the short-tailed shrew at the northeastern portion of Lyman Mill Pond is higher when compared to upstream background. Consequently, mitigation of risks in this area may be warranted.

5 CONCLUSION

Integral's Comments identify, document, and discuss the technical shortcomings of the analyses that comprise USEPA's Supplemental Oxbow Area BHHRA/BERA reports. The Comments focus on exposure scenarios and risk assessment topics with the potentially greatest implications for setting target remediation goals and assessing remedial options.

From an exposure area standpoint, the analyses presented in the Supplemental Oxbow Area BHHRA/BERA do not take full advantage of the recently collected flood plain soils data. USEPA should have evaluated individually each of the exposure areas detailed above using the sampling data from Integral's supplemental investigation. As demonstrated in Integral's attached HHRA, when the 2010 sampling results are applied in the recommended manner, the potential human health risks associated with the Oxbow Area's human health exposure area and all of the general areas do not pose a significant risk to human health (i.e., computed cancer risks are within or lower than USEPA's cancer risk range, and noncancer hazards are below USEPA's noncancer threshold). Moreover, when the analysis is conducted as in Integral's attached streamlined ecological risk analysis, the only exposure area that may pose an ecological health risk above background is the floodplain in the northeastern portion of Lyman Mill Pond.

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APPENDIX A

Centredale Manor Restoration Project Site
Human Health Risk Assessment
Oxbow Area and Lyman Mill Pond Flood Plain Soils

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October 20, 2011

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ACRONYMS AND ABBREVIATIONS

ADD	average daily dose
AF	adherence factor
ABSd	dermal absorption factor
ATc	averaging time carcinogenic
ATnc	averaging time noncarcinogenic
ATSDR	Agency for Toxic Substance and Disease Registry
BERA	baseline ecological risk assessment
BHHRA	baseline human health risk assessment
BW	body weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	conversion factory
CMRP	Centredale Manor Restoration Project
COPC	chemical of potential concern
CSF	cancer slope factor
CTE	central tendency exposure
ED	exposure duration
EF	exposure frequency
EPC	exposure point concentration
HHRA	human health risk assessment
IR	ingestion rate
IRIS	integrated risk information system
LADD	lifetime average daily dose
LEA	Loureiro Engineering Associates
LOAEL	lowest observable adverse effect level
NOAEL	no observable adverse effect level
PPRTV	Provisional Peer Reviewed Toxicity Value
RBA	relative biovailability
RfD	reference dose

RME	reasonable maximum exposure
SA	surface area
TCDD	tetrachlorodibenzo-p-dioxin
TEQ	toxicity equivalency
UCL	upper confidence interval
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WOE	Weight of Evidence

EXECUTIVE SUMMARY

This human health risk assessment (HHRA) has been prepared using data collected from a supplemental investigation conducted in 2010 of the Centredale Manor Restoration Project Superfund Site (CMRP Site) in North Providence, Rhode Island. The 2010 supplemental sampling program included the collection of soil sampling data from four areas adjacent to the Lyman Mill Reach of the Woonasquatucket River and Lyman Mill Pond. The sampling was conducted for Emhart Industries, Inc. (Emhart) by Integral Consulting, Inc. (Integral) and Loureiro Engineering Associates (LEA), in accordance with the Administrative Settlement and Order on Consent for the Centredale Manor Restoration Project Superfund Site, CERCLA Docket Number: 01-2010-0045, as amended (USEPA 2010).

The purpose of this HHRA is to quantitatively assess potential human health risks associated with the specific exposure areas identified below. In addition, the HHRA evaluates plausible receptor populations using exposure parameters that are indicative of likely uses of the defined exposure areas. The receptors and corresponding exposure parameters were developed based on observations of the physical environ within the exposure areas.

In total, there are five exposure areas evaluated in the HHRA:

1. "Human health exposure" area within the Oxbow area,
2. "General use" area within the Oxbow Area,
3. Flood plain soils in the northeastern portion of Lyman Mill Pond, east of the Oxbow area,
4. The emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond), and
5. The flood plain soil in the southeastern portion of Lyman Mill Pond.

The accessible portion of the Oxbow area is an upland forest area denoted as the human health exposure area. This area is principally located in the central-eastern part of the Oxbow area, along the banks of the Lyman Mill Reach and south of the so-called Remnant Oxbow, the primary east-west water feature in the Oxbow area. Data used to assess risks associated with the human health exposure area are derived from samples collected only from this area. The human health exposure area is distinctly different from the rest of the Oxbow area because it is topographically higher, the soils are drier, there is less underbrush, and access is made possible by existing trails.

Forested wetland areas to the north, west and south of the human health exposure area are far less accessible; the areas are overgrown with dense underbrush and the soils tend to be wet.

Travel through the forested wetland during the sampling program was made possible only with the assistance of a machete, protective clothing, and waterproof boots or waders. Field staff encountered no evidence that these portions of the study area had been accessed by humans. Accordingly, potential exposure to COPCs in soils within the forested wetland portions of the Oxbow area is considered to be possible, but limited. The forested wetland soils are identified as a "general use" exposure area.

The flood plain soils in the northeastern and southeastern portions of Lyman Mill Pond as well as soils at the confluence of Assapumpset Brook and the Woonasquatucket River also have poor access, and thus are also identified as "general use" exposure areas.

The potential receptors that might use the human health exposure area within the Oxbow for passive activity include children (1-6 yrs.), adolescents (7-18 yrs) and adults (19-30 yrs). The human health exposure area is the only area where a young child or older child would regularly visit.

While it is unlikely that the "general exposure" areas would be routinely accessed by any receptor, for the purposes of this risk assessment, it is assumed that a teenager (13 to18 years) and an adult (19 to 30 years) might occasionally enter the general areas in the Oxbow, the northeastern and southeastern portions of Lyman Mill Pond, and at the confluence of Assapumpset Brook.

Exposures to chemicals of potential concern were estimated assuming dermal contact and incidental ingestion of surface soil. Both central tendency and reasonable maximum exposures were assessed for all receptors, exposure pathways, and exposure areas.

For each exposure area, noncancer hazard indexes were computed for each receptor age group, and potential cancer risks were computed based on an average lifetime exposure. Noncancer hazard indexes for all receptors and exposure areas were less than 1.0. Cancer risks were either below the USEPA acceptable risk range of 10^{-4} to 10^{-6} or at the lower end of this range (between 10^{-5} and 10^{-6}). A summary of noncancer hazards and cancer risks for each receptor and area is provided in Table A-ES.1.

The noncancer hazards and cancer risks computed herein demonstrate that the exposure areas that were the subject of the 2010 supplemental sampling program do not pose an unacceptable risk to human health. Therefore, remediation is unnecessary to mitigate human health risks in these areas.

A.1 INTRODUCTION

This human health risk assessment (HHRA) has been prepared using data collected from a 2010 supplemental investigation of the Centredale Manor Restoration Project Superfund Site (CMRP Site) in North Providence, Rhode Island, which included the collection of soil sampling data from four areas adjacent to the Lyman Mill Reach of the Woonasquatucket River and Lyman Mill Pond. The sampling was conducted for Emhart Industries, Inc. (Emhart) by Integral Consulting, Inc. (Integral) and Loureiro Engineering Associates, Inc. (LEA), in accordance with the Administrative Settlement and Order on Consent for the Centredale Manor Restoration Project Superfund Site, CERCLA Docket Number: 01-2010-0045, as amended (USEPA 2010).

The four areas sampled that are considered in this HHRA include:

1. The forested wetland and upland soils in the Oxbow area,
2. The flood plain soils in the northeastern portion of Lyman Mill Pond, east of the Oxbow area,
3. The emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond), and
4. The flood plain soil in the southeastern portion of Lyman Mill Pond.

Figure A-1.1 shows the general location of the area of study for this report, and Figure A-1.2 identifies the above-listed areas evaluated herein.

In 2006, United States Environmental Protection Agency (USEPA) prepared the Addendum to the Interim Final Baseline Risk Assessment: Oxbow Area (Oxbow Addendum), which included a baseline human health risk assessment (BHHRA) for the first area identified above (Oxbow area). The USEPA BHHRA focused on a limited portion of the Oxbow area and did not assess areas 2 through 4 listed above.

Emhart submitted comments that noted several deficiencies with the BHHRA (AMEC 2006). The most significant issues concerned the paucity of soil sampling data used by USEPA to assess the large area of the Oxbow, and USEPA's reliance on unrealistically high exposure parameters to evaluate potential exposures to passive users of this area.

In order to better characterize the Oxbow area and the other flood plain areas identified above (areas 2 through 4), Emhart proposed a supplemental investigation of the Lyman Mill Reach Stream Sediment and Flood Plain Soils (Integral 2010). Sampling of the four subject areas was conducted by Integral and LEA in September, October and November of 2010. The sampling, validation, and assessment of data from the supplemental investigation are provided in the

Field Sampling and Data Report: 2010 Supplemental Investigation of the Lyman Mill Sediment and Flood Plain Soils (Integral 2011), herein referred to as the 2010 supplemental investigation.

A.1.1 OBJECTIVE

The purpose of this Appendix is to present an HHRA that uses the data generated during the 2010 supplemental investigation to assess potential health risks associated with the areas identified above. In addition, the HHRA evaluates receptor populations that are plausible using exposure parameters that are indicative of likely uses of the defined exposure areas. The receptors and corresponding exposure parameters were developed based on observations of the physical environ within the exposure areas.

The first area identified above, the forested wetland and upland soils in the Oxbow area, is further segregated into two exposure areas based on site-specific conditions and information from USEPA. These two exposure areas, the "human health exposure" and "general use" areas, were defined by USEPA in development of the Oxbow area soil sampling plan.

Access to the Oxbow area is made possible due to the presence of a foot path that descends southerly into the Oxbow area from Allendale Avenue. However, once in the Oxbow area, access to the forested wetland portion of the Oxbow area is limited due to excessively wet and occasionally submerged soil, and the presence of dense, physically disagreeable, thorny and poisonous vegetation such as green briar, poison ivy and bramble.

The portion of the Oxbow area that is most accessible is an upland forest area denoted as the human health exposure area. This area is principally located in the central-eastern part of the Oxbow area, along the banks of the Lyman Mill Reach and south of the so-called Remnant Oxbow, the primary east-west water feature in the Oxbow area (USACE 2008). Data used to assess the human health exposure area are from samples collected from this area. These sample are indicated by the sample label, ''SS_H-XX'. The human health exposure area is distinctly different from the rest of the Oxbow area because it is topographically higher, the soils are drier, there is less underbrush, and access is made possible by existing trails.

Forested wetland areas to the north, west and south of the human health exposure area are far less accessible because the area is overgrown with dense underbrush and the ground tends to be wet or submerged. The vegetation in this area includes northern arrow-wood, red osier dogwood, highbush blueberry, glossy buckthorn, speckled alder winterberry, poison ivy, Virginia creeper, honeysuckle, and red maple (USACE 2008; AMEC 2008). Travel through the forested wetland was made possible only with the assistance of a machete and waterproof boots or waders. Thus, potential exposure to COPCs in soils within the forested wetland portions of the Oxbow area is possible, but limited. Samples used to describe the occurrence and distribution of COPCs in the less accessible forested wetland areas within the Oxbow, termed "general use" area, are denoted by the sample label "SS_G-XX".

It should also be noted that though sampling of scrub/shrub and emergent wetland sediment was conducted by Integral and LEA in the southern portion of the Oxbow, access to the scrub/shrub and emergent wetlands in the southern portion of the Oxbow area is, for all intents and purposes, non-existent due to the extremely dense underbrush present. The lack of accessibility to the wetland sediment precludes direct contact exposure to contaminants in the sediment. Consequently, there are no complete exposure pathways to the wetland sediments in the southern portion of the Oxbow. Thus, the scrub/shrub and emergent wetland is not considered further in this HHRA.

In addition to the human health exposure and general use areas within the Oxbow, there are three additional distinct exposure areas. These include flood plain soil in the northeastern portion of Lyman Mill Pond, flood plain soil in the southeastern portion of Lyman Mill Pond, and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River. In total, there are five exposure areas evaluated in the HHRA:

1. "Human health exposure" area within the Oxbow area,
2. "General use" area within the Oxbow,
3. Flood plain soils in the northeastern portion of Lyman Mill Pond, east of the Oxbow area,
4. The emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond), and
5. The flood plain soil in the southeastern portion of Lyman Mill Pond.

These human health exposure areas are shown on Figure A-1.3.

Ultimately, the objective of this HHRA is to compute plausible estimates of exposure and potential human health risk for these exposure areas. The information from the HHRA can then be used to assess the need for and scope of remediation efforts within these areas.

A.1.2 DOCUMENT ORGANIZATION

The remainder of the HHRA includes the following components:

- Section 2 - Hazard Identification, which briefly describes the sampling data used in this assessment and the methods used to characterize the media and compounds of potential concern selected for the areas evaluated.

- Section 3 - Exposure Assessment, which provides an explanation of plausible receptors and presents the methods used to quantify potential exposures to the identified receptors.
- Section 4 - Toxicity Assessment, which presents toxicological information related to the compounds assessed in the HHRA.
- Section 5 - Risk Characterization, which combines the exposure and toxicity assessments into a quantitative estimate of carcinogenic risks and non-carcinogenic hazards for each receptor group and exposure area identified.
- Section 6 – Uncertainty, which presents a description of factors contributing to the uncertainty in the risk estimates presented in Section 5.

A.2 HAZARD IDENTIFICATION

The hazard identification consists of a data evaluation step to define the appropriate environmental media and data relevant to human exposures, and a chemical of potential concern (COPC) selection process to identify those chemicals that are the focus of the HHRA. This section presents the data that were used to evaluate potential risks to human health and the results of the COPC selection process for chemicals present in surface soil.

A.2.1 DATA EVALUATION AND SELECTION CRITERIA

This assessment relies on soil data collected during the 2010 supplemental investigation. For this investigation, surface soil samples were collected at 38 locations that could plausibly be visited by passive users of the areas under investigation. Unlike previous sampling efforts in these areas, the spatial density of the sample locations provides a reasonable representation of the extent of contamination within the areas being evaluated in this HHRA. The sediment data collected in 2010 from the emergent and submerged portions of the Oxbow and Northeast Lyman Mill Pond areas are not applied in this assessment, given that, as described previously, human exposures to sediments in these areas are not expected to occur.

Data from previous investigations are not applied in this assessment for several reasons. First, these data are available only for limited portions of the Oxbow area and, thus, do not address three of the four areas being evaluated. Second, though some data have been collected in the Oxbow during previous investigations, the depth of these samples (0-0.5′) is inconsistent with the Region 1 human health risk assessment definition of surface soil, which is the top foot of soil (i.e., 0-1′). Finally, the analytical parameters evaluated in previously collected samples differ by sample, limiting the comparability of the data.

Given that the data collected in 2010 cover all four exposure areas of interest, are spatially more robust than previously collected data, are representative of the 0-1′ surface soil interval, and are uniform in terms of the analyses conducted on those samples, this HHRA relies on the 2010 surface soil sampling data. A summary of the surface soil sampling data for the exposure areas is provided in Section 7 of the 2010 supplemental investigation report.

A.2.1.1 Identification of Chemicals of Potential Concern

The selection of human health compounds of potential concern for surface soil focuses the HHRA on the chemicals that most contribute to potential human health risks. The selection of a chemical as a COPC is not limited to whether that chemical is related to the historical operations of the Site, but rather is based on evidence of its presence in an environmental medium to which humans might be exposed. As stated above, COPCs are identified for each exposure area based on the chemical data set from the 2010 supplemental investigation. The COPC selection process

involves multiple steps that are outlined in federal guidance (USEPA 1989), and includes the evaluation of the frequency of detection for each chemical, assessing essential nutrients detected in Site media, identifying appropriate risk-based screening levels, and comparing Site concentrations to these selected screening levels for each detected chemical. The data used in the COPC screening for this HHRA are presented in Tables 7-1 through 7-20 of the 2010 supplemental investigation report.

Tables A-2.1 through A-2.5 summarize the data and the selection of COPCs in surface soil for each of he exposure areas under consideration. These tables summarize the detection frequencies and the minimum and maximum detected concentrations for all analytes that have been detected at least once. The maximum concentrations are used to screen COPCs. For this exercise, comparisons of site-specific concentrations to background concentrations were not considered.

A.2.1.1.1 Frequency of Detection

The first step in selecting COPCs involves assessing the frequency of detection for all chemicals (USEPA 1989). Chemicals that are not detected in any sample are not carried forward in the COPC screening process. Typically, chemicals with a low frequency of detection (e.g., <5%) in a given medium are also removed from further consideration because they are not present over a large enough area to pose a potential human health risk. However, chemicals that may be Site-related should not be excluded. Due to the number of samples collected in each exposure area, if a chemical was detected at least once, it was retained for further screening as discussed below.

A.2.1.1.2 Evaluation of Essential Nutrients

Some chemicals occur naturally in the environment and are beneficial or essential to sustaining human life. These are chemicals that are essential human nutrients, toxic only at very high doses, and are present at concentrations that would not be attributable to Site activities. According to USEPA (1989) guidance, chemicals that are essential nutrients are not given further consideration. Typically, calcium, magnesium, potassium, and sodium are essential nutrients that are excluded from the COPC selection process. However, for this assessment the samples that were collected were not analyzed for essential nutrients. Therefore, no chemicals were excluded based on this evaluation.

A.2.1.1.3 Selection of Screening Values

To define the COPCs that are carried forward for further evaluation, maximum concentrations of the chemicals were compared to risk-based screening values. USEPA Residential soil Regional Screening Levels (RSLs) from October 2010 are the source of the screening values used in this assessment.

Tables A-2.1 through A-2.5 identify which compounds are retained for the quantitative portion of the HHRA for the human health exposure area in the Oxbow, and the four general exposure areas identified for this assessment.

A.3 EXPOSURE ASSESSMENT

The purpose of the exposure assessment is to estimate the type and magnitude of human exposure to COPCs identified at a site. To estimate exposure, concentrations at the point of contact are combined with assumptions regarding receptor activity patterns to calculate chemical intakes for each complete pathway. The intakes are then combined with toxicity criteria for the COPCs to estimate risks as part of the risk characterization. The exposure assessment evaluates which of the potential routes of human exposure may be complete now or in the future. This evaluation is made according to whether an exposure pathway contains all of the following elements (USEPA 1989):

- A source and mechanism for release of constituents,
- A transport or retention medium,
- A point of potential human contact (exposure point) with the affected medium, and
- An exposure route at the exposure point.

If any one of these elements is missing, the pathway is not considered complete and exposure is not assessed. For example, if human activity patterns and/or the location of potentially exposed individuals relative to the location of an affected exposure medium prevent human contact, then that exposure pathway is not complete. The following section summarizes key points of the environmental setting and potential exposure areas. Subsequent sections present the methods and exposure assumptions used to estimate chemical intakes for each complete pathway included in the quantitative assessment.

A.3.1 CONTAMINATION OF EXPOSURE AREAS

This section reviews the likely sources and transport mechanisms of COPCs, based on the setting and history of the Site and the analysis of the mechanisms and release pathways, as well as local land use, demographics, and regional climate.

COPCs present in the areas evaluated herein may have been introduced to the environment from releases that may have occurred upstream of the study area. These releases may have resulted in contamination of the Woonasquatucket River surface water and sediment under non-flood conditions. During high flow events, COPCs may have been carried by suspended solids in the water column to the Lyman Mill Reach flood plain, including the Oxbow area, the northeastern portion of Lyman Mill Pond, and, to a much lesser extent, the floodplain at the confluence of Assapumpset Brook and the Woonasquatucket River. Water turbulence in the flood plain is reduced, which may allow the suspended solids to settle on the flood plain soil.

Another source of COPCs to the study area may include the partial breaches of Allendale Dam in 1991 and 2001, which may have resulted in contaminated sediment transport and deposition to the subject area in a manner consistent with that described above. It is also possible that contaminants may have been transported on suspended particles via Lyman Mill Pond flood backwater with subsequent deposition onto the soil surface.

For certain areas, contaminants may have been placed along with the placement of fill. Evidence of fill was noted near samples SS_G-10, SS_G-12, and SS_G-13.

Finally, contaminants in the Assapumpset Brook flood plain soil may have been transported to this area from the Assapumpset Brook watershed via historic releases of contaminants to this brook and/or secondary releases during Assapumpset Brook flood events.

COPCs adsorbed to particles that may have settled out might have resulted in the contamination of the soil and sediment as described in the 2010 supplemental investigation report. A description of the samples collected and data generated for the human health exposure and general use areas are described in Sections 4 and 7 of the 2010 supplemental investigation report.

A.3.2 POTENTIAL RECEPTORS

Five potential surface soil exposure areas have been identified for this assessment. Potential receptors that might use these areas fall into two categories, human health exposure area receptors, and the general use area receptors. Each of these is discussed below.

Human Health Exposure Area Receptors

Within the human health exposure area of the Oxbow, the soils are drier, the vegetation is less dense and some foot trails exist. It is possible that individuals might walk through this area, but no other routine activity is likely. The potential receptors who might use the human health exposure area within the Oxbow for passive activity include children (1-6 yrs.), adolescents (7-18 yrs) and adults (19-30 yrs). The human health exposure area is the only area that a young child or older child would regularly visit.

General Use Area Receptors

For purposes of this HHRA, the areas other than the human health exposure area are considered general use areas (i.e., areas 2 through 5). Access to these areas by the casual user is limited due to the dense and hazardous vegetation, which includes green briar, poison ivy, and bramble, as well as easily saturated soil (muddy soil). If present, paths within these general use areas are limited to small game trails. Access through these paths requires the use of a machete. Although this area could be accessed with great difficulty, to do so more often than on a very

infrequent basis is extremely unlikely due to the limitations imposed by the physical nature of the surroundings. Given these physical hazards, it is unreasonable to assume that a child (1 to 12 years) would access the general areas. While it is unlikely that these areas would be routinely accessed by any receptor, for the purposes of this risk assessment, it is assumed that a teenager (13 to 18 years) and an adult (19 to 30 years) might occasionally enter the general areas in the Oxbow, the northeastern and southeastern portions of Lyman Mill Pond, and at the confluence of Assapumpset Brook.

Although the same receptor groups are assumed for each of these general use areas, the receptors are considered independent groups given the distance between the exposure areas. Therefore, theoretical risks are not aggregated across the different exposure areas.

A.3.3 EXPOSURE PATHWAYS

Exposure pathways define the routes through which chemicals may be encountered and enter the human body. For a pathway to be considered potentially complete, and therefore included in an exposure analysis, there must be a chemical presence in an environmental media (e.g., air, soil, water), an exposure point where contact with the contaminated media can occur, and an exposure route via which chemicals could enter the body (e.g., ingestion, inhalation, dermal absorption). Potentially complete exposure pathways are quantitatively evaluated in this HHRA. If any of the elements of an exposure pathway is missing, the pathway is considered incomplete and exposure does not occur. These incomplete exposure pathways are not evaluated further in this HHRA.

Because this HHRA is evaluating potential human exposures to floodplain soils, the pathways included in this analysis are those through which humans would have the greatest contact with soils. The potentially complete exposure pathways evaluated in this assessment are incidental ingestion of soil and dermal contact with soil. Exposure to soil through inhalation of entrained soil particles is not evaluated in this analysis. Exposures through this route are not likely given the presence of extensive vegetation and leaf litter, which minimize the potential for soil particles to become entrained in the air.

A.3.4 EXPOSURE POINT CONCENTRATIONS

To estimate the magnitude of exposure from each exposure medium, a representative concentration of each COPC is calculated and applied to the intake equations described in subsequent sections. The representative concentration is commonly called the exposure point concentration or EPC. An EPC is a conservative estimate of the average chemical concentration in a medium that a receptor is likely to contact over time (USEPA 1989).

Where adequate data are available (e.g., at least ten detections of a COPC out of all samples taken from the exposure area; n>10) the EPC is computed as the 95-percent upper confidence limit (95% UCL) of the mean, derived using the most recent version of USEPA's ProUCL software (version 4.00.05). If the 95-percent UCL exceeded the maximum detected concentration, the maximum concentration is used as the EPC. As a conservative measure, if a compound is detected at least once among all the samples taken from an exposure area, any non-detects in this same area are treated as being present at a concentration of one-half the sample-specific detection limit. Adequate samples are available for the human health exposure and the general use areas of the Oxbow to compute 95% UCLs for COPCs in these areas. The 95% UCL is used as the EPC for both the reasonable maximum exposure (RME) and central tendency exposure (CTE) calculations for the Oxbow area.

For the other general exposure areas, the number of samples is limited to between 2 and 5. As a result, 95% UCLs cannot be computed. For these areas, the mean concentration is used to represent the EPC for the central tendency exposure (CTE) calculations, and the maximum detected concentration is used to calculate the reasonable maximum exposure (RME).

A.3.5 EXPOSURE INTAKES

Human intakes resulting from exposures to COPCs are estimated using exposure algorithms (equations) and assumptions regarding such parameters as intake rate, exposure frequency, and exposure duration. Intake estimates represent the daily dose of a chemical taken into the body, averaged over the appropriate exposure period. Intakes are typically expressed in milligrams of chemical per kilogram of body weight per day (mg/kg-day). The following sections provide the exposure algorithms and exposure factors for each medium that are used to estimate intakes of COPCs for each receptor in this HHRA.

The generalized equation for calculating chemical intakes is as follows:

$$I = \frac{EPC \times CR \times EF \times ED \times F \times Ab}{BW \times AT}$$

Where:

I	=	Intake, the amount of chemical taken in by the receptor (mg chemical per kg body weight per day)
EPC	=	Exposure point concentration, the chemical concentration contacted over the exposure period at the exposure point (e.g., mg/kg soil)
CR	=	Contact rate, the amount of affected medium contacted per unit time or event (e.g., soil ingestion rate [mg/day])
EF	=	Exposure frequency, describes how often exposure occurs (days/year)

ED	=	Exposure duration, describes how long exposure occurs (years)
F	=	Intake fraction, fraction of medium contacted that is assumed to be from the contaminated source (unitless)
Ab	=	Absorption factor (unitless)
BW	=	Body weight, the average body weight over the exposure period (kg)
AT	=	Averaging time, period over which exposure is averaged (days).

The variables shown in the above equation are called exposure parameters, and they vary depending on the receptor population being evaluated. For some exposure pathways, the equation format also might vary slightly from the generalized format shown above and might include parameters that describe chemical-specific factors. Intakes for all pathways are expressed as average daily doses (ADDs) for noncancer hazards and lifetime average daily doses (LADDs) for cancer risks. EPCs are derived from media- and Site-specific analytical data. The remaining parameters shown in the generalized equation describe chemical-specific differences as well as the activity patterns associated with each receptor population, such as amount and frequency of contact with potentially contaminated media, and frequency and duration of exposure.

For every exposure pathway, it is expected that there will be differences among individuals in the level of exposure due to differences in intake rates, body weights, exposure frequencies, and exposure durations. This results in a wide range of average daily intakes among different members of an exposed population. Daily intake calculations must specify what part of the expected distribution of intakes is being estimated. Typically, attention focuses on intakes that are "average" or near the central portion of the range (CTE) and on intakes that are near the "upper end" of the range (RME). The RME case provides a conservative estimate of exposure that is plausible but still well above the average exposure level.

A.3.6 EXPOSURE PARAMETERS

For incidental ingestion and dermal contact with soil, a number of the exposure parameters are common to both pathways while other parameters are pathway-specific. Common and pathway-specific parameters for the general use and human health exposure areas are discussed in the following sections. Table A-3.1 summarizes the parameters for the general exposure areas and Table A-3.2 summarizes the parameters for the human health exposure area.

A.3.6.1 Common Exposure Parameters

Exposure parameters common across the exposure pathways include exposure frequency, exposure duration, body weight, and averaging time. These parameters are discussed below.

Exposure frequency

For the general exposure areas, the RME exposure frequency for both the teenager and adult is 12 days per year. This assumes that these individuals visit the areas twice a month over a six-month period (May through October). This frequency was selected given the access and mobility issues that are associated with the general exposure areas discussed above. The CTE exposure frequency for the teenager and adult is three days per year. This assumes that these individuals visit the areas one day per month during the three warm summer months (June, July and August).

For the human health exposure area, the RME exposure frequency for the young child (1 to 6 years old), the older child (7 to 18 years old), and the adult (19 to 30 years old) is 39 days per year. This assumes that these individuals visit the area once a week during the months of May, September and October, and visit the area twice a week during the warmer months of June, July and August. The CTE exposure frequency is 18 days per year and is approximately one-half of the RME frequency. It assumes that individuals visit the area once every other week during the months of May, September and October, and once per week during June, July and August.

Exposure duration

For the general exposure areas, the RME exposure duration totals a 30-year duration as recommended by USEPA (1989) as the national upper-bound time living at one residence. These 30 years are distributed among the receptor groups based on the age range of each (i.e., six years for the teenager and 24 years for the adult). The CTE exposure duration totals a nine year duration as recommended by USEPA (1989) as the average time living at one residence. Although the general exposure areas are difficult to access and rarely visited, it is assumed that a teenager is more attracted to the areas than an adult. Therefore, distributing the nine years among the receptor groups, the exposure duration for the teenager is six years and the exposure duration for the adult is three years.

For the human health exposure area, the RME exposure duration totals a 30-year duration as recommended by USEPA (1989) and is distributed among the receptor groups based on the age range of each (i.e., six years for the young child,12 years for the older child, and 12 years for the adult). The CTE exposure duration totals a nine year duration as recommended by USEPA (1989) as the average time living at one residence. Unlike the general exposure areas, it is assumed that the exposure duration for the adult is greater than the duration for the children. Therefore, distributing the nine years among the receptor groups, the exposure duration is two years for the young child, three years for the older child, and four years for the adult.

Averaging times

The carcinogenic averaging time is based on a 70-year lifetime or 25,550 days. The noncancer averaging time equals the exposure duration in days.

Body weights

Body weights are based on USEPA (1997) and are age-specific. For the general exposure areas, the RME and CTE body weights are 59 and 70 kg for the teenager and adult, respectively. For the human health exposure area, the RME and CTE body weights are 15, 45 and 70 kg for the young child, older child and adult, respectively.

A.3.6.2 Incidental Ingestion of Soil

The following equation is used to calculate the intake from incidental ingestion of soil.

$$\text{Intake (mg/kg-d)} = C_{soil} \times IgR_{soil} \times EF \times ED \times F_s \times RBA \times CF \times (1/BW) \times (1/AT)$$

Where:

C_{soil}	=	Chemical concentration in soil (mg/kg),
IgR_{soil}	=	Ingestion rate of soil (mg/day),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
F_s	=	Fraction of soil ingested from Site (unitless),
RBA	=	Relative bioavailability factor,
BW	=	Body weight (kg),
CF	=	Conversion factor (kg/mg),
AT_c	=	Carcinogenic averaging time (days), and
AT_{nc}	=	Non-carcinogenic averaging time (days).

For incidental ingestion of soil, the pathway-specific exposure parameters are the soil ingestion rates and the fraction of soil ingested from the Site. USEPA's default rates of 200 and 100 mg/day for children and adults, respectively, represent very conservative estimates of soil ingestion. Although these rates likely overestimate soil ingestion in situations where soil contact is more frequent and with greater intensity (e.g., residential exposures), these rates clearly overestimate soil ingestion for the limited contact that occurs within the exposure areas defined in this analysis. Therefore, more realistic ingestions rates are used. Based on the following discussion, the RME soil ingestion rate for the adult, older child, and teenager is 50 mg/day and the CTE rate is 10 mg/day. For the young child, the RME and CTE rates are 100 and 50 mg/day, respectively.

The *Exposure Factors Handbook* (USEPA 1997) provides adult soil ingestion rates, ranging from 0.5 to 100 mg/day, based primarily on a 1990 study conducted by Calabrese et al. (1990). A subsequent study of adults by the same investigators (Stanek et al. 1997) includes a number of improvements over the 1990 study and provides more reliable daily estimates of soil ingestion, although this 1997 study is not without problems. Of the ten adults participating in the study, one had an unusually high soil ingestion estimate (2 grams) for the first day of the study week. The high estimate resulted in an inflated upper percentile estimate of the overall ingestion rate. Dr. Calabrese (a co-author of the Stanek et al. 1997 paper) reported that the subject had four times higher freeze-dried fecal weight on the first day than on any other day of the study, suggesting that the subject's excretion on that first day reflected a multi-day accumulation, instead of just one day, as assumed in the calculations. This fact confirms that the 95th percentile value from this study, which is driven by the result for this one subject, is not only uncertain but substantially overestimated. Due to the aberrant result from this one participant, Dr. Calabrese (2003) has recommended that the upper 75th percentile (49 mg/day, rounded to 50 mg/day) from the Stanek et al. (1997) study is the most appropriate value to use as an estimate of high-end soil ingestion by adults. In addition, Calabrese (2003) recommended 10 mg/day for the central tendency estimate, which is consistent with the adult mean daily soil ingestion rate of 6 mg/day reported in Stanek et al. (1997).

USEPA's default value for soil ingestion of 200 mg/day for children overstates actual exposures to soil. Stanek et al. (2001) gathered data from 64 children ages 1–4 who resided in Anaconda, Montana, and were evaluated for soil ingestion over a 7-day period. This study represents the most robust data set to date on childhood soil ingestion that has been used to characterize a distribution for soil ingestion rates (Paustenbach et al. 2006; Kirman et al. 2011). Paustenbach et al. (2006) reported a 95th percentile value of 88 mg/day for soil intake in children based upon the Stanek et al. data. Similarly, based on fitting the data to two lognormal distributions, Kirman et al. (2011) reported that the 95th percentile value for soil intake in children is approximately 92 mg/day.

Because the soil contact is limited in both the general use exposure areas and the human health exposure area, it is unreasonable to expect that individuals would ingest their daily soil intake from the Site. For this assessment, it is assumed that 50 percent of the daily soil intake comes from the Site. This value is used for both the RME and CTE evaluations.

A.3.6.3 Dermal Contact with Soil

Intake from dermal contact with soil is calculated by the following equation.

$$\text{Intake (mg/kg-d)} = C_{soil} \times SA \times AF \times ABS_d \times EF \times ED \times CF \times (1/BW) \times (1/AT)$$

Where:

C_{soil} = Chemical concentration in sediment (mg/kg),

SA	=	Exposed skin surface area (cm^2),
AF	=	Adherence factor (mg/cm^2-day),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
ABS_d	=	Chemical-specific dermal absorption factor (unitless),
BW	=	Body weight (kg),
CF	=	Conversion factor (kg/mg),
AT_c	=	Carcinogenic averaging time (days), and
AT_{nc}	=	Noncancer averaging time (days).

For dermal contact with soil, the pathway-specific exposure parameters include the exposed skin surface area and the soil adherence factor. USEPA's risk assessment (Battelle 2006) applies the default surface area value for residential exposures. For the adult and older child, the default residential value includes the skin surface area for head, hands, forearms, and lower legs. For the young child, USEPA has assumed the skin surface area for the feet as well. Just as the default soil ingestion rates overstate the likely exposures, the total exposed surface area is overstated under the exposure conditions.

For the general use exposure areas, the vegetation is dense and physically hazardous. The lack of established walking trails, and the presence of vegetation such as green briar, poison ivy and brambles limit access and contact with soil in these areas. Due to the lack of established access and the presence of thick vegetation, it is reasonable to assume that individuals wear long pants and shoes. It also is very likely that they wear long sleeve shirts or jackets, but it is possible that one might wear a short sleeve shirt. Because the intensity of soil contact is limited and little or no dust is generated, it is unreasonable to assume that the entire head would be exposed. It is possible that individuals might brush their face with dirty hands. For the RME adult and teenager, the potentially exposed skin includes the face, forearms, and hands. Based on age-specific surface areas for various body parts (USEPA 2004), the total exposed skin surface area for the RME adult is 2479 cm^2 and 2274 cm^2 for the RME teenager. For the CTE adult and teenager, it is assumed that the individuals wear long sleeve shirts or jackets so only the hands and face are potentially exposed. In this case, the total exposed surface areas are 1306 and 1297 cm^2 for the adult and teenager, respectively. The soil adherence factors represent USEPA (2004) residential adult values of 0.07 and 0.01 mg/cm^2 for the RME and CTE, respectively.

For the human health exposure area, access is less restrictive than in the general use areas. Because vegetation in this area allows for easier movement, it is possible that individuals might wear shorts and short sleeve shirts. It remains unreasonable to assume that individuals would be walking in this area without shoes. Similar to the general use exposure areas, the face rather than the entire head might be exposed. Therefore, for the RME adult, older child and young child, the potentially exposed skin includes the face, forearms, hands and lower legs. Corresponding potentially exposed surface areas for the adult, older child and young child are

4849, 3522, and 1727 cm^2, respectively. These same surface areas are used for the CTE estimates. The soil adherence factors for the adult and older child represent USEPA (2004) residential adult values of 0.07 and 0.01 mg/cm^2 for the RME and CTE, respectively. The soil adherence factor for the young child represents USEPA's residential child values of 0.2 and 0.04 for the RME and CTE, respectively.

A.3.6.4 Chemical-Specific Parameters

In this assessment, the chemical-specific parameters include the dermal absorption fraction from soil and the relative bioavailability of contaminants from a soil matrix. Table A-3.3 summarizes these factors for each chemical evaluated. The dermal absorption factor is used to determine the percentage of a chemical applied to the skin surface that is absorbed into the blood. Values used in this assessment were derived from USEPA dermal guidance (USEPA 2004).

The relative bioavailability factor accounts for the fact that a chemical in an environmental soil matrix may be less bioavailable via the ingestion exposure route than it is in the matrix used to develop its toxicity value(s). For example, the cancer slope factor for 2,3,7,8-TCDD is derived from studies where rodents were administered dioxin orally (by gavage) in a corn oil matrix. The bioavailability of dioxin in corn oil is relatively high. However, because the dioxin strongly sorbs to soil particles, even in the gastrointestinal tract, the bioavailability of dioxin in ingested soil is much lower. USEPA (2010) acknowledges that relative bioavailability of dioxins in a soil matrix is less than 100 percent.

Given the foregoing, it is appropriate to use studies that evaluate relative bioavailability from soil comprised primarily of the 2,3,7,8-TCDD congener when considering an RBA for this Site. USEPA (2010) identifies six studies that report a total of seventeen RBA test results for 2,3,7,8-TCDD in soil. The RBA values for these studies, summarized in Table A-3.4, range from <1 percent to 49 percent. An RBA of 30 percent is the 50th percentile RBA value for the data presented in USEPA (2010) for those studies that evaluated 2,3,7,8-TCDD only. The mean of the selected test results is 26 percent.

USEPA (2010) also notes that relative bioavailability appears to be dose-dependent, with higher doses potentially having higher relative bioavailability. The doses computed for this risk assessment are at least two orders of magnitude lower than the doses reported in USEPA (2010). It is reasonable to conclude that the RBA for dioxin chosen for this assessment should not be based on the high-end dosing regiment studies shown in USEPA (2010), as the high-end doses were over one million times greater than what is computed for the receptors evaluated herein. It is reasonable, justifiable, and perhaps conservative to assign an RBA value at the central tendency of the range. Therefore, an RBA of 30 percent is used for the assessment of exposure to dioxin.

RBA values used in this assessment are summarized in Table A-3.3.

A.4 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to summarize health effects that may be associated with exposure to the chemicals included in the risk assessment, and to identify doses that may be associated with those effects. Toxicity values are numerical expressions of chemical dose and response, and vary based on factors such as the route of exposure and duration of exposure. Exposure to a chemical does not necessarily result in adverse effects. The relationship between dose and response defines the quantitative indices of toxicity required to evaluate the potential health risks associated with a given level of exposure. If the nature of the dose-response relationship is such that no effects can be demonstrated below a certain level of exposure, a threshold can be defined and an acceptable exposure level derived. Humans are routinely exposed to naturally occurring non-nutritive chemicals and man-made chemicals at low levels with no apparent adverse effects. However, the potential for adverse effects may occur if the exposure level exceeds the threshold.

Toxicity values for cancer and noncancer health effects have been developed for many chemicals by government agencies, including USEPA, ATSDR, Health Canada, and the World Health Organization. As recommended by USEPA (2003), the primary sources consulted for toxicity values are, in order of priority, USEPA's Integrated Risk Information System (IRIS) and USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) from the National Center for Environmental Assessment/Superfund Health Risk Technical Support Center. When neither IRIS toxicity values nor PPRTVs are available, toxicity values are obtained from other documented sources, such as the California Environmental Protection Agency, ATSDR minimal risk levels, Oak Ridge National Laboratory, and USEPA's Health Effects Assessment Summary Tables. The following two sections describe the toxicity values used to assess noncancer and cancer effects of chemicals.

A.4.1 NONCANCER EFFECTS

The potential for noncancer health effects from long duration or chronic exposures (i.e., greater than 7 years) is evaluated by comparing the estimated daily intake with a chronic oral reference dose (RfD) for ingestion. These toxicity values represent an average daily exposure level at which no adverse effects are expected to occur with chronic exposures. Although childhood exposures are assumed to occur for 6 years, chronic RfDs are used for calculating noncancer hazards for children, consistent with USEPA's historical practice and USEPA's stated concern with adequately protecting children as potentially sensitive receptors. RfDs reflect the underlying assumption that systemic toxicity occurs as a result of processes that have a threshold (i.e., that a safe level of exposure exists and that toxic effects will not be observed until this level has been exceeded).

The RfDs for many noncancer effects are generally derived on the basis of laboratory animal studies or epidemiological studies in humans. In such studies, the RfD is typically calculated by first identifying the highest concentration or dose that does not cause observable adverse effects (the no-observed-adverse-effect level, or NOAEL) in the study subject. If a NOAEL cannot be identified from the study, a lowest-observed-adverse-effect level (LOAEL) may be used. The NOAEL or LOAEL is then divided by uncertainty factors to calculate an RfD. The uncertainty factors are applied to account for limitations in the underlying data and are intended to ensure that the toxicity value calculated based on the data will not result in adverse health effects in exposed human populations. For example, an uncertainty factor of 10 might be used to account for interspecies differences (if animal studies were used as the basis for the calculation), and another factor of 10 might be used to address the potential that human subpopulations such as children or the elderly may have increased sensitivity to the chemical's adverse effects. Thus, variations in the strength of the underlying data are reflected in the uncertainty factors used to calculate the toxicity values.

Toxicity values have not been established for dermal exposure. In the absence of dermal toxicity values, USEPA (2004) recommends using the oral value, adjusted when necessary. Oral toxicity values are expressed as administered doses, whereas the exposure estimates for the dermal pathway are expressed as absorbed doses. For assessing the dermal exposure pathway for certain chemicals, the oral toxicity value is adjusted to represent an absorbed rather than administered dose. This adjustment accounts for the absorption efficiency in the critical study that forms the basis of the oral toxicity value (USEPA 2004). When the oral absorption in the critical study is greater than 50 percent, it is assumed that the absorbed dose is equivalent to the administered dose, and USEPA (2004) does not require an adjustment. When oral adsorption in the critical study is poor, the absorbed dose is much lower than the administered dose and toxicity factors need to be adjusted (USEPA 2004). When an adjustment is necessary, the oral RfD is multiplied by the oral absorption in the critical toxicity study. Route-to-route extrapolation assumes that once a chemical is absorbed into the bloodstream, the health effects are similar regardless of whether the route of exposure is oral or dermal. This assumption may be valid for some chemicals with pharmacokinetic characteristics that are similar regardless of route of administration; however, for many chemicals, factors such as absorption, metabolism, distribution, and elimination vary by exposure route, leading to substantial differences in toxicity. Nevertheless, adjusted oral RfDs are used to evaluate dermal exposure in this analysis.

The toxicity values used to estimate potential noncancer hazards for oral and dermal exposure routes are summarized in Table A-3.3.

A.4.2 CANCER EFFECTS

To assess cancer health effects, cancer slope factors (CSFs) are used for oral and dermal exposures. CSFs are upper-bound estimates of the carcinogenic potency of chemicals. They are

used to estimate the incremental risk of developing cancer, corresponding to a lifetime of exposure at the levels described in the exposure assessment. In standard risk assessment procedures, estimates of carcinogenic potency reflect the conservative assumption that no threshold exists for cancer effects (i.e., that any exposure to a carcinogenic chemical will contribute an incremental amount to an individual's overall risk of developing cancer).

Another component of assessing cancer health effects is a qualitative evaluation of the extent to which a chemical is a human carcinogen. For most chemicals listed in IRIS, this evaluation is conducted by USEPA using a classification system called a weight of evidence (WOE) determination. A chemical is assigned a WOE classification based on data obtained from both human and animal studies. Once a WOE is assigned to a chemical, a CSF is derived. Chemicals for which EPA considers human data adequate to categorize as "known human carcinogens" are assigned a WOE Class A. Other chemicals with various levels of supporting data are classified as "probable human carcinogens" (WOE Class B1 or B2), or "possible human carcinogens" (WOE Class C). Where USEPA considers that data are inadequate for determining carcinogenicity, the chemical is "not classifiable as to human carcinogenicity" (WOE Class D). When studies provide evidence of noncarcinogenicity, a chemical is assigned a WOE Class E.

As discussed in the previous section, toxicity values have not been established for dermal exposure. In the absence of dermal toxicity values, USEPA (2004) recommends using the oral value, adjusted when necessary. When an adjustment is necessary, the oral CSF is divided by the oral absorption in the critical toxicity study. The toxicity values used to estimate potential cancer risks are summarized in Table A-3.3 for oral and dermal exposure routes.

A.5 RISK CHARACTERIZATION

Risk characterization is the final step in the risk assessment process. In this step, information from previous steps in the risk assessment is integrated to synthesize an overall picture of Site-related risk. The goal of risk characterization is to present and interpret the key findings of the risk assessment, along with their limitations and uncertainties, for use in risk management decision making. The risk characterization is an integral part of this decision making process and is considered, along with other information, critical to evaluating options for how to best reduce risks, if needed, and protect human health and the environment. Risks are quantified by combining the intakes estimated in the exposure assessment (Section 3) with the toxicity values compiled in the toxicity assessment (Section 4) to yield numerical estimates of potential health risk. The risk estimates for exposure pathways identified as complete for each scenario are combined to calculate total estimates for individual scenarios.

Risks for noncancer and cancer effects are estimated separately because of differences in calculation methods. Sections A5.1 and A5.2 present the risk estimates and the methods used to calculate the risks for noncancer and cancer effects, respectively.

A.5.1 NONCANCER HAZARDS

The potential for noncancer adverse health effects to occur due to exposure to a given chemical at a given concentration is evaluated by comparing the estimated average daily intake (or dose - ADD) over the duration of exposure with an RfD derived for a similar exposure period. As described in Section A4.1, RfDs are estimates of acceptable daily doses developed by USEPA and other agencies. USEPA defines the chronic RfD as an estimate 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).

The ratio of the estimated average daily intake to the RfD is called a hazard quotient (HQ). When one or more hazard quotients are added, either for multiple exposure pathways or for multiple chemicals, the sum is called a hazard index (HI). If the HQ or HI is less than 1, no adverse health effects are expected (USEPA 1989). If the HQ or HI is greater than 1, further risk evaluation might be needed. However, HQs and HIs greater than 1 do not necessarily mean that adverse health effects will be observed. A substantial margin of safety has been incorporated into the RfDs developed for the COPCs. For these chemicals, adverse health effects may not be likely even if the HQ or HI is much larger than 1. The ratio is not a measure of probability that adverse health effects will occur. That is, the level of concern for health effects to occur does not necessarily increase linearly as the RfD is approached or exceeded (USEPA 1989).

The HQ is calculated using the following equation:

$$HQ = \frac{ADD}{RfD}$$

Where:

HQ	=	Hazard quotient associated with exposure to the chemical via the specified route of exposure (dimensionless)
ADD[1]	=	Estimated average daily dose of the chemical via the specified exposure route (mg/kg-day)
RfD	=	Reference dose for the COPC (mg/kg-day)

The HI is calculated using the following formula:

$$HI = HQ_1 + HQ_2 + \ldots + HQ_i$$

Where:

HI	=	hazard index (unitless)
HQ_i	=	the hazard quotient for the ith chemical

In this analysis, an HI for each exposure pathway was calculated by summing the HQs for all COPCs, regardless of health effect endpoint. Once HQs for individual chemicals are added within an exposure pathway, the HI for each pathway is summed across multiple pathways to yield a total HI for each exposure scenario. The approach of assuming additivity is generally believed to overestimate the potential for noncancer health effects due to simultaneous exposure to multiple chemicals that might impact different endpoints or target organs (USEPA 1989).

The following sections describe the HIs calculated for the COPCs identified for this Site. Noncancer hazards for the general use exposure areas are summarized in Section A5.1.1 and the noncancer hazards for the human health exposure area are discussed in Section A5.1.2. Noncancer hazards are presented separately for children and adults because childhood exposures typically yield higher noncancer hazards.

[1] For exposure via dermal contact, the average daily dose is referred to as the dermally absorbed dose (DAD); however, for simplicity, intakes are referred to in the general equation as the ADD for all exposure routes.

RME noncancer hazards and indices for all areas discussed in sections A5.1.1 and A5.1.2 are summarized in Table A-5.1. CTE noncancer hazards and indices for all areas discussed in sections A5.1.1 and A5.1.2 are summarized in Table A-5.2.

The exposure and risk calculations tables supporting the values shown in Tables A-5.1 and A-5.2 are provided in Attachment A.

A.5.1.1 Noncancer Hazards for General Use Areas

Oxbow General Area

The RME HI for the adult exposed via incidental ingestion and dermal contact with soil for this area is 0.020. The RME HI for the teenager exposed via incidental ingestion and dermal contact with soil is 0.022.

The CTE HI for the adult exposed via incidental ingestion and dermal contact with soil is estimated at 0.00054. The CTE HI for the teenager exposed via incidental ingestion and dermal contact with soil is 0.00064.

These HIs are well below the target HI of one; therefore, no adverse noncancer effects are expected from direct contact with soil in this area.

Northeastern Portion of Lyman Mill Pond

The RME HI for the adult exposed via incidental ingestion and dermal contact with soil for this area is 0.034. The RME HI for the teenager exposed via incidental ingestion and dermal contact with soil is 0.037.

The CTE HI for the adult exposed via incidental ingestion and dermal contact with soil is estimated at 0.0003. The CTE HI for the teenager exposed via incidental ingestion and dermal contact with soil is 0.00035.

These HIs are well below the target HI of one; therefore, no adverse noncancer effects are expected from direct contact with soil in this area.

Southeastern Portion of Lyman Mill Pond

The RME HI for the adult exposed via incidental ingestion and dermal contact with soil for this area is 0.0086. The RME HI for the teenager exposed via incidental ingestion and dermal contact with soil is 0.0096.

The CTE HI for the adult exposed via incidental ingestion and dermal contact with soil is estimated at 0.00019. The CTE HI for the teenager exposed via incidental ingestion and dermal contact with soil is 0.00022.

These HIs are well below the target HI of one; therefore, no adverse noncancer effects are expected from direct contact with soil in this area.

Confluence of Assapumpset Brook

The RME HI for the adult exposed via incidental ingestion and dermal contact with soil for this area is 0.015. The RME HI for the teenager exposed via incidental ingestion and dermal contact with soil is 0.017.

The CTE HI for the adult exposed via incidental ingestion and dermal contact with soil is estimated at 0.00033. The CTE HI for the teenager exposed via incidental ingestion and dermal contact with soil is 0.00039.

These HIs are well below the target HI of one; therefore, no adverse noncancer effects are expected from direct contact with soil in this area.

A.5.1.2 Noncancer Hazards for Human Health Exposure Area

The RME HI for the adult exposed via incidental ingestion and dermal contact with soil for this area is estimated at 0.069. The RME HI for the older child exposed via incidental ingestion and dermal contact with soil is 0.083. The RME HI for the young child exposed via incidental ingestion and dermal contact with soil is 0.38.

The CTE HI for the adult exposed via incidental ingestion and dermal contact with soil for this area is estimated at 0.0049. The CTE HI for the older child exposed via incidental ingestion and dermal contact with soil is 0.006. The CTE HI for the young child exposed via incidental ingestion and dermal contact with soil is 0.05.

These His are well below the target HI of one; therefore, no adverse noncancer effects are expected from direct contact with soil under this exposure scenario

A.5.2 CANCER RISKS

Cancer health risks are estimated as the incremental probability of an individual developing cancer over a lifetime as the result of exposure to carcinogenic chemicals. Because cancer risks from environmental exposures are usually very small numbers, they are typically expressed in scientific notation. The notation $1x10^{-6}$ is equivalent to 0.000001, or 1/1,000,000, or one in a million. The term incremental probability reflects the fact that the risk associated with Site-related exposure is in addition to the background risk of cancer experienced by all individuals in the course of daily life. The lifetime probability of a male resident of the United States developing cancer is 1 in 2, which is equivalent to $5x10^{-1}$ (i.e., 0.5 or 500,000 in one million) (ACS

2010). The lifetime probability of a female resident of the United States developing cancer is 1 in 3, or 3.3×10^{-1} (i.e., 0.33 or 330,000 in one million) (ACS 2010).

Both federal and state regulatory agencies define what is considered an acceptable level of cancer risk associated with exposure to chemicals in environmental media. USEPA considers 1×10^{-6} to 1×10^{-4} to be the target range for acceptable risks at sites where remediation is considered (USEPA 1990). Estimates of lifetime incremental increases in cancer risks less than 1×10^{-6} are considered low enough not to warrant any further investigation or analysis (USEPA 1990).

Estimated daily intakes averaged over a lifetime of exposure are multiplied by CSFs to yield incremental probabilities of cancer risk, as expressed in the following equation:

$$Cancer\ Risk = Intake\left(\frac{mg}{kg \cdot day}\right) \times CSF\left(\frac{mg}{kg \cdot day}\right)^{-1}$$

As with HIs, the estimated incremental increase in cancer risks for each chemical and exposure pathway are summed regardless of the cancer endpoint to estimate the total, or cumulative, incremental increase in cancer risk for the exposed individual. Given that the CSFs used to estimate risk are often upper 95 percent confidence limits of the probability of response from experimental animal data, the incremental increase in cancer risks calculated are generally upper-bound estimates (USEPA 1989). It can be assumed that the true risks associated with the site do not exceed the cumulative incremental increase in cancer risks estimated for an exposure scenario, and they may be well below the estimated values. In fact, the range of possible risks includes zero.

The following sections describe the lifetime incremental increase in cancer risks calculated for the COPCs identified for this Site. Cancer risks for the areas discussed below are summarized in Table A-5.3. In contrast with noncancer hazards, cancer risks are presented for children and adults combined to represent a lifetime risk.

A.5.2.1 Cancer Risks For General Use Areas

Oxbow General Area

The total RME cancer risk for incidental ingestion and dermal contact with soil for this area is 5.5×10^{-6}. The total CTE cancer risk for incidental ingestion and dermal contact with soil for this area is 6.5×10^{-8}. The CTE and RME cancer risks are either below or within the target risk range of 1×10^{-4} to 1×10^{-6}; therefore, direct contact with soil under these exposure conditions do not pose an unacceptable risk.

Northeastern Portion of Lyman Mill Pond

The total RME cancer risk for incidental ingestion and dermal contact with soil for this area is $5.8x10^{-6}$. The total CTE cancer risk for incidental ingestion and dermal contact with soil for this area is $1.9x10^{-8}$. The CTE and RME cancer risks are either below or within the target risk range of $1x10^{-4}$ to$1x10^{-6}$; therefore, direct contact with soil under these exposure conditions do not pose an unacceptable risk.

Southeastern Portion of Lyman Mill Pond

The total RME cancer risk for incidental ingestion and dermal contact with soil for this area is $1.3x10^{-7}$. The total CTE cancer risk for incidental ingestion and dermal contact with soil for this area is $1.3x10^{-9}$. Both the CTE and RME cancer risks are below the target risk level of $1x10^{-6}$; therefore, direct contact with soil under these exposure conditions do not pose an unacceptable risk.

Confluence of Assapumpset Brook

The total RME cancer risk for incidental ingestion and dermal contact with soil for this area is $3.0x10^{-7}$. The total CTE cancer risk for incidental ingestion and dermal contact with soil for this area is $2.7x10^{-9}$. Both the CTE and RME cancer risks are below the target risk level of $1x10^{-6}$; therefore, direct contact with soil under these exposure conditions do not pose an unacceptable risk.

A.5.2.2 Cancer Risks For Human Health Exposure Area

The total RME cancer risk for incidental ingestion and dermal contact with soil for this area is $4.5x10^{-7}$. The total CTE cancer risk for incidental ingestion and dermal contact with soil for this area is $2.3x10^{-8}$. Both the CTE and RME cancer risks are below the target risk level of $1x10^{-6}$; therefore, direct contact with soil under these exposure conditions do not pose an unacceptable risk.

A.6 UNCERTAINTY ANALYSIS

The method followed in this analysis to calculate risk is a point estimate approach, in which single fixed input values (i.e., point estimates) are used to represent exposure and toxicity parameters in the risk assessment equations. The output of this approach is a single value of risk for each exposure pathway and scenario. Point estimates are based on a considerable number of assumptions and do not characterize the variability inherent in population exposures and responses, or the uncertainty associated with the assumptions made (USEPA 1989; 2001). As a result, there is a potentially high degree of uncertainty in the characterization of risk at this Site. Therefore, to place risk estimates in perspective and to provide a comprehensive characterization of risk, it is necessary to examine generic and site-specific uncertainties associated with the assessment.

Within any of the steps of the risk assessment process, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. Every assumption introduces some degree of uncertainty into the risk assessment process. Conservative assumptions are made throughout the risk assessment to ensure that public health is protected. Therefore, when all of the assumptions are combined, it is much more likely that actual risks, if any, are overestimated rather than underestimated. The assumptions that introduce the greatest amount of uncertainty in this risk assessment are discussed in the following sections.

A.6.1 UNCERTAINTIES IN THE DATA EVALUATION AND COPC SELECTION

During the data evaluation step, constituents are selected for inclusion in the quantitative risk assessment. Uncertainties in data evaluation include adequacy of sampling design, analytical error, and selection of COPCs. Generally, there is less uncertainty in this phase of the risk assessment process than in other phases, because these types of uncertainties are likely better understood.

The adequacy of the sampling strategies to characterize site conditions is a potential source of uncertainty in the data analysis phase. Because there are limited resources available, sampling is generally performed. For example, only two surface soil samples were collected from the southeastern Lyman Mill Pond flood and Assapumpset Brook flood plain areas. When data from only two samples exists, a maximum concentration is typically used for the RME assessment. This could result in an overestimation of risks.

In addition, sampling (especially in multiple sampling events) is typically not random but is designed to locate the highest constituent concentrations (for example, in the northwestern portion of the Oxbow area). Combining data biased in this manner with EPC calculation

procedures that do not account for the bias result in EPCs that are biased high and overestimate the actual concentration to which receptors might be exposed. Use of the upper 95 percent UCL of the average concentration as the EPC adds an additional conservative assumption.

Appropriate quality assurance/quality control measures such as the collection of duplicate samples and trip and field blanks were taken and noted. In summary, analytical uncertainty is relatively small compared to sampling uncertainty and the bias introduced by EPC estimation methods that fail to account for the biased nature of sample locations.

A.6.2 UNCERTAINTIES IN THE EXPOSURE ASSESSMENT

During the exposure assessment, average daily doses of COPCs to which receptors are potentially exposed are estimated. This process involves assumptions about how often exposure occurs. Such assumptions include location, accessibility, and use of an area. With this in mind, the receptor, who may potentially be exposed, and the location of exposure, are both defined for this risk assessment.

In the CSM, the primary uncertainty is associated with correctly identifying complete exposure pathways. If an exposure pathway is identified as complete when, in fact, it is not complete, risk will be overestimated for that receptor. Likewise, if an exposure pathway is identified as incomplete when it is complete, risk will be underestimated for that receptor. Due to the dense vegetation and the type of vegetation (e.g., poison ivy), particularly in the general use areas, it is likely that no soil contact would occur on a regular, long-term basis; therefore, risks are likely overestimated.

A.6.3 UNCERTAINTIES IN THE TOXICITY ASSESSMENT

Dose-response values are usually based on limited toxicological data. For this reason, a margin of safety is built into estimates of both noncancer hazards and cancer risks, and actual hazards and risks are lower than those estimated. The two major areas of uncertainty introduced in the toxicity assessment are: (1) animal to human extrapolation; and (2) high to low dose extrapolation. These are discussed below.

Human dose-response values are often extrapolated or estimated using the results of animal studies. Extrapolation from animals to humans introduces a much of uncertainty in the risk assessment. In most instances, it is not known how differently a human may react to the constituent compared to the animal species used to test the constituent. Thus, predicting potential health effects requires the use of models to extrapolate the observed health effects from the high doses used in laboratory studies to the anticipated human health effects from low doses experienced in the environment. The models contain conservative assumptions to account for the large degree of uncertainty associated with this extrapolation, especially for

potential carcinogens. As a result, the procedures used to extrapolate from animals to humans are more likely to overestimate the potential for adverse effects to humans.

A.6.4 UNCERTAINTIES IN THE RISK CHARACTERIZATION

The major area of uncertainty in the risk characterization process is the combination of upper-bound exposure estimates with upper-bound toxicity estimates, resulting in an overestimation of risks.

A.7 CONCLUSION

This human health risk assessment quantitatively assesses the potential cancer and noncancer human health risk associated with passive recreational use of five distinct upland and floodplain areas adjacent to the Lyman Mill Reach of the Woonasquatucket River and Lyman Mill Pond. The risk assessment relied on the 2010 soil sampling data coupled with conservative, yet reasonable exposure assumptions for plausible receptors.

For each exposure area, noncancer hazard indexes were computed for each receptor age group, and potential cancer risks were computed based on an average lifetime exposure. Noncancer hazard indexes for all receptors and exposure areas were less than 1.0. Cancer risks were either below the USEPA acceptable risk range of 10^{-4} to 10^{-6} or at the lower end of this range (between 10^{-5} and 10^{-6}).

The noncancer hazards and cancer risks computed herein demonstrate that the exposure areas that were the subject of the 2010 supplemental sampling program do not pose an unacceptable risk to human health. Therefore, remediation is unnecessary to mitigate human health risks in these areas.

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FIGURES

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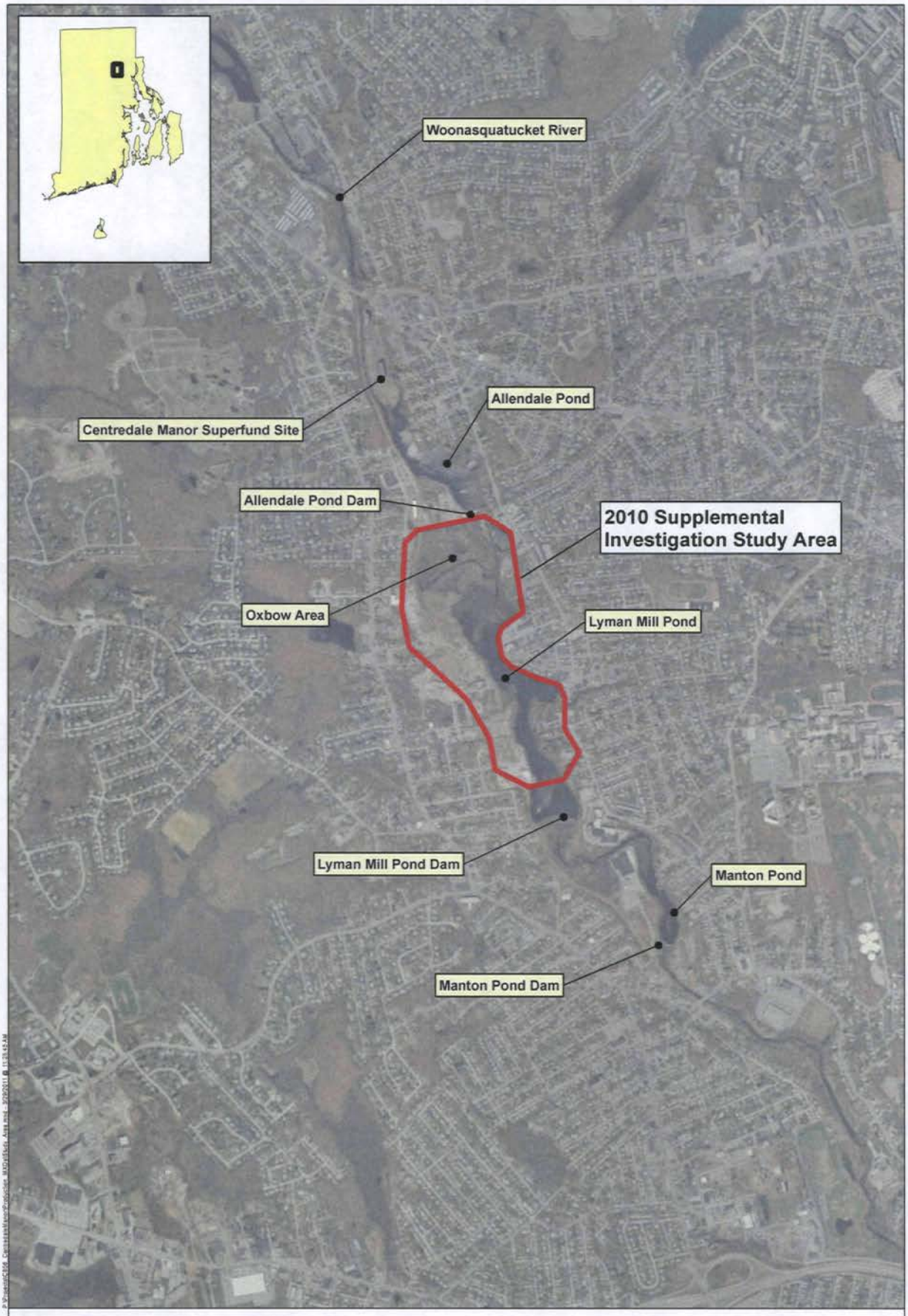

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Figure A-1.1.
2010 Supplemental Investigation Study Area

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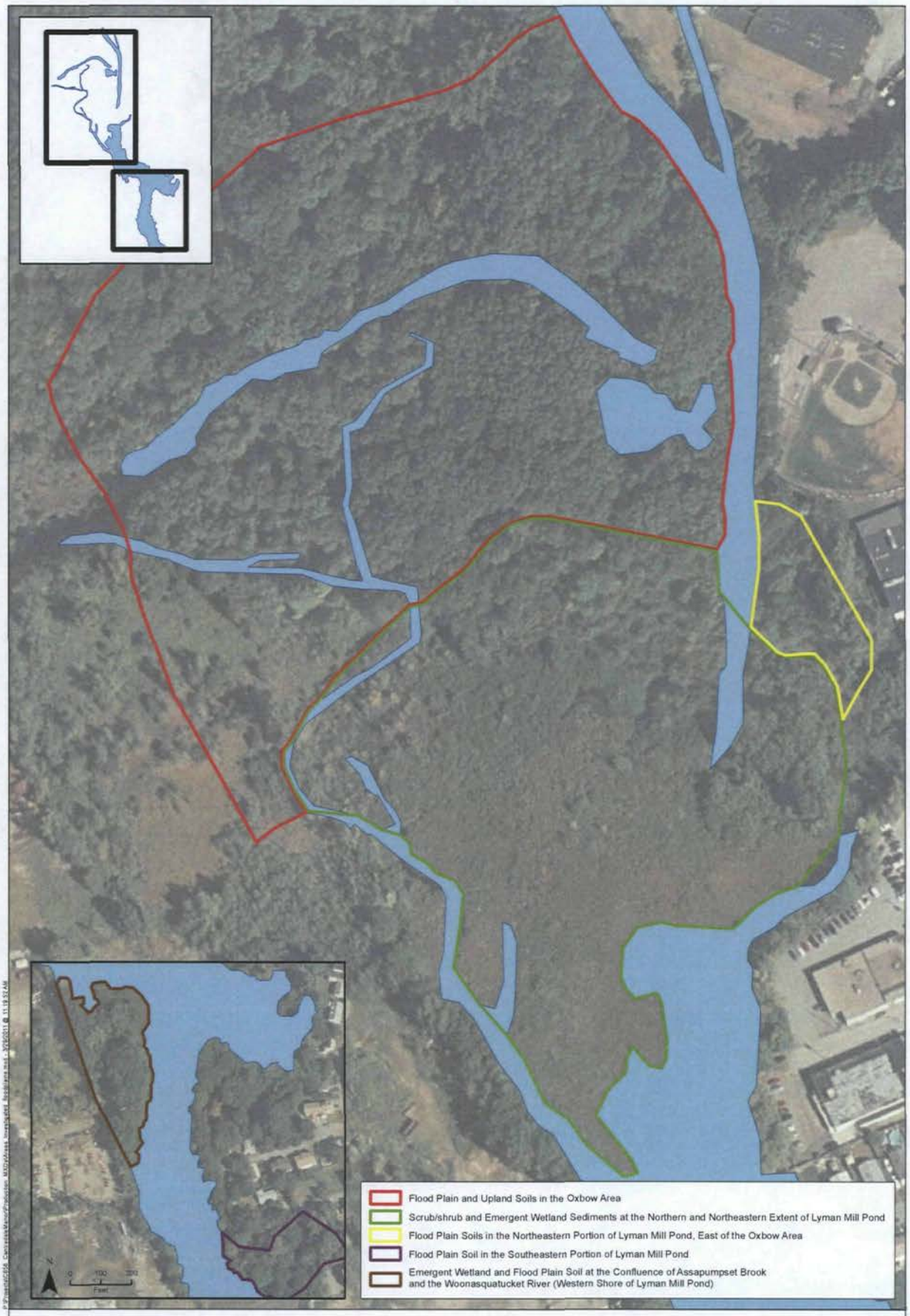

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Figure A-1.2.
Areas Investigated in the 2010 Supplemental Investigation

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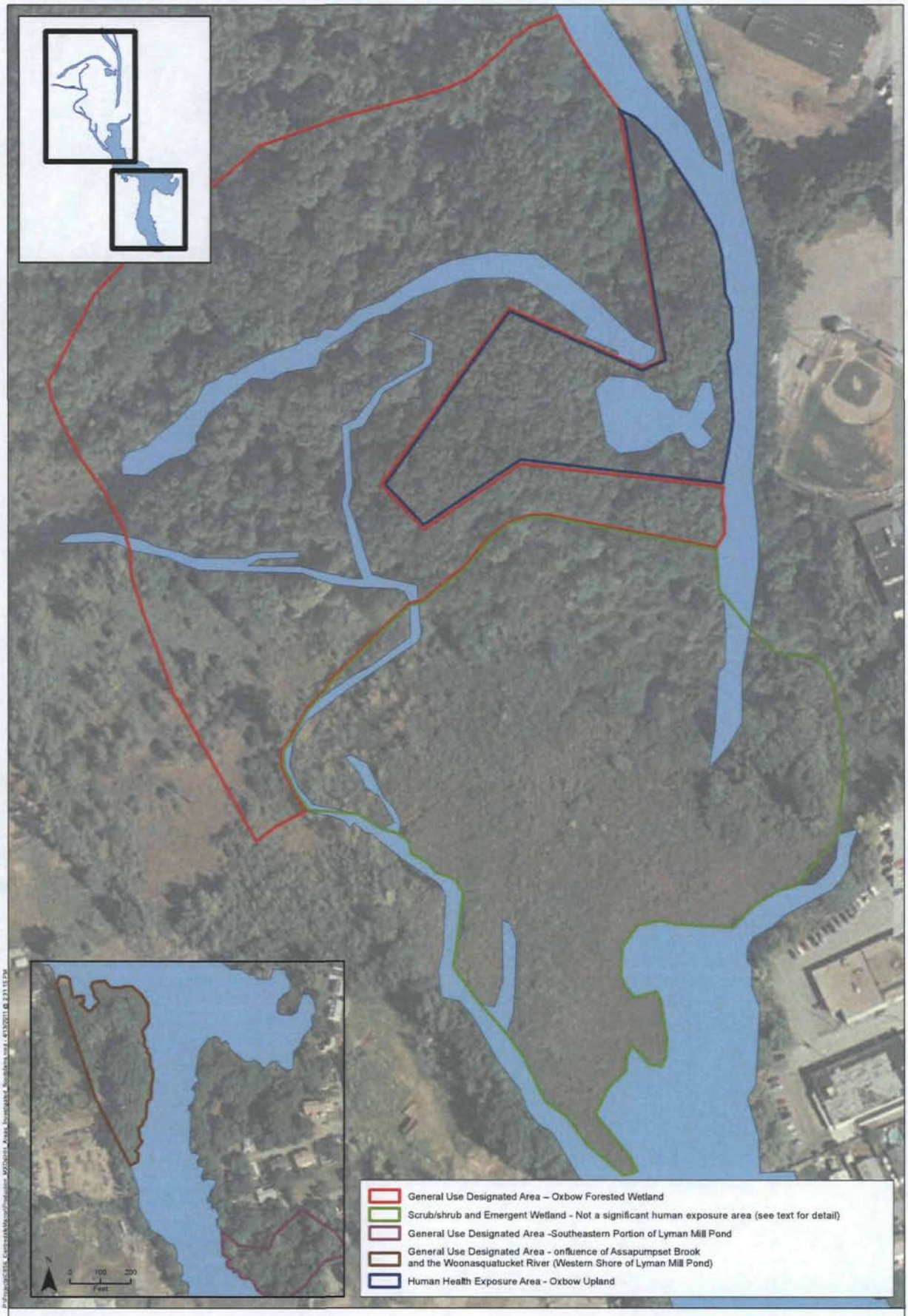

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Figure 1-3.
HHRA Exposure Areas.

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TABLES

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Table A-ES.1. Summary of Human Health Risk Assessment Results

Exposure Area	Receptor	Noncancer Hazard		Cancer Risk	
		RME	CTE	RME	CTE
Oxbow Human Health Exposure Area	Child	0.38	0.050	--	--
	Adolescent	0.083	0.0060	--	--
	Adult	0.069	0.0049	--	--
	Lifetime	--	--	4.5E-07	2.3E-08
Oxbow General Use Area	Adolescent	0.022	0.00064	--	--
	Adult	0.020	0.000544	--	--
	Lifetime	--	--	5.5E-06	6.5E-08
Northeast Lyman Mill Pond Flood Plain General Use	Adolescent	0.037	0.000354	--	--
	Adult	0.020	0.00030	--	--
	Lifetime	--	--	5.8E-06	1.9E-08
Southeast Lyman Mill Pond Flood Plain General Use	Adolescent	0.0086	0.00022	--	--
	Adult	0.0096	0.000186	--	--
	Lifetime	--	--	1.3E-07	1.3E-09
Assapumpset Brook Flood Plain General Use	Adolescent	0.017	0.000386	--	--
	Adult	0.015	0.000326	--	--
	Lifetime	--	--	3.0E-07	2.7E-09

Table A-2.1. COPC Screening - Oxbow Area Human Health Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Heptachlor Epoxide	1024-57-3	PESTP	4/11	36	0.095	0.53	UG/KG_DRY	0.00053	0.053	No
4,4'-DDT	50-29-3	PESTP	10/11	91	0.53	3.7	UG/KG_DRY	0.0037	1.7	No
alpha-Chlordane	12789-03-6	PESTP	2/11	18	0.13	0.26	UG/KG_DRY	0.00026	1.6	No
gamma-Chlordane	5566-34-7	PESTP	4/11	36	0.098	0.19	UG/KG_DRY	0.00019	No RSL	YES
Endosulfan I	959-98-8	PESTP	1/11	9	0.13	0.13	UG/KG_DRY	0.00013	No RSL	YES
gamma-BHC (Lindane)	58-89-9	PESTP	1/11	9	0.2	0.2	UG/KG_DRY	0.0002	0.52	No
Dieldrin	60-57-1	PESTP	4/11	36	0.22	0.73	UG/KG_DRY	0.00073	0.03	No
Endosulfan Sulfate	1031-07-8	PESTP	2/11	18	0.3	0.4	UG/KG_DRY	0.0004	No RSL	YES
4,4'-DDD	72-54-8	PESTP	1/11	9	0.13	0.13	UG/KG_DRY	0.00013	2	No
4,4'-DDE	72-55-9	PESTP	11/11	100	0.4	3	UG/KG_DRY	0.003	1.4	No
Benzo(a)pyrene	50-32-8	OS	5/11	45	13	72	UG/KG_DRY	0.072	0.015	YES
Benzoic Acid	65-85-0	OS	6/11	55	110	190	UG/KG_DRY	0.19	240000	No
Butyl Benzyl Phthalate	85-68-7	OS	8/11	73	5.2	10	UG/KG_DRY	0.01	260	No
Benz(a)anthracene	56-55-3	OS	11/11	100	16	40	UG/KG_DRY	0.04	0.15	No
Fluorene	86-73-7	OS	6/11	55	1.4	3.7	UG/KG_DRY	0.0037	2300	No
Pyrene	129-00-0	OS	11/11	100	32	110	UG/KG_DRY	0.11	1700	No
Benzyl Alcohol	100-51-6	OS	4/11	36	3.9	7	UG/KG_DRY	0.007	6100	No
Carbazole	86-74-8	OS	8/11	73	3	8.1	UG/KG_DRY	0.0081	No RSL	YES
Dibenz(a,h)anthracene	53-70-3	OS	6/11	55	2.2	8.3	UG/KG_DRY	0.0083	0.015	No
Anthracene	120-12-7	OS	8/11	73	3.7	15	UG/KG_DRY	0.015	17000	No
Naphthalene	91-20-3	OS	4/11	36	3	4.1	UG/KG_DRY	0.0041	3.6	No
Bis(2-ethylhexyl) Phthalate	117-81-7	OS	7/11	64	7.3	18	UG/KG_DRY	0.018	35	No
2-Methylnaphthalene	91-57-6	OS	3/11	27	2.5	3.5	UG/KG_DRY	0.0035	310	No
Dibenzofuran	132-64-9	OS	5/11	45	1.3	2.3	UG/KG_DRY	0.0023	78	No
Benzo(g,h,i)perylene	191-24-2	OS	11/11	100	12	51	UG/KG_DRY	0.051	No RSL	YES
Indeno(1,2,3-cd)pyrene	193-39-5	OS	11/11	100	12	53	UG/KG_DRY	0.053	0.15	No
Benzo(b)fluoranthene	205-99-2	OS	11/11	100	21	80	UG/KG_DRY	0.08	0.15	No
Fluoranthene	206-44-0	OS	11/11	100	32	110	UG/KG_DRY	0.11	2300	No
Benzo(k)fluoranthene	207-08-9	OS	11/11	100	9.5	25	UG/KG_DRY	0.025	1.5	No
Acenaphthylene	208-96-8	OS	11/11	100	4.8	16	UG/KG_DRY	0.016	No RSL	YES
Dimethyl Phthalate	131-11-3	OS	1/11	9	30	30	UG/KG_DRY	0.03	No RSL	YES
Di-n-butyl Phthalate	84-74-2	OS	2/11	18	8.4	10	UG/KG_DRY	0.01	6100	No
Phenol	108-95-2	OS	2/11	18	2.6	2.9	UG/KG_DRY	0.0029	18000	No
Chrysene	218-01-9	OS	11/11	100	21	68	UG/KG_DRY	0.068	15	No
Acenaphthene	83-32-9	OS	3/11	27	1.8	2.4	UG/KG_DRY	0.0024	3400	No
Benzaldehyde	100-52-7	OS	4/11	36	10	17	UG/KG_DRY	0.017	7800	No
Phenanthrene	85-01-8	OS	11/11	100	18	55	UG/KG_DRY	0.055	No RSL	YES
2,4-Dinitrotoluene	121-14-2	OS	1/11	9	34	34	UG/KG_DRY	0.034	1.6	No
Manganese	7439-96-5	M	11/11	100	39.7	721	MG/KG_DRY	721	1800	No
Cobalt	7440-48-4	M	11/11	100	0.75	2.2	MG/KG_DRY	2.2	23	No
Chromium	7440-47-3	M	11/11	100	3.88	7.8	MG/KG_DRY	7.8	120000	No
Vanadium	7440-62-2	M	11/11	100	12	25.7	MG/KG_DRY	25.7	5.5	YES

Table A-2.1. COPC Screening - Oxbow Area Human Health Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Cadmium	7440-43-9	M	7/11	64	0.07	0.16	MG/KG_DRY	0.16	70	No
Beryllium	7440-41-7	M	11/11	100	0.24	0.42	MG/KG_DRY	0.42	160	No
Barium	7440-39-3	M	11/11	100	12	29	MG/KG_DRY	29	15000	No
Arsenic	7440-38-2	M	11/11	100	1.7	8.9	MG/KG_DRY	8.9	0.39	YES
Antimony	7440-36-0	M	8/11	73	0.12	0.257	MG/KG_DRY	0.257	31	No
Molybdenum	7439-98-7	M	4/11	36	1.05	1.44	MG/KG_DRY	1.44	390	No
Lead	7439-92-1	M	11/11	100	21.7	45	MG/KG_DRY	45	400	No
Zinc	7440-66-6	M	11/11	100	11.5	32.3	MG/KG_DRY	32.3	23000	No
Selenium	7782-49-2	M	10/11	91	0.2	0.7	MG/KG_DRY	0.7	390	No
Copper	7440-50-8	M	11/11	100	5.2	14.4	MG/KG_DRY	14.4	3100	No
Nickel	7440-02-0	M	11/11	100	2	4.41	MG/KG_DRY	4.41	1500	No
2,3,7,8-TCDD	1746-01-6	DIOX	11/11	100	0.717	7.9	PG/G_DRY	0.0000079	No RSL	YES
1,2,3,7,8,9-HxCDD	19408-74-3	DIOX	8/11	73	0.286	0.683	PG/G_DRY	6.83E-07	No RSL	YES
Total TCDF	55722-27-5	DIOX	11/11	100	8	25.9	PG/G_DRY	0.0000259	No RSL	YES
Total TCDD	41903-57-5	DIOX	11/11	100	3.1	11.9	PG/G_DRY	0.0000119	No RSL	YES
1,2,3,7,8,9-HxCDF	72918-21-9	DIOX	2/11	18	0.0653	0.118	PG/G_DRY	1.18E-07	No RSL	YES
1,2,3,4,7,8-HxCDF	70648-26-9	DIOX	11/11	100	0.602	4.59	PG/G_DRY	4.59E-06	No RSL	YES
1,2,3,4,6,7,8-HpCDF	67562-39-4	DIOX	11/11	100	2.49	43.1	PG/G_DRY	0.0000431	No RSL	YES
2,3,4,6,7,8-HxCDF	60851-34-5	DIOX	11/11	100	0.568	2.04	PG/G_DRY	2.04E-06	No RSL	YES
1,2,3,6,7,8-HxCDD	57653-85-7	DIOX	11/11	100	0.322	0.838	PG/G_DRY	8.38E-07	No RSL	YES
1,2,3,6,7,8-HxCDF	57117-44-9	DIOX	11/11	100	0.413	1.24	PG/G_DRY	1.24E-06	No RSL	YES
1,2,3,7,8-PeCDF	57117-41-6	DIOX	10/11	91	0.387	0.964	PG/G_DRY	9.64E-07	No RSL	YES
2,3,4,7,8-PeCDF	57117-31-4	DIOX	11/11	100	0.549	1.85	PG/G_DRY	1.85E-06	No RSL	YES
1,2,3,4,7,8,9-HpCDF	55673-89-7	DIOX	7/11	64	0.148	0.545	PG/G_DRY	5.45E-07	No RSL	YES
2,3,7,8-TCDF	51207-31-9	DIOX	11/11	100	0.388	2.08	PG/G_DRY	2.08E-06	No RSL	YES
Total PeCDF	30402-15-4	DIOX	11/11	100	8.99	29	PG/G_DRY	0.000029	No RSL	YES
1,2,3,7,8-PeCDD	40321-76-4	DIOX	9/11	82	0.151	0.365	PG/G_DRY	3.65E-07	No RSL	YES
1,2,3,4,7,8-HxCDD	39227-28-6	DIOX	9/11	82	0.185	0.309	PG/G_DRY	3.09E-07	No RSL	YES
OCDF	39001-02-0	DIOX	11/11	100	2.54	24.9	PG/G_DRY	0.0000249	No RSL	YES
Total HpCDF	38998-75-3	DIOX	11/11	100	2.65	71.8	PG/G_DRY	0.0000718	No RSL	YES
Total HpCDD	37871-00-4	DIOX	11/11	100	7.47	22.6	PG/G_DRY	0.0000226	No RSL	YES
Total PeCDD	36088-22-9	DIOX	11/11	100	2.05	8.99	PG/G_DRY	8.99E-06	No RSL	YES
1,2,3,4,6,7,8-HpCDD	35822-46-9	DIOX	11/11	100	3.24	10	PG/G_DRY	0.00001	No RSL	YES
Total HxCDD	34465-46-8	DIOX	11/11	100	3.99	25	PG/G_DRY	0.000025	No RSL	YES
OCDD	3268-87-9	DIOX	11/11	100	20.1	64.7	PG/G_DRY	0.0000647	No RSL	YES
Total HxCDF	55684-94-1	DIOX	11/11	100	5.66	20.6	PG/G_DRY	0.0000206	No RSL	YES
TEQ mammal	TEM	Diox	11/11	100	1.47	8.66	PG/G_DRY	8.66E-06	0.0000045	YES

Table A-2.2. COPC Screening - Oxbow Area General Use Designated Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Aroclor 1254	11097-69-1	PESTP	12/21	57	7.7	570	UG/KG_DRY	0.57	0.22	YES
Endrin Aldehyde	7421-93-4	PESTP	9/21	43	0.23	11	UG/KG_DRY	0.011	No RSL	YES
4,4'-DDE	72-55-9	PESTP	16/21	76	0.91	14	UG/KG_DRY	0.014	1.4	No
Methoxychlor	72-43-5	PESTP	1/21	5	2.4	2.4	UG/KG_DRY	0.0024	310	No
Heptachlor Epoxide	1024-57-3	PESTP	3/21	14	0.085	11	UG/KG_DRY	0.011	0.053	No
Endosulfan Sulfate	1031-07-8	PESTP	4/21	19	0.28	0.97	UG/KG_DRY	0.00097	No RSL	YES
Dieldrin	60-57-1	PESTP	6/21	29	0.52	17	UG/KG_DRY	0.017	0.03	No
gamma-BHC (Lindane)	58-89-9	PESTP	4/21	19	0.18	2.3	UG/KG_DRY	0.0023	0.52	No
Aroclor 1260	11096-82-5	PESTP	5/21	24	62	120	UG/KG_DRY	0.12	0.22	No
4,4'-DDD	72-54-8	PESTP	6/21	29	0.48	3	UG/KG_DRY	0.003	2	No
Aroclor 1268	11100-14-4	PESTP	3/21	14	24	38	UG/KG_DRY	0.038	No RSL	YES
gamma-Chlordane	5566-34-7	PESTP	18/21	86	0.15	74	UG/KG_DRY	0.074	No RSL	YES
Endrin Ketone	53494-70-5	PESTP	7/21	33	0.16	2.3	UG/KG_DRY	0.0023	No RSL	YES
alpha-Chlordane	5103-71-9	PESTP	15/21	71	0.12	85	UG/KG_DRY	0.085	No RSL	YES
4,4'-DDT	50-29-3	PESTP	17/21	81	1.8	78	UG/KG_DRY	0.078	1.7	No
Endosulfan II	33213-65-9	PESTP	2/21	10	0.34	1.7	UG/KG_DRY	0.0017	No RSL	YES
beta-BHC	319-85-7	PESTP	2/21	10	5.1	5.3	UG/KG_DRY	0.0053	0.27	No
alpha-BHC	319-84-6	PESTP	5/21	24	0.12	1.5	UG/KG_DRY	0.0015	0.077	No
Chlordane	57-74-9	PESTP	10/21	48	3.9	570	UG/KG_DRY	0.57	No RSL	YES
Endrin	72-20-8	PESTP	5/21	24	0.25	1.6	UG/KG_DRY	0.0016	18	No
Endosulfan I	959-98-8	PESTP	2/21	10	2.5	2.8	UG/KG_DRY	0.0028	No RSL	YES
Heptachlor	76-44-8	PESTP	3/21	14	1.3	4.2	UG/KG_DRY	0.0042	0.11	No
Pyrene	129-00-0	OS	21/21	100	37	90000	UG/KG_DRY	90	1700	No
Benzyl Alcohol	100-51-6	OS	5/21	24	5.2	58	UG/KG_DRY	0.058	6100	No
Bis(2-ethylhexyl) Phthalate	117-81-7	OS	16/21	76	10	850	UG/KG_DRY	0.85	35	No
Di-n-octyl Phthalate	117-84-0	OS	1/21	5	62	62	UG/KG_DRY	0.062	No RSL	YES
Anthracene	120-12-7	OS	21/21	100	4.2	20000	UG/KG_DRY	20	17000	No
Fluorene	86-73-7	OS	19/21	90	1.1	7200	UG/KG_DRY	7.2	2300	No
Dibenz(a,h)anthracene	53-70-3	OS	21/21	100	3.8	7300	UG/KG_DRY	7.3	0.015	YES
Carbazole	86-74-8	OS	21/21	100	3.4	6800	UG/KG_DRY	6.8	No RSL	YES
2,4,6-Trichlorophenol	88-06-2	OS	1/21	5	5.2	5.2	UG/KG_DRY	0.0052	44	No
Naphthalene	91-20-3	OS	12/21	57	2.6	3800	UG/KG_DRY	3.8	3.6	YES
Nitrobenzene	98-95-3	OS	4/21	19	16	3500	UG/KG_DRY	3.5	4.8	No
2-Methylnaphthalene	91-57-6	OS	7/21	33	3.1	1900	UG/KG_DRY	1.9	310	No
Phenanthrene	85-01-8	OS	21/21	100	18	67000	UG/KG_DRY	67	No RSL	YES

Table A-2.2. COPC Screening - Oxbow Area General Use Designated Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Dimethyl Phthalate	131-11-3	OS	12/21	57	30	160	UG/KG_DRY	0.16	No RSL	YES
Dibenzofuran	132-64-9	OS	12/21	57	1.5	4100	UG/KG_DRY	4.1	78	No
Benzo(g,h,i)perylene	191-24-2	OS	21/21	100	17	25000	UG/KG_DRY	25	No RSL	YES
Indeno(1,2,3-cd)pyrene	193-39-5	OS	21/21	100	17	30000	UG/KG_DRY	30	0.15	YES
Benzo(b)fluoranthene	205-99-2	OS	21/21	100	29	50000	UG/KG_DRY	50	0.15	YES
Fluoranthene	206-44-0	OS	21/21	100	37	100000	UG/KG_DRY	100	2300	No
Biphenyl	92-52-4	OS	2/21	10	2.4	430	UG/KG_DRY	0.43	3900	No
Benzo(k)fluoranthene	207-08-9	OS	21/21	100	11	19000	UG/KG_DRY	19	1.5	YES
2,4,5-Trichlorophenol	95-95-4	OS	5/21	24	1.6	25	UG/KG_DRY	0.025	6100	No
Acenaphthylene	208-96-8	OS	21/21	100	4.4	3600	UG/KG_DRY	3.6	No RSL	YES
Benzo(a)pyrene	50-32-8	OS	21/21	100	23	52000	UG/KG_DRY	52	0.015	YES
Chrysene	218-01-9	OS	21/21	100	24	52000	UG/KG_DRY	52	15	YES
Butyl Benzyl Phthalate	85-68-7	OS	19/21	90	5.8	230	UG/KG_DRY	0.23	260	No
Benzaldehyde	100-52-7	OS	3/21	14	8.7	18	UG/KG_DRY	0.018	7800	No
Benz(a)anthracene	56-55-3	OS	21/21	100	16	52000	UG/KG_DRY	52	0.15	YES
Benzoic Acid	65-85-0	OS	4/21	19	130	800	UG/KG_DRY	0.8	240000	No
Phenol	108-95-2	OS	3/21	14	4.9	33	UG/KG_DRY	0.033	18000	No
Acenaphthene	83-32-9	OS	14/21	67	1.8	7000	UG/KG_DRY	7	3400	No
Diethyl Phthalate	84-66-2	OS	1/21	5	54	54	UG/KG_DRY	0.054	49000	No
Di-n-butyl Phthalate	84-74-2	OS	1/21	5	9.1	9.1	UG/KG_DRY	0.0091	6100	No
Cadmium	7440-43-9	M	20/21	95	0.04	2.1	MG/KG_DRY	2.1	70	No
Beryllium	7440-41-7	M	21/21	100	0.25	1.92	MG/KG_DRY	1.92	160	No
Cobalt	7440-48-4	M	21/21	100	0.94	10	MG/KG_DRY	10	23	No
Nickel	7440-02-0	M	21/21	100	2.57	148	MG/KG_DRY	148	1500	No
Arsenic	7440-38-2	M	21/21	100	3.2	13.3	MG/KG_DRY	13.3	0.39	YES
Antimony	7440-36-0	M	17/21	81	0.235	1.33	MG/KG_DRY	1.33	31	No
Thallium	7440-28-0	M	2/21	10	0.4	0.7	MG/KG_DRY	0.7		No
Silver	7440-22-4	M	8/21	38	0.2	0.4	MG/KG_DRY	0.4	390	No
Barium	7440-39-3	M	21/21	100	15.3	191	MG/KG_DRY	191	15000	No
Molybdenum	7439-98-7	M	21/21	100	0.4	19.1	MG/KG_DRY	19.1	390	No
Lead	7439-92-1	M	21/21	100	26	792	MG/KG_DRY	792	400	YES
Chromium	7440-47-3	M	21/21	100	5.66	67.4	MG/KG_DRY	67.4	120000	No
Copper	7440-50-8	M	21/21	100	6.2	151	MG/KG_DRY	151	3100	No
Vanadium	7440-62-2	M	21/21	100	11	45.2	MG/KG_DRY	45.2	5.5	YES
Zinc	7440-66-6	M	21/21	100	16	354	MG/KG_DRY	354	23000	No

Table A-2.2. COPC Screening - Oxbow Area General Use Designated Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Selenium	7782-49-2	M	21/21	100	0.4	2.2	MG/KG_DRY	2.2	390	No
Manganese	7439-96-5	M	21/21	100	156	2440	MG/KG_DRY	2440	1800	YES
1,2,3,7,8,9-HxCDD	19408-74-3	DIOX	16/21	76	0.417	18.2	PG/G_DRY	1.82E-05	No RSL	YES
2,3,7,8-TCDD	1746-01-6	DIOX	21/21	100	3.12	14600	PG/G_DRY	0.0146	No RSL	YES
Total TCDD	41903-57-5	DIOX	21/21	100	8.34	14900	PG/G_DRY	0.0149	No RSL	YES
1,2,3,7,8,9-HxCDF	72918-21-9	DIOX	11/21	52	0.107	1.7	PG/G_DRY	1.7E-06	No RSL	YES
1,2,3,4,7,8-HxCDF	70648-26-9	DIOX	20/21	95	0.662	13.6	PG/G_DRY	1.36E-05	No RSL	YES
1,2,3,4,6,7,8-HpCDF	67562-39-4	DIOX	21/21	100	3.76	150	PG/G_DRY	0.00015	No RSL	YES
2,3,4,6,7,8-HxCDF	60851-34-5	DIOX	20/21	95	0.608	13.9	PG/G_DRY	1.39E-05	No RSL	YES
1,2,3,6,7,8-HxCDD	57653-85-7	DIOX	19/21	90	0.542	23.8	PG/G_DRY	2.38E-05	No RSL	YES
1,2,3,6,7,8-HxCDF	57117-44-9	DIOX	21/21	100	0.514	12	PG/G_DRY	0.000012	No RSL	YES
1,2,3,7,8-PeCDF	57117-41-6	DIOX	19/21	90	0.413	6.36	PG/G_DRY	6.36E-06	No RSL	YES
Total TCDF	55722-27-5	DIOX	21/21	100	11.2	243	PG/G_DRY	0.000243	No RSL	YES
Total HxCDF	55684-94-1	DIOX	21/21	100	7.66	330	PG/G_DRY	0.00033	No RSL	YES
2,3,4,7,8-PeCDF	57117-31-4	DIOX	21/21	100	0.557	11.3	PG/G_DRY	1.13E-05	No RSL	YES
2,3,7,8-TCDF	51207-31-9	DIOX	21/21	100	0.87	14.1	PG/G_DRY	1.41E-05	No RSL	YES
Total PeCDF	30402-15-4	DIOX	21/21	100	10.3	358	PG/G_DRY	0.000358	No RSL	YES
1,2,3,7,8-PeCDD	40321-76-4	DIOX	18/21	86	0.322	14.7	PG/G_DRY	1.47E-05	No RSL	YES
1,2,3,4,7,8-HxCDD	39227-28-6	DIOX	15/21	71	0.276	11.1	PG/G_DRY	1.11E-05	No RSL	YES
OCDF	39001-02-0	DIOX	21/21	100	4.13	274	PG/G_DRY	0.000274	No RSL	YES
Total HpCDF	38998-75-3	DIOX	21/21	100	5.97	315	PG/G_DRY	0.000315	No RSL	YES
Total HpCDD	37871-00-4	DIOX	21/21	100	16.3	979	PG/G_DRY	0.000979	No RSL	YES
Total PeCDD	36088-22-9	DIOX	21/21	100	2.34	160	PG/G_DRY	0.00016	No RSL	YES
1,2,3,4,6,7,8-HpCDD	35822-46-9	DIOX	21/21	100	8.34	555	PG/G_DRY	0.000555	No RSL	YES
Total HxCDD	34465-46-8	DIOX	21/21	100	5.43	351	PG/G_DRY	0.000351	No RSL	YES
OCDD	3268-87-9	DIOX	21/21	100	48.9	3700	PG/G_DRY	0.0037	No RSL	YES
1,2,3,4,7,8,9-HpCDF	55673-89-7	DIOX	17/21	81	0.244	8.74	PG/G_DRY	8.74E-06	No RSL	YES
TEQ mammal	TEM	Diox	21/21	100	8.24	14633	PG/G_DRY	0.014633	0.0000045	YES

Table A-2.3. COPC Screening - Assapumpset Brook Flood Plain Soil General Use Designated Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
4,4'-DDD	72-54-8	PESTP	2/2	100	4.1	14	UG/KG_DRY	0.014	2	No
4,4'-DDT	50-29-3	PESTP	2/2	100	14	53	UG/KG_DRY	0.053	1.7	No
alpha-Chlordane	5103-71-9	PESTP	2/2	100	2.8	6.4	UG/KG_DRY	0.0064	No RSL	YES
gamma-Chlordane	5566-34-7	PESTP	2/2	100	4.5	13	UG/KG_DRY	0.013	No RSL	YES
Endosulfan Sulfate	1031-07-8	PESTP	1/2	50	2.3	2.3	UG/KG_DRY	0.0023	No RSL	YES
Chlordane	57-74-9	PESTP	2/2	100	42	64	UG/KG_DRY	0.064	No RSL	YES
Endrin	72-20-8	PESTP	1/2	50	0.8	0.8	UG/KG_DRY	0.0008	18	No
4,4'-DDE	72-55-9	PESTP	2/2	100	8.5	8.8	UG/KG_DRY	0.0088	1.4	No
Aroclor 1260	11096-82-5	PESTP	2/2	100	92	280	UG/KG_DRY	0.28	0.22	YES
Endrin Aldehyde	7421-93-4	PESTP	1/2	50	1.6	1.6	UG/KG_DRY	0.0016	No RSL	YES
Aroclor 1254	11097-69-1	PESTP	2/2	100	51	250	UG/KG_DRY	0.25	0.22	YES
Butyl Benzyl Phthalate	85-68-7	OS	2/2	100	84	230	UG/KG_DRY	0.23	260	No
Dibenzofuran	132-64-9	OS	1/2	50	16	16	UG/KG_DRY	0.016	78	No
Carbazole	86-74-8	OS	2/2	100	28	53	UG/KG_DRY	0.053	No RSL	YES
Acenaphthene	83-32-9	OS	1/2	50	25	25	UG/KG_DRY	0.025	3400	No
Benzo(g,h,i)perylene	191-24-2	OS	2/2	100	260	510	UG/KG_DRY	0.51	No RSL	YES
Phenanthrene	85-01-8	OS	2/2	100	170	570	UG/KG_DRY	0.57	No RSL	YES
Dimethyl Phthalate	131-11-3	OS	2/2	100	48	70	UG/KG_DRY	0.07	No RSL	YES
Indeno(1,2,3-cd)pyrene	193-39-5	OS	2/2	100	240	530	UG/KG_DRY	0.53	0.15	YES
Pyrene	129-00-0	OS	2/2	100	450	1200	UG/KG_DRY	1.2	1700	No
Benzo(a)pyrene	50-32-8	OS	2/2	100	290	670	UG/KG_DRY	0.67	0.015	YES
Fluorene	86-73-7	OS	1/2	50	45	45	UG/KG_DRY	0.045	2300	No
Benzo(b)fluoranthene	205-99-2	OS	2/2	100	410	910	UG/KG_DRY	0.91	0.15	YES
Fluoranthene	206-44-0	OS	2/2	100	470	1300	UG/KG_DRY	1.3	2300	No
Benzo(k)fluoranthene	207-08-9	OS	2/2	100	140	300	UG/KG_DRY	0.3	1.5	No
Acenaphthylene	208-96-8	OS	2/2	100	74	140	UG/KG_DRY	0.14	No RSL	YES
Chrysene	218-01-9	OS	2/2	100	320	740	UG/KG_DRY	0.74	15	No
Dibenz(a,h)anthracene	53-70-3	OS	2/2	100	54	120	UG/KG_DRY	0.12	0.015	YES
Bis(2-ethylhexyl) Phthalate	117-81-7	OS	2/2	100	300	1200	UG/KG_DRY	1.2	35	No
Benz(a)anthracene	56-55-3	OS	2/2	100	220	590	UG/KG_DRY	0.59	0.15	YES
Anthracene	120-12-7	OS	2/2	100	68	170	UG/KG_DRY	0.17	17000	No
Lead	7439-92-1	M	2/2	100	93	213	MG/KG_DRY	213	400	No
Beryllium	7440-41-7	M	2/2	100	0.6	0.89	MG/KG_DRY	0.89	160	No
Barium	7440-39-3	M	2/2	100	78.2	83	MG/KG_DRY	83	15000	No
Arsenic	7440-38-2	M	2/2	100	5.3	13.7	MG/KG_DRY	13.7	0.39	YES
Antimony	7440-36-0	M	2/2	100	0.249	1.38	MG/KG_DRY	1.38	31	No
Thallium	7440-28-0	M	1/2	50	0.8	0.8	MG/KG_DRY	0.8		No
Silver	7440-22-4	M	1/2	50	2.2	2.2	MG/KG_DRY	2.2	390	No
Nickel	7440-02-0	M	2/2	100	20.7	28.3	MG/KG_DRY	28.3	1500	No
Selenium	7782-49-2	M	2/2	100	0.6	4.5	MG/KG_DRY	4.5	390	No
Manganese	7439-96-5	M	2/2	100	516	882	MG/KG_DRY	882	1800	No
Chromium	7440-47-3	M	2/2	100	17.3	18.2	MG/KG_DRY	18.2	120000	No
Cobalt	7440-48-4	M	2/2	100	3.64	9.11	MG/KG_DRY	9.11	23	No

Table A-2.3. COPC Screening - Assapumpset Brook Flood Plain Soil General Use Designated Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Copper	7440-50-8	M	2/2	100	35.3	119	MG/KG_DRY	119	3100	No
Vanadium	7440-62-2	M	2/2	100	12.9	22.8	MG/KG_DRY	22.8	5.5	YES
Cadmium	7440-43-9	M	2/2	100	0.44	0.83	MG/KG_DRY	0.83	70	No
Zinc	7440-66-6	M	2/2	100	127	190	MG/KG_DRY	190	23000	No
Molybdenum	7439-98-7	M	2/2	100	1.12	1.73	MG/KG_DRY	1.73	390	No
1,2,3,7,8,9-HxCDD	19408-74-3	DIOX	2/2	100	5.78	17.2	PG/G_DRY	0.0000172	No RSL	YES
2,3,7,8-TCDD	1746-01-6	DIOX	2/2	100	2.44	132	PG/G_DRY	0.000132	No RSL	YES
OCDD	3268-87-9	DIOX	2/2	100	1050	4230	PG/G_DRY	0.00423	No RSL	YES
Total PeCDF	30402-15-4	DIOX	2/2	100	96.1	443	PG/G_DRY	0.000443	No RSL	YES
2,3,7,8-TCDF	51207-31-9	DIOX	2/2	100	3.51	12.7	PG/G_DRY	0.0000127	No RSL	YES
1,2,3,7,8,9-HxCDF	72918-21-9	DIOX	1/2	50	8.6	8.6	PG/G_DRY	0.0000086	No RSL	YES
1,2,3,4,7,8-HxCDF	70648-26-9	DIOX	1/2	50	41.3	41.3	PG/G_DRY	0.0000413	No RSL	YES
1,2,3,4,6,7,8-HpCDF	67562-39-4	DIOX	2/2	100	60.1	241	PG/G_DRY	0.000241	No RSL	YES
2,3,4,6,7,8-HxCDF	60851-34-5	DIOX	2/2	100	8.84	31.4	PG/G_DRY	0.0000314	No RSL	YES
1,2,3,6,7,8-HxCDD	57653-85-7	DIOX	2/2	100	7.5	28.7	PG/G_DRY	0.0000287	No RSL	YES
1,2,3,6,7,8-HxCDF	57117-44-9	DIOX	2/2	100	7.44	30.4	PG/G_DRY	0.0000304	No RSL	YES
1,2,3,7,8-PeCDF	57117-41-6	DIOX	2/2	100	3.74	17.3	PG/G_DRY	0.0000173	No RSL	YES
2,3,4,7,8-PeCDF	57117-31-4	DIOX	2/2	100	4.72	38.6	PG/G_DRY	0.0000386	No RSL	YES
Total HxCDF	55684-94-1	DIOX	2/2	100	107	436	PG/G_DRY	0.000436	No RSL	YES
1,2,3,4,7,8,9-HpCDF	55673-89-7	DIOX	2/2	100	4.32	17.3	PG/G_DRY	0.0000173	No RSL	YES
Total HxCDD	34465-46-8	DIOX	2/2	100	59.9	282	PG/G_DRY	0.000282	No RSL	YES
Total TCDD	41903-57-5	DIOX	2/2	100	76.9	145	PG/G_DRY	0.000145	No RSL	YES
1,2,3,7,8-PeCDD	40321-76-4	DIOX	1/2	50	6.3	6.3	PG/G_DRY	0.0000063	No RSL	YES
1,2,3,4,7,8-HxCDD	39227-28-6	DIOX	1/2	50	8.83	8.83	PG/G_DRY	0.00000883	No RSL	YES
OCDF	39001-02-0	DIOX	2/2	100	98.3	576	PG/G_DRY	0.000576	No RSL	YES
Total HpCDF	38998-75-3	DIOX	2/2	100	121	614	PG/G_DRY	0.000614	No RSL	YES
Total HpCDD	37871-00-4	DIOX	2/2	100	272	1070	PG/G_DRY	0.00107	No RSL	YES
Total PeCDD	36088-22-9	DIOX	2/2	100	21.6	139	PG/G_DRY	0.000139	No RSL	YES
1,2,3,4,6,7,8-HpCDD	35822-46-9	DIOX	2/2	100	142	592	PG/G_DRY	0.000592	No RSL	YES
Total TCDF	55722-27-5	DIOX	2/2	100	60.9	262	PG/G_DRY	0.000262	No RSL	YES
TEQ mammal	TEM	Diox	2/2	100	48.6	139.2	PG/G_DRY	0.0001392	0.0000045	YES

Table A-2.4. COPC Screening - Northeastern Lyman Mill Pond Flood Plain Soil General Use Designated Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Endosulfan Sulfate	1031-07-8	PESTP	1/5	20	0.53	0.53	UG/KG_DRY	0.00053	No RSL	YES
4,4'-DDE	72-55-9	PESTP	5/5	100	2.4	11	UG/KG_DRY	0.011	1.4	No
4,4'-DDD	72-54-8	PESTP	4/5	80	1	6.4	UG/KG_DRY	0.0064	2	No
Endrin	72-20-8	PESTP	3/5	60	0.21	1.3	UG/KG_DRY	0.0013	18	No
Aroclor 1268	11100-14-4	PESTP	1/5	20	54	54	UG/KG_DRY	0.054	No RSL	YES
Endrin Aldehyde	7421-93-4	PESTP	2/5	40	1.8	2.3	UG/KG_DRY	0.0023	No RSL	YES
Chlordane	57-74-9	PESTP	5/5	100	27	540	UG/KG_DRY	0.54	No RSL	YES
Aroclor 1254	11097-69-1	PESTP	5/5	100	40	360	UG/KG_DRY	0.36	0.22	YES
Heptachlor Epoxide	1024-57-3	PESTP	1/5	20	0.24	0.24	UG/KG_DRY	0.00024	0.053	No
gamma-Chlordane	5566-34-7	PESTP	5/5	100	3	45	UG/KG_DRY	0.045	No RSL	YES
Endrin Ketone	53494-70-5	PESTP	3/5	60	0.28	1.9	UG/KG_DRY	0.0019	No RSL	YES
alpha-Chlordane	5103-71-9	PESTP	5/5	100	1.6	30	UG/KG_DRY	0.03	No RSL	YES
4,4'-DDT	50-29-3	PESTP	4/5	80	5.4	42	UG/KG_DRY	0.042	1.7	No
Endosulfan II	33213-65-9	PESTP	2/5	40	3.6	7.5	UG/KG_DRY	0.0075	No RSL	YES
alpha-BHC	319-84-6	PESTP	3/5	60	0.18	0.27	UG/KG_DRY	0.00027	0.077	No
delta-BHC	319-86-8	PESTP	1/5	20	0.29	0.29	UG/KG_DRY	0.00029	No RSL	YES
Heptachlor	76-44-8	PESTP	1/5	20	6.2	6.2	UG/KG_DRY	0.0062	0.11	No
Benzo(g,h,i)perylene	191-24-2	OS	5/5	100	250	2500	UG/KG_DRY	2.5	No RSL	YES
Benzoic Acid	65-85-0	OS	5/5	100	480	3500	UG/KG_DRY	3.5	240000	No
Acenaphthene	83-32-9	OS	5/5	100	14	190	UG/KG_DRY	0.19	3400	No
Dibenz(a,h)anthracene	53-70-3	OS	5/5	100	55	680	UG/KG_DRY	0.68	0.015	YES
Phenanthrene	85-01-8	OS	5/5	100	240	5000	UG/KG_DRY	5	No RSL	YES
2,4-Dinitrophenol	51-28-5	OS	2/5	40	170	480	UG/KG_DRY	0.48	120	No
Butyl Benzyl Phthalate	85-68-7	OS	2/5	40	35	410	UG/KG_DRY	0.41	260	No
2-Methylnaphthalene	91-57-6	OS	1/5	20	29	29	UG/KG_DRY	0.029	310	No
Fluorene	86-73-7	OS	5/5	100	16	350	UG/KG_DRY	0.35	2300	No
Benz(a)anthracene	56-55-3	OS	5/5	100	250	3100	UG/KG_DRY	3.1	0.15	YES
Indeno(1,2,3-cd)pyrene	193-39-5	OS	5/5	100	260	2800	UG/KG_DRY	2.8	0.15	YES
Benzo(b)fluoranthene	205-99-2	OS	5/5	100	480	5000	UG/KG_DRY	5	0.15	YES
Fluoranthene	206-44-0	OS	5/5	100	590	6600	UG/KG_DRY	6.6	2300	No
Benzo(k)fluoranthene	207-08-9	OS	5/5	100	160	1700	UG/KG_DRY	1.7	1.5	YES
Acenaphthylene	208-96-8	OS	5/5	100	40	720	UG/KG_DRY	0.72	No RSL	YES
Chrysene	218-01-9	OS	5/5	100	370	3700	UG/KG_DRY	3.7	15	No
Carbazole	86-74-8	OS	5/5	100	40	570	UG/KG_DRY	0.57	No RSL	YES
Naphthalene	91-20-3	OS	2/5	40	37	84	UG/KG_DRY	0.084	3.6	No
Benzo(a)pyrene	50-32-8	OS	5/5	100	330	3900	UG/KG_DRY	3.9	0.015	YES
Pyrene	129-00-0	OS	5/5	100	550	6800	UG/KG_DRY	6.8	1700	No
Anthracene	120-12-7	OS	5/5	100	50	1000	UG/KG_DRY	1	17000	No
Bis(2-ethylhexyl) Phthalate	117-81-7	OS	5/5	100	95	1300	UG/KG_DRY	1.3	35	No
Dimethyl Phthalate	131-11-3	OS	5/5	100	25	130	UG/KG_DRY	0.13	No RSL	YES
Dibenzofuran	132-64-9	OS	5/5	100	8.7	140	UG/KG_DRY	0.14	78	No
Cobalt	7440-48-4	M	5/5	100	1.1	7.3	MG/KG_DRY	7.3	23	No
Antimony	7440-36-0	M	4/5	80	0.237	1.51	MG/KG_DRY	1.51	31	No
Silver	7440-22-4	M	1/5	20	0.3	0.3	MG/KG_DRY	0.3	390	No
Nickel	7440-02-0	M	5/5	100	5.4	23.4	MG/KG_DRY	23.4	1500	No

Table A-2.4. COPC Screening - Northeastern Lyman Mill Pond Flood Plain Soil General Use Designated Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Molybdenum	7439-98-7	M	5/5	100	0.8	14.8	MG/KG_DRY	14.8	390	No
Manganese	7439-96-5	M	5/5	100	178	831	MG/KG_DRY	831	1800	No
Lead	7439-92-1	M	5/5	100	15.9	308	MG/KG_DRY	308	400	No
Barium	7440-39-3	M	5/5	100	14.8	113	MG/KG_DRY	113	15000	No
Beryllium	7440-41-7	M	5/5	100	0.28	2.08	MG/KG_DRY	2.08	160	No
Chromium	7440-47-3	M	5/5	100	8.2	92.6	MG/KG_DRY	92.6	120000	No
Copper	7440-50-8	M	5/5	100	6.4	92.7	MG/KG_DRY	92.7	3100	No
Vanadium	7440-62-2	M	5/5	100	4.6	52.3	MG/KG_DRY	52.3	5.5	YES
Zinc	7440-66-6	M	5/5	100	35.5	199	MG/KG_DRY	199	23000	No
Selenium	7782-49-2	M	4/5	80	0.1	1.5	MG/KG_DRY	1.5	390	No
Arsenic	7440-38-2	M	4/5	80	2.1	18.4	MG/KG_DRY	18.4	0.39	YES
Cadmium	7440-43-9	M	5/5	100	0.1	2.4	MG/KG_DRY	2.4	70	No
1,2,3,7,8,9-HxCDD	19408-74-3	DIOX	4/5	80	2.26	27.7	PG/G_DRY	0.0000277	No RSL	YES
Total TCDF	55722-27-5	DIOX	5/5	100	28.9	252	PG/G_DRY	0.000252	No RSL	YES
2,3,7,8-TCDD	1746-01-6	DIOX	5/5	100	590	12600	PG/G_DRY	0.0126	No RSL	YES
Total PeCDF	30402-15-4	DIOX	5/5	100	51.7	410	PG/G_DRY	0.00041	No RSL	YES
Total TCDD	41903-57-5	DIOX	5/5	100	608	12800	PG/G_DRY	0.0128	No RSL	YES
1,2,3,7,8,9-HxCDF	72918-21-9	DIOX	2/5	40	1.62	1.73	PG/G_DRY	0.00000173	No RSL	YES
1,2,3,4,7,8-HxCDF	70648-26-9	DIOX	4/5	80	2.14	17.4	PG/G_DRY	0.0000174	No RSL	YES
1,2,3,4,6,7,8-HpCDF	67562-39-4	DIOX	5/5	100	24.2	265	PG/G_DRY	0.000265	No RSL	YES
2,3,4,6,7,8-HxCDF	60851-34-5	DIOX	5/5	100	2.57	24.4	PG/G_DRY	0.0000244	No RSL	YES
1,2,3,6,7,8-HxCDD	57653-85-7	DIOX	4/5	80	3.34	40.5	PG/G_DRY	0.0000405	No RSL	YES
1,2,3,6,7,8-HxCDF	57117-44-9	DIOX	4/5	80	2.17	20.9	PG/G_DRY	0.0000209	No RSL	YES
1,2,3,7,8-PeCDF	57117-41-6	DIOX	5/5	100	0.809	6.91	PG/G_DRY	0.00000691	No RSL	YES
2,3,4,7,8-PeCDF	57117-31-4	DIOX	5/5	100	1.52	9.57	PG/G_DRY	0.00000957	No RSL	YES
1,2,3,4,7,8,9-HpCDF	55673-89-7	DIOX	5/5	100	1.5	14.3	PG/G_DRY	0.0000143	No RSL	YES
2,3,7,8-TCDF	51207-31-9	DIOX	4/5	80	1.3	11.7	PG/G_DRY	0.0000117	No RSL	YES
OCDD	3268-87-9	DIOX	5/5	100	499	6490	PG/G_DRY	0.00649	No RSL	YES
1,2,3,7,8-PeCDD	40321-76-4	DIOX	5/5	100	0.928	9.57	PG/G_DRY	0.00000957	No RSL	YES
1,2,3,4,7,8-HxCDD	39227-28-6	DIOX	3/5	60	1.4	14	PG/G_DRY	0.000014	No RSL	YES
OCDF	39001-02-0	DIOX	5/5	100	43.5	462	PG/G_DRY	0.000462	No RSL	YES
Total HpCDF	38998-75-3	DIOX	5/5	100	54.6	555	PG/G_DRY	0.000555	No RSL	YES
Total HpCDD	37871-00-4	DIOX	5/5	100	120	1640	PG/G_DRY	0.00164	No RSL	YES
Total PeCDD	36088-22-9	DIOX	5/5	100	11.4	81.9	PG/G_DRY	0.0000819	No RSL	YES
1,2,3,4,6,7,8-HpCDD	35822-46-9	DIOX	5/5	100	64.5	826	PG/G_DRY	0.000826	No RSL	YES
Total HxCDD	34465-46-8	DIOX	5/5	100	28.7	299	PG/G_DRY	0.000299	No RSL	YES
Total HxCDF	55684-94-1	DIOX	5/5	100	52.9	448	PG/G_DRY	0.000448	No RSL	YES
TEQ mammal	TEM	DIOX	5/5	100	594.3	12641.6	PG/G_DRY	0.0126416	0.0000045	YES

Table A-2.5. COPC Screening - Southeastern Lyman Mill Pond Flood Plain Soil General Use Designated Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Aroclor 1260	11096-82-5	PESTP	1/2	50	29	29	UG/KG_DRY	0.029	0.22	No
4,4'-DDT	50-29-3	PESTP	2/2	100	1.2	52	UG/KG_DRY	0.052	1.7	No
alpha-Chlordane	5103-71-9	PESTP	1/2	50	0.32	0.32	UG/KG_DRY	0.00032	No RSL	YES
gamma-Chlordane	5566-34-7	PESTP	1/2	50	0.28	0.28	UG/KG_DRY	0.00028	No RSL	YES
Chlordane	57-74-9	PESTP	1/2	50	5.8	5.8	UG/KG_DRY	0.0058	No RSL	YES
Aroclor 1254	11097-69-1	PESTP	1/2	50	26	26	UG/KG_DRY	0.026	0.22	No
Methoxychlor	72-43-5	PESTP	1/2	50	0.76	0.76	UG/KG_DRY	0.00076	310	No
4,4'-DDD	72-54-8	PESTP	2/2	100	0.7	3.8	UG/KG_DRY	0.0038	2	No
4,4'-DDE	72-55-9	PESTP	2/2	100	1.1	36	UG/KG_DRY	0.036	1.4	No
Endosulfan Sulfate	1031-07-8	PESTP	1/2	50	1.2	1.2	UG/KG_DRY	0.0012	No RSL	YES
Carbazole	86-74-8	OS	2/2	100	3.9	49	UG/KG_DRY	0.049	No RSL	YES
Benzoic Acid	65-85-0	OS	2/2	100	96	960	UG/KG_DRY	0.96	240000	No
Benz(a)anthracene	56-55-3	OS	2/2	100	23	300	UG/KG_DRY	0.3	0.15	YES
Naphthalene	91-20-3	OS	1/2	50	25	25	UG/KG_DRY	0.025	3.6	No
Dibenzofuran	132-64-9	OS	1/2	50	19	19	UG/KG_DRY	0.019	78	No
Benzyl Alcohol	100-51-6	OS	1/2	50	2.6	2.6	UG/KG_DRY	0.0026	6100	No
Butyl Benzyl Phthalate	85-68-7	OS	1/2	50	4.2	4.2	UG/KG_DRY	0.0042	260	No
Dibenz(a,h)anthracene	53-70-3	OS	2/2	100	6.2	79	UG/KG_DRY	0.079	0.015	YES
Pyrene	129-00-0	OS	2/2	100	51	650	UG/KG_DRY	0.65	1700	No
Benzo(a)pyrene	50-32-8	OS	2/2	100	42	410	UG/KG_DRY	0.41	0.015	YES
Phenanthrene	85-01-8	OS	2/2	100	23	370	UG/KG_DRY	0.37	No RSL	YES
Benzo(g,h,i)perylene	191-24-2	OS	2/2	100	32	350	UG/KG_DRY	0.35	No RSL	YES
Indeno(1,2,3-cd)pyrene	193-39-5	OS	2/2	100	36	370	UG/KG_DRY	0.37	0.15	YES
Benzo(b)fluoranthene	205-99-2	OS	2/2	100	51	580	UG/KG_DRY	0.58	0.15	YES
Fluoranthene	206-44-0	OS	2/2	100	52	640	UG/KG_DRY	0.64	2300	No
Benzo(k)fluoranthene	207-08-9	OS	2/2	100	17	170	UG/KG_DRY	0.17	1.5	No
Acenaphthylene	208-96-8	OS	2/2	100	16	240	UG/KG_DRY	0.24	No RSL	YES
Chrysene	218-01-9	OS	2/2	100	36	450	UG/KG_DRY	0.45	15	No
Fluorene	86-73-7	OS	2/2	100	1.9	34	UG/KG_DRY	0.034	2300	No
Bis(2-ethylhexyl) Phthalate	117-81-7	OS	1/2	50	17	17	UG/KG_DRY	0.017	35	No
Anthracene	120-12-7	OS	2/2	100	10	150	UG/KG_DRY	0.15	17000	No
Dimethyl Phthalate	131-11-3	OS	1/2	50	28	28	UG/KG_DRY	0.028	No RSL	YES
Chromium	7440-47-3	M	2/2	100	4.9	12.8	MG/KG_DRY	12.8	120000	No
Beryllium	7440-41-7	M	2/2	100	0.23	0.34	MG/KG_DRY	0.34	160	No
Barium	7440-39-3	M	2/2	100	37.6	105	MG/KG_DRY	105	15000	No
Arsenic	7440-38-2	M	2/2	100	6	6.3	MG/KG_DRY	6.3	0.39	YES
Antimony	7440-36-0	M	2/2	100	0.131	3.18	MG/KG_DRY	3.18	31	No
Silver	7440-22-4	M	1/2	50	0.4	0.4	MG/KG_DRY	0.4	390	No
Nickel	7440-02-0	M	2/2	100	5.16	28.6	MG/KG_DRY	28.6	1500	No

Table A-2.5. COPC Screening - Southeastern Lyman Mill Pond Flood Plain Soil General Use Designated Exposure Area (0-1' soil)

Parameter	CAS No.	Class	Frequency of Detection	Percent Detected	Minimum Detected	Maximum Detected	Units	Max Detected (MG/KG)	Residential RSLs (MG/KG)	Retain as COPC?
Molybdenum	7439-98-7	M	2/2	100	0.53	1.06	MG/KG_DRY	1.06	390	No
Manganese	7439-96-5	M	2/2	100	65.7	150	MG/KG_DRY	150	1800	No
Lead	7439-92-1	M	2/2	100	25	337	MG/KG_DRY	337	400	No
Cobalt	7440-48-4	M	2/2	100	2.28	3.25	MG/KG_DRY	3.25	23	No
Copper	7440-50-8	M	2/2	100	16.2	91.9	MG/KG_DRY	91.9	3100	No
Vanadium	7440-62-2	M	2/2	100	7.1	13.5	MG/KG_DRY	13.5	5.5	YES
Zinc	7440-66-6	M	2/2	100	67.2	188	MG/KG_DRY	188	23000	No
Selenium	7782-49-2	M	1/2	50	0.4	0.4	MG/KG_DRY	0.4	390	No
Cadmium	7440-43-9	M	2/2	100	0.99	2.43	MG/KG_DRY	2.43	70	No
1,2,3,7,8,9-HxCDD	19408-74-3	DIOX	2/2	100	0.621	3.77	PG/G_DRY	3.77E-06	No RSL	YES
Total TCDF	55722-27-5	DIOX	2/2	100	6	135	PG/G_DRY	0.000135	No RSL	YES
Total PeCDF	30402-15-4	DIOX	2/2	100	11.8	201	PG/G_DRY	0.000201	No RSL	YES
2,3,7,8-TCDD	1746-01-6	DIOX	1/2	50	1.21	1.21	PG/G_DRY	1.21E-06	No RSL	YES
Total TCDD	41903-57-5	DIOX	2/2	100	0.76	17.3	PG/G_DRY	0.0000173	No RSL	YES
1,2,3,7,8,9-HxCDF	72918-21-9	DIOX	2/2	100	0.0642	3.53	PG/G_DRY	3.53E-06	No RSL	YES
1,2,3,4,7,8-HxCDF	70648-26-9	DIOX	2/2	100	0.546	13.3	PG/G_DRY	0.0000133	No RSL	YES
1,2,3,4,6,7,8-HpCDF	67562-39-4	DIOX	2/2	100	8.73	74.3	PG/G_DRY	0.0000743	No RSL	YES
2,3,4,6,7,8-HxCDF	60851-34-5	DIOX	2/2	100	0.774	16.8	PG/G_DRY	0.0000168	No RSL	YES
1,2,3,6,7,8-HxCDD	57653-85-7	DIOX	2/2	100	0.899	4.92	PG/G_DRY	4.92E-06	No RSL	YES
1,2,3,6,7,8-HxCDF	57117-44-9	DIOX	2/2	100	0.516	11.7	PG/G_DRY	0.0000117	No RSL	YES
1,2,3,7,8-PeCDF	57117-41-6	DIOX	2/2	100	0.285	5.85	PG/G_DRY	5.85E-06	No RSL	YES
2,3,4,7,8-PeCDF	57117-31-4	DIOX	2/2	100	0.478	12.4	PG/G_DRY	0.0000124	No RSL	YES
1,2,3,4,7,8,9-HpCDF	55673-89-7	DIOX	2/2	100	0.358	4.31	PG/G_DRY	4.31E-06	No RSL	YES
2,3,7,8-TCDF	51207-31-9	DIOX	1/2	50	5.88	5.88	PG/G_DRY	5.88E-06	No RSL	YES
OCDD	3268-87-9	DIOX	2/2	100	138	441	PG/G_DRY	0.000441	No RSL	YES
1,2,3,7,8-PeCDD	40321-76-4	DIOX	1/2	50	2	2	PG/G_DRY	0.000002	No RSL	YES
1,2,3,4,7,8-HxCDD	39227-28-6	DIOX	1/2	50	0.375	0.375	PG/G_DRY	3.75E-07	No RSL	YES
OCDF	39001-02-0	DIOX	2/2	100	14.6	38.5	PG/G_DRY	0.0000385	No RSL	YES
Total HpCDF	38998-75-3	DIOX	2/2	100	17.5	115	PG/G_DRY	0.000115	No RSL	YES
Total HpCDD	37871-00-4	DIOX	2/2	100	40.5	139	PG/G_DRY	0.000139	No RSL	YES
Total PeCDD	36088-22-9	DIOX	2/2	100	1.26	27.5	PG/G_DRY	0.0000275	No RSL	YES
1,2,3,4,6,7,8-HpCDD	35822-46-9	DIOX	2/2	100	19.6	66.7	PG/G_DRY	0.0000667	No RSL	YES
Total HxCDD	34465-46-8	DIOX	2/2	100	7.13	51.3	PG/G_DRY	0.0000513	No RSL	YES
Total HxCDF	55684-94-1	DIOX	2/2	100	11.3	163	PG/G_DRY	0.000163	No RSL	YES
TEQ mammal	TEM	DIOX	2/2	100	0.86	14.96	PG/G_DRY	1.496E-05	0.0000045	YES

Table A-3.1. Exposure Parameters for Visitors to the General Oxbow, Northeast and Southeast Lyman Mill Pond and Assapumpsett Brook Flood Plain Soils

					Visitor			
					Teenage Adolescent		Adult	
Exposure Pathway	Exposure Parameter	Variable ID	Sampled Medium	Units	CTE	RME	CTE	RME
Soil Ingestion	Soil ingestion rate	IR	Soil	mg/day	10	50	10	50
	Fraction from site	F_s	Soil	unitless	0.5	0.5	0.5	0.5
Dermal Contact with Soil	Surface area	SA	Soil	cm2	1,297	2,274	1,306	2,479
	Adherence factor	AF	Soil	mg/cm2	0.01	0.07	0.01	0.07
All	Exposure frequency	EF	Soil	days/year	3	12	3	12
	Exposure duration	ED	Standard	years	6	6	3	24
	Body weight	BW	All	kg	59	59	70	70
	Averaging time - non-cancer	ATn	Standard	days	2,190	2,190	1,095	8,760
	Averaging time - cancer	ATc	All	days	25,550	25,550	25,550	25,550

Table A-3.2. Exposure Parameter Values for Visitors to the Human Health Exposure Area of the Oxbow

					Visitor					
					Child		Adolescent		Adult	
Exposure Pathway	Exposure Parameter	Variable ID	Sampled Medium	Units	CTE	RME	CTE	RME	CTE	RME
Soil Ingestion	Soil ingestion rate	IR	Soil	mg/day	50	100	10	50	10	50
	Fraction from site	F_S	Soil	unitless	0.5	0.5	0.5	0.5	0.5	0.5
Dermal Contact with Soil	Surface area	SA	Soil	cm2	1,727	1,727	3,522	3,522	4,849	4,849
	Adherence factor	AF	Soil	mg/cm2	0.04	0.2	0.01	0.07	0.01	0.07
All	Exposure frequency	EF	Soil	days/year	18	39	18	39	18	39
	Exposure duration	ED	Standard	years	2	6	3	12	4	12
	Body weight	BW	All	kg	15	15	45	45	70	70
	Averaging time - non-cancer	ATn	Standard	days	730	2,190	1,095	4,380	1,460	4,380
	Averaging time - cancer	ATc	All	days	25,550	25,550	25,550	25,550	25,550	25,550

Table A-3.3. Chemical-Specific Toxicological and Bioavailability Information for COPCs

		Toxicological Information								Bioavailability Information	
		Oral Route				Dermal Route[a]					
Chemicals of Potential Concern	CAS Numbers	CSF_o (kg-d/mg)	Source	Chronic RfD_o (mg/kg-d)	Source	ABS_{GI}	Source	Chronic RfD_D (mg/kg-d)	CSF_D (kg-d/mg)	ABS[d]	RBA
alpha-Chlordane	5103-71-9	3.50E-01	IRIS - chlordane (12789-03-6)	5.00E-04	IRIS - chlordane (12789-03-6)	1		5.0E-04	3.5E-01	0.04	1
Acenaphthylene	208-96-8	NA		6.00E-02	IRIS - acenaphthene surrogate	1	USEPA 2004	6.0E-02	NA	0.13	1
Aroclor 1254	11097-69-1	2	RSLs, 2010	0.00002	USEPA 2005a	1	USEPA 2004	2.0E-05	2.0E+00	0.14	1
Aroclor 1260	11096-82-5	2	RSLs, 2010	2.00E-05	ATSDR 2000	1	USEPA 2004	2.0E-05	2.0E+00	0.14	1
Aroclor 1268	11100-14-4	NA		NA		1	USEPA 2004	NA	NA	0.14	1
Arsenic	7440-38-2	1.5	RSLs, 2010	0.0003		1	USEPA 2004	3.0E-04	1.5E+00	0.03	1
Benz(a)anthracene	56-55-3	0.73	RSLs, 2010	NA		1	USEPA 2004	NA	7.3E-01	0.13	1
Benzo(a)pyrene	50-32-8	7.3	RSLs, 2010	NA		1	USEPA 2004	NA	7.3E+00	0.13	1
Benzo(b)fluoranthene	205-99-2	0.73	RSLs, 2010	NA		1	USEPA 2004	NA	7.3E-01	0.13	1
Benzo(g,h,i)perylene	191-24-2	7.3	surrogate - benzo(a)pyrene	NA	IRIS - Benzo(a)pyrene surrogate	1	USEPA 2004	NA	7.3E+00	0.13	1
Benzo(k)fluoranthene	207-08-9	0.073	RSLs, 2010	NA		1	USEPA 2004	NA	7.3E-02	0.13	1
Carbazole	86-74-8	2.00E-02	Heast	NA		1	USEPA 2004	NA	2.0E-02	0.1	1
Chlordane	12789-03-6	3.50E-01	IRIS	5.00E-04	IRIS	1	USEPA 2004	5.0E-04	3.5E-01	0.04	1
Chrysene	218-01-9	0.0073	RSLs, 2010	NA		1	USEPA 2004	NA	7.3E-03	0.13	1
delta-BHC	319-86-8	1.1	CalEPA	3.00E-04	IRIS - lindane surrogate	1	USEPA 2004	3.0E-04	1.1E+00	0.04	1
Dibenz(a,h)anthracene	53-70-3	7.3	RSLs, 2010	NA		1	USEPA 2004	NA	7.3E+00	0.13	1
Dimethyl Phthalate	131-11-3	NA		8.00E-01	IRIS - diethyl phthalate surrogate	1	USEPA 2004	8.0E-01	NA	0.1	1
Di-n-octyl Phthalate	117-84-0	1.40E-02	surrogate - bis(2-ethylhexyl)phthalate	2.00E-02	surrogate - bis(2-ethylhexyl)phthalate	1	USEPA 2004	2.0E-02	1.4E-02	0.1	1
Endosulfan I	959-98-8	NA		6.00E-03	IRIS - endosulfan surrogate	1	USEPA 2004	6.0E-03	NA	0.1	1
Endosulfan II	33213-65-9	NA		6.00E-03	IRIS - endosulfan surrogate	1	USEPA 2004	6.0E-03	NA	0.1	1
Endosulfan Sulfate	1031-07-8	NA		6.00E-03	IRIS - endosulfan surrogate	1	USEPA 2004	6.0E-03	NA	0.1	1
Endrin Aldehyde	7421-93-4	1.70E+01	IRIS - aldrin surrogate	3.00E-05	IRIS - aldrin surrogate	1	USEPA 2004	3.0E-05	1.7E+01	0.1	1
Endrin Ketone	53494-70-5	1.70E+01	IRIS - aldrin surrogate	3.00E-05	IRIS - aldrin surrogate	1	USEPA 2004	3.0E-05	1.7E+01	0.1	1
gamma-Chlordane	5566-34-7	3.50E-01	IRIS - chlordane (12789-03-6)	5.00E-04		1	USEPA 2004	5.0E-04	3.5E-01	0.04	1
Indeno(1,2,3-cd)pyrene	193-39-5	0.73	RSLs, 2010	NA		1	USEPA 2004	NA	7.3E-01	0.13	1
Lead	7439-92-1	8.50E-03	CalEPA	NA		1	Moore et al. 1980 cited in USEPA 2001	NA	8.5E-03	0.001	1
Naphthalene	91-20-3	NA	NA	0.02	USEPA 2005a	1	USEPA 2004	2.0E-02	NA	0.13	1
Phenanthrene	85-01-8	NA		3.00E-01	IRIS - anthracene surrogate	1	USEPA 2004	3.0E-01	NA	0.13	1
TEQ mammal	TEM	150,000		NA		1	USEPA 2004	NA	1.5E+05	0.03	0.3
Vanadium	7440-62-2	NA		7.00E-05	PPRTV	0.026	USEPA 2004	1.8E-06	NA	0.01	1

a. Toxicity values for the dermal route are calculated by multiplying the oral RfD or dividing the oral CSF by the ABS_{GI} value listed.

CSF - cancer slope factor
RfD - reference dose
ABS_{GI} - gastrointestinal absorption factor
ABSd - Dermal absorption factor from USEPA, 2004
RBA - Relative bioavailability factor
NA - not available

Table A-3.4. Summary of Relative Bioavailablity Data for 2,3,7,8-TCDD (from EPA, 2011)

Cited Study	Source Material Concentration	Test Species	Reported RBA (%)
Bonaccorsi et al., 1984	2,3,7,8-TCDD: 81 ng/g	Rabbit	32
			22
Lucier et al. 1986	2,3,7,8-TCDD: 880 ng/g	S-D Rat	45
	2,3,7,8-TCDD: 770 ng/g		8
McConnel et al., 1984	2,3,7,8-TCDD: 880 ng/g	Guinea pig	11
		S-D Rat	44
		S-D Rat	49
		S-D Rat	38
		S-D Rat	43
		S-D Rat	45
Shu et al., 1988	2,3,7,8-TCDD: 1.9-723 ng/g	S-D Rat	37
	2,3,7,8-TCDD: ~2,300 ng/g		1
Umbreit et al., 1986	2,3,7,8-TCDD: Conc. not reported	Guinea pig	24
		Guinea pig	7
	2,3,7,8-TCDD: 510 ng/g	Guinea pig	30
		Guinea pig	2
Wendling et al., 1989	2,3,7,8-TCDD: 1,400 ng/g	Guinea pig	1.6

Table A-5.1. RME Non-cancer Hazards, Passive Recreational Visitor, Exposure Routes Combined

Chemicals of Potential Concern	Human Health Exposure Area HQ (RME)			General Oxbow HQ (RME)		NE Lyman HQ (RME)		Assapumpset Brook HQ (RME)		SE Lyman HQ (RME)	
	Child	Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	Adolescent	Adult
Pesticides and PCBs											
alpha-Chlordane	1.47E-07	2.68E-08	1.91E-08	1.57E-06	1.35E-06	1.05E-06	9.00E-07	2.24E-07	1.92E-07	1.12E-08	9.60E-09
Aroclor 1254				2.85E-04	2.50E-04	4.74E-04	4.17E-04	3.29E-04	2.89E-04		
Aroclor 1268				NA	NA	NA	NA				
Chlordane				3.93E-06	3.38E-06	1.89E-05	1.62E-05	2.24E-06	1.92E-06	2.03E-07	1.74E-07
delta-BHC						1.69E-08	1.45E-08				
Endosulfan I	6.14E-09	1.20E-09	9.18E-10	4.93E-09	4.30E-09						
Endosulfan II				5.69E-09	4.96E-09	2.85E-08	2.49E-08				
Endosulfan Sulfate	3.44E-08	6.74E-09	5.14E-09	4.06E-09	3.54E-09	2.01E-09	1.76E-09	8.74E-09	7.63E-09	4.56E-09	3.98E-09
Endrin Aldehyde				3.05E-06	2.66E-06	1.75E-06	1.53E-06	1.22E-06	1.06E-06		
Endrin Ketone				2.66E-06	2.32E-06	1.44E-06	1.26E-06				
gamma-Chlordane	1.12E-07	2.04E-08	1.45E-08	5.09E-07	4.37E-07	1.57E-06	1.35E-06	4.54E-07	3.90E-07	9.79E-09	8.40E-09
Semivolatile Organic Compounds											
Acenaphthylene	1.29E-07	2.59E-08	2.02E-08	2.81E-07	2.46E-07	3.06E-07	2.68E-07	5.94E-08	5.21E-08	1.02E-07	8.93E-08
Benz(a)anthracene				NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene				NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene				NA	NA	NA	NA				
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene				NA	NA						
Dibenz(a,h)anthracene				NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl Phthalate	2.26E-08	4.42E-09	3.37E-09	3.89E-09	3.40E-09	3.71E-09	3.23E-09	2.00E-09	1.74E-09	7.98E-10	6.96E-10
Di-n-octyl Phthalate				4.22E-08	3.68E-08						
Indeno(1,2,3-cd)pyrene				NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene				2.56E-06	2.25E-06						
Phenanthrene	8.91E-08	1.79E-08	1.39E-08	3.15E-06	2.76E-06	4.24E-07	3.72E-07	4.84E-08	4.24E-08	3.14E-08	2.75E-08
Metals											
Arsenic	6.08E-03	1.09E-03	7.59E-04	4.00E-04	3.42E-04	1.02E-03	8.70E-04	7.58E-04	6.48E-04	3.48E-04	2.98E-04
Lead				NA	NA						
Vanadium	3.76E-01	8.21E-02	6.86E-02	2.12E-02	1.90E-02	3.59E-02	3.22E-02	1.56E-02	1.40E-02	9.27E-03	8.31E-03
PCDD/Fs											
TEQ mammal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total HI (RME)	**3.8E-01**	**8.3E-02**	**6.9E-02**	**2.2E-02**	**2.0E-02**	**3.7E-02**	**3.4E-02**	**1.7E-02**	**1.5E-02**	**9.6E-03**	**8.6E-03**

Table A-5.2. CTE Non-cancer Hazards, Passive Recreational Visitor, Exposure Routes Combined

Chemicals of Potential Concern	Human Health Exposure Area HQ (CTE)			General Oxbow HQ (CTE)		NE Lyman HQ (CTE)		Assapumpset Brook HQ (CTE)		SE Lyman HQ (CTE)	
	Child	Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	Adolescent	Adult
Pesticides and PCBs											
alpha-Chlordane	2.96E-08	2.28E-09	1.58E-09	6.89E-08	5.81E-08	1.53E-08	1.29E-08	7.07E-09	5.97E-09	3.74E-10	3.15E-10
Aroclor 1254				1.03E-05	8.67E-06	6.01E-06	5.06E-06	7.14E-06	6.03E-06		
Aroclor 1268				NA	NA	NA	NA				
Chlordane				1.73E-07	1.46E-07	2.44E-07	2.06E-07	8.15E-08	6.87E-08	8.11E-09	6.84E-09
delta-BHC						4.11E-10	3.46E-10				
Endosulfan I	1.07E-09	9.53E-11	7.08E-11	1.90E-10	1.60E-10						
Endosulfan II				2.19E-10	1.85E-10	3.35E-10	2.82E-10				
Endosulfan Sulfate	6.00E-09	5.34E-10	3.97E-10	1.56E-10	1.32E-10	4.26E-10	3.59E-10	1.72E-10	1.45E-10	9.18E-11	7.75E-11
Endrin Aldehyde				1.17E-07	9.92E-08	2.28E-08	1.92E-08	2.93E-08	2.48E-08		
Endrin Ketone				1.02E-07	8.65E-08	2.63E-08	2.22E-08				
gamma-Chlordane	2.25E-08	1.73E-09	1.20E-09	2.24E-08	1.89E-08	2.66E-08	2.24E-08	1.35E-08	1.13E-08	6.38E-10	5.38E-10
Semivolatile Organic Compounds											
Acenaphthylene	2.13E-08	2.00E-09	1.52E-09	1.03E-08	8.66E-09	4.35E-09	3.67E-09	1.66E-09	1.40E-09	1.99E-09	1.68E-09
Benz(a)anthracene				NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene				NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene				NA	NA	NA	NA				
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene				NA	NA						
Dibenz(a,h)anthracene				NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl Phthalate	3.93E-09	3.50E-10	2.60E-10	1.50E-10	1.26E-10	4.77E-11	4.02E-11	6.47E-11	5.46E-11	1.56E-11	1.32E-11
Di-n-octyl Phthalate				1.63E-09	1.37E-09						
Indeno(1,2,3-cd)pyrene				NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene				9.37E-08	7.91E-08						
Phenanthrene	1.47E-08	1.38E-09	1.05E-09	1.15E-07	9.72E-08	4.53E-09	3.82E-09	1.15E-09	9.70E-10	6.10E-10	5.15E-10
Metals											
Arsenic	1.26E-03	9.38E-05	6.43E-05	1.81E-05	1.52E-05	1.38E-05	1.17E-05	2.38E-05	2.00E-05	1.54E-05	1.30E-05
Lead				NA	NA						
Vanadium	4.89E-02	5.87E-03	4.81E-03	6.14E-04	5.19E-04	3.34E-04	2.82E-04	3.55E-04	3.00E-04	2.05E-04	1.73E-04
PCDD/Fs											
TEQ mammal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total HI (CTE)	**5.0E-02**	**6.0E-03**	**4.9E-03**	**6.4E-04**	**5.4E-04**	**3.5E-04**	**3.0E-04**	**3.9E-04**	**3.3E-04**	**2.2E-04**	**1.9E-04**

Table A-5.3. RME and CTE Cancer Risks, Passive Recreational Visitor, All Ages and Exposure Routes Combined

Chemicals of Potential Concern	Human Health Exposure Area CR		General Oxbow CR		NE Lyman CR		Assapumpset Brook CR		SE Lyman CR	
	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE
Pesticides and PCBs										
alpha-Chlordane	3.59E-12	1.81E-13	1.04E-10	1.47E-12	6.97E-11	3.26E-13	1.49E-11	1.51E-13	7.44E-13	7.97E-15
Aroclor 1254			4.41E-09	5.01E-11	7.34E-09	2.93E-11	5.10E-09	3.48E-11		
Aroclor 1268			NA	NA	NA	NA				
Chlordane			2.62E-10	3.69E-12	1.26E-09	5.21E-12	1.49E-10	1.74E-12	1.35E-11	1.73E-13
delta-BHC					2.12E-12	1.65E-14				
Endosulfan I	NA	NA	NA	NA						
Endosulfan II			NA	NA	NA	NA				
Endosulfan Sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin Aldehyde			5.99E-10	7.30E-12	3.43E-10	1.42E-12	2.39E-10	1.82E-12		
Endrin Ketone			5.23E-10	6.37E-12	2.83E-10	1.63E-12				
gamma-Chlordane	2.72E-12	1.37E-13	3.38E-11	4.77E-13	1.05E-10	5.66E-13	3.02E-11	2.87E-13	6.51E-13	1.36E-14
Semivolatile Organic Compounds										
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benz(a)anthracene			2.10E-07	2.43E-09	2.23E-08	1.11E-10	4.24E-09	3.36E-11	2.16E-09	1.34E-11
Benzo(a)pyrene	3.02E-08	1.25E-09	2.12E-06	2.45E-08	2.80E-07	1.37E-09	4.81E-08	3.98E-10	2.95E-08	1.87E-10
Benzo(b)fluoranthene			2.08E-07	2.40E-09	3.59E-08	1.79E-10	6.54E-09	5.47E-11	4.17E-09	2.62E-11
Benzo(g,h,i)perylene	2.65E-08	1.09E-09	1.02E-06	1.18E-08	1.80E-07	9.38E-10	3.66E-08	3.19E-10	2.51E-08	1.58E-10
Benzo(k)fluoranthene			1.68E-09	1.93E-11	1.22E-09	5.69E-12				
Carbazole	9.96E-12	4.33E-13	6.58E-10	8.01E-12	1.00E-10	4.49E-13	9.30E-12	8.66E-14	8.60E-12	5.66E-14
Chrysene			2.11E-09	2.43E-11						
Dibenz(a,h)anthracene			2.98E-07	3.43E-09	4.88E-08	2.39E-10	8.62E-09	7.21E-11	5.68E-09	3.53E-11
Dimethyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octyl Phthalate			4.55E-12	5.55E-14						
Indeno(1,2,3-cd)pyrene			1.22E-07	1.40E-09	2.01E-08	9.89E-11	3.81E-09	3.19E-11	2.66E-09	1.68E-11
Naphthalene			NA	NA						
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals										
Arsenic	3.77E-07	1.96E-08	6.81E-08	9.91E-10	1.73E-07	7.58E-10	1.29E-07	1.30E-09	5.94E-08	8.44E-10
Lead			1.17E-08	1.89E-10						
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCDD/Fs										
TEQ mammal	2.05E-08	8.89E-10	1.46E-06	1.78E-08	4.99E-06	1.54E-08	5.50E-08	4.52E-10	5.91E-09	3.74E-11
Total Risk	**4.5E-07**	**2.3E-08**	**5.5E-06**	**6.5E-08**	**5.8E-06**	**1.9E-08**	**3.0E-07**	**2.7E-09**	**1.3E-07**	**1.3E-09**

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ATTACHMENT A

Table A-A.1. Calculation of Ingestion Exposures and Risks for Adolescent Teenager and Adult Visitors to the General Area of the Oxbow

Receptor:	Visitor
Age:	Adolescent Teenager (13-18); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	General Area Oxbow
Exposure Pathway:	Ingestion
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Adolescent CTE	Adolescent RME	Adult CTE	Adult RME	Units
Soil ingestion rate	IR	10	50	10	50	mg/day
Fraction soil ingested from Site	F_S	0.5	0.5	0.5	0.5	unitless
Exposure frequency	EF	3	12	3	12	day/yr
Exposure duration	ED	6	6	3	24	yr
Averaging time - noncancer	ATn	2190	2190	1095	8760	day
Averaging time - cancer	ATc	25550	25550	25550	25550	day
Body weight	BW	59	59	70	70	kg
Unit conversion factor	CF	1.00E-06	1.00E-06	1.00E-06	1.00E-06	kg/mg
ADD intake factor	**ADDif**	**7.0E-10**	**1.4E-08**	**5.9E-10**	**1.2E-08**	**1/day**
LADD intake factor	**LADDif**	**6.0E-11**	**1.2E-09**	**2.6E-11**	**4.0E-09**	**1/day**

Equations for Risk Calculations

Non-Cancer

ADDif = IR x F_S x EF x ED x CF/ (ATn x BW)
ADD = Csoil x RBA x ADDif
HQ = ADD / RfD
HI = Sum($HQcopc_a$ + $HQcopc_i$,...)

Cancer

LADDif = IR x F_S x EF x ED x CF/ (ATc x BW)
LADD = Csoil x RBA x LADDif
Total LADD = LADDchild + LADDadolescent + LADDadult
CR = Total LADD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (95% UCL) (mg/kg)	RBA (unitless)	ADD - RME (mg/kg-day) Adolescent	ADD - RME (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- RME (unitless) Adolescent	HQ- RME (unitless) Adult	LADD - RME (mg/kg-day) Adolescent	LADD - RME (mg/kg-day) Adult	LADD - RME (mg/kg-day) Total LADD	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR RME (unitless)
Aroclor 1254	0.2163	1.00	3.01E-09	2.54E-09	2.00E-05	1.51E-04	1.27E-04	2.58E-10	8.71E-10	1.13E-09	2.0E+00	2.26E-09
Endrin Aldehyde	0.004018	1.00	5.60E-11	4.72E-11	3.00E-05	1.87E-06	1.57E-06	4.80E-12	1.62E-11	2.10E-11	1.7E+01	3.57E-10
Endosulfan Sulfate	0.001068	1.00	1.49E-11	1.25E-11	6.00E-03	2.48E-09	2.09E-09	1.28E-12	4.30E-12	5.57E-12	NA	--
Aroclor 1268	0.02999	1.00	4.18E-10	3.52E-10	NA	--	--	3.58E-11	1.21E-10	1.57E-10	NA	--
gamma-Chlordane	0.01456	1.00	2.03E-10	1.71E-10	5.00E-04	4.06E-07	3.42E-07	1.74E-11	5.86E-11	7.60E-11	3.5E-01	2.66E-11
Endrin Ketone	0.003504	1.00	4.88E-11	4.11E-11	3.00E-05	1.63E-06	1.37E-06	4.18E-12	1.41E-11	1.83E-11	1.7E+01	3.11E-10
alpha-Chlordane	0.04483	1.00	6.25E-10	5.26E-10	5.00E-04	1.25E-06	1.05E-06	5.35E-11	1.80E-10	2.34E-10	3.5E-01	8.19E-11
Endosulfan II	0.001496	1.00	2.08E-11	1.76E-11	6.00E-03	3.47E-09	2.93E-09	1.79E-12	6.02E-12	7.81E-12	NA	--
Chlordane	0.1125	1.00	1.57E-09	1.32E-09	5.00E-04	3.13E-06	2.64E-06	1.34E-10	4.53E-10	5.87E-10	3.5E-01	2.06E-10
Endosulfan I	0.001298	1.00	1.81E-11	1.52E-11	6.00E-03	3.01E-09	2.54E-09	1.55E-12	5.23E-12	6.78E-12	NA	--
Di-n-octyl Phthalate	0.03705	1.00	5.16E-10	4.35E-10	2.00E-02	2.58E-08	2.18E-08	4.42E-11	1.49E-10	1.93E-10	1.4E-02	2.71E-12
Dibenz(a,h)anthracene	4.144	1.00	5.77E-08	4.87E-08	NA	--	--	4.95E-09	1.67E-08	2.16E-08	7.3E+00	1.58E-07
Carbazole	3.747	1.00	5.22E-08	4.40E-08	NA	--	--	4.47E-09	1.51E-08	1.96E-08	2.0E-02	3.91E-10
Naphthalene	2.011	1.00	2.80E-08	2.36E-08	2.00E-02	1.40E-06	1.18E-06	2.40E-09	8.10E-09	1.05E-08	NA	--
Phenanthrene	37.068	1.00	5.16E-07	4.35E-07	3.00E-01	1.72E-06	1.45E-06	4.43E-08	1.49E-07	1.93E-07	NA	--
Dimethyl Phthalate	0.1366	1.00	1.90E-09	1.60E-09	8.00E-01	2.38E-09	2.00E-09	1.63E-10	5.50E-10	7.13E-10	NA	--
Benzo(g,h,i)perylene	14.224	1.00	1.98E-07	1.67E-07	NA	--	--	1.70E-08	5.73E-08	7.42E-08	7.3E+00	5.42E-07
Indeno(1,2,3-cd)pyrene	16.94	1.00	2.36E-07	1.99E-07	NA	--	--	2.02E-08	6.82E-08	8.84E-08	7.3E-01	6.45E-08
Benzo(b)fluoranthene	28.99	1.00	4.04E-07	3.40E-07	NA	--	--	3.46E-08	1.17E-07	1.51E-07	7.3E-01	1.10E-07
Benzo(k)fluoranthene	2.332	1.00	3.25E-08	2.74E-08	NA	--	--	2.78E-09	9.39E-09	1.22E-08	7.3E-02	8.89E-10
Acenaphthylene	0.661	1.00	9.21E-09	7.76E-09	6.00E-02	1.53E-07	1.29E-07	7.89E-10	2.66E-09	3.45E-09	NA	--
Benzo(a)pyrene	29.505	1.00	4.11E-07	3.46E-07	NA	--	--	3.52E-08	1.19E-07	1.54E-07	7.3E+00	1.12E-06
Chrysene	29.321	1.00	4.08E-07	3.44E-07	NA	--	--	3.50E-08	1.18E-07	1.53E-07	7.3E-03	1.12E-09
Benz(a)anthracene	29.287	1.00	4.08E-07	3.44E-07	NA	--	--	3.50E-08	1.18E-07	1.53E-07	7.3E-01	1.12E-07
Arsenic	7.225	1.00	1.01E-07	8.48E-08	3.00E-04	3.36E-04	2.83E-04	8.63E-09	2.91E-08	3.77E-08	1.5E+00	5.66E-08
Lead	261.3	1.00	3.64E-06	3.07E-06	NA	--	--	3.12E-07	1.05E-06	1.36E-06	8.5E-03	1.16E-08
Vanadium	30.87	1.00	4.30E-07	3.62E-07	7.00E-05	6.14E-03	5.18E-03	3.69E-08	1.24E-07	1.61E-07	NA	--
TEQ mammal	0.003704	0.30	1.55E-11	1.30E-11	NA	--	--	1.33E-12	4.47E-12	5.80E-12	1.5E+05	8.70E-07
Totals						**HI:**	**6.64E-03**	**5.60E-03**				**3.05E-06**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (95% UCL) (mg/kg)	RBA (unitless)	ADD - CTE (mg/kg-day) Adolescent	ADD - CTE (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- CTE (unitless) Adolescent	HQ- CTE (unitless) Adult	LADD - CTE (mg/kg-day) Adolescent	LADD - CTE (mg/kg-day) Adult	LADD - CTE (mg/kg-day) Total LADD	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR CTE (unitless)
Aroclor 1254	0.2163	1.00	1.51E-10	1.27E-10	2.00E-05	7.53E-06	6.35E-06	1.29E-11	5.44E-12	1.84E-11	2.0E+00	3.67E-11
Endrin Aldehyde	0.004018	1.00	2.80E-12	2.36E-12	3.00E-05	9.33E-08	7.86E-08	2.40E-13	1.01E-13	3.41E-13	1.7E+01	5.80E-12
Endosulfan Sulfate	0.001068	1.00	7.44E-13	6.27E-13	6.00E-03	1.24E-10	1.05E-10	6.38E-14	2.69E-14	9.06E-14	NA	--
Aroclor 1268	0.02999	1.00	2.09E-11	1.76E-11	NA	--	--	1.79E-12	7.55E-13	2.55E-12	NA	--
gamma-Chlordane	0.01456	1.00	1.01E-11	8.55E-12	5.00E-04	2.03E-08	1.71E-08	8.69E-13	3.66E-13	1.24E-12	3.5E-01	4.32E-13
Endrin Ketone	0.003504	1.00	2.44E-12	2.06E-12	3.00E-05	8.14E-08	6.86E-08	2.09E-13	8.82E-14	2.97E-13	1.7E+01	5.06E-12
alpha-Chlordane	0.04483	1.00	3.12E-11	2.63E-11	5.00E-04	6.25E-08	5.26E-08	2.68E-12	1.13E-12	3.80E-12	3.5E-01	1.33E-12
Endosulfan II	0.001496	1.00	1.04E-12	8.78E-13	6.00E-03	1.74E-10	1.46E-10	8.93E-14	3.76E-14	1.27E-13	NA	--
Chlordane	0.1125	1.00	7.84E-11	6.60E-11	5.00E-04	1.57E-07	1.32E-07	6.72E-12	2.83E-12	9.55E-12	3.5E-01	3.34E-12
Endosulfan I	0.001298	1.00	9.04E-13	7.62E-13	6.00E-03	1.51E-10	1.27E-10	7.75E-14	3.27E-14	1.10E-13	NA	--
Di-n-octyl Phthalate	0.03705	1.00	2.58E-11	2.18E-11	2.00E-02	1.29E-09	1.09E-09	2.21E-12	9.32E-13	3.14E-12	1.4E-02	4.40E-14
Dibenz(a,h)anthracene	4.144	1.00	2.89E-09	2.43E-09	NA	--	--	2.47E-10	1.04E-10	3.52E-10	7.3E+00	2.57E-09
Carbazole	3.747	1.00	2.61E-09	2.20E-09	NA	--	--	2.24E-10	9.43E-11	3.18E-10	2.0E-02	6.36E-12
Naphthalene	2.011	1.00	1.40E-09	1.18E-09	2.00E-02	7.00E-08	5.90E-08	1.20E-10	5.06E-11	1.71E-10	NA	--
Phenanthrene	37.068	1.00	2.58E-08	2.18E-08	3.00E-01	8.61E-08	7.25E-08	2.21E-09	9.33E-10	3.15E-09	NA	--
Dimethyl Phthalate	0.1366	1.00	9.51E-11	8.02E-11	8.00E-01	1.19E-10	1.00E-10	8.16E-12	3.44E-12	1.16E-11	NA	--
Benzo(g,h,i)perylene	14.224	1.00	9.91E-09	8.35E-09	NA	--	--	8.49E-10	3.58E-10	1.21E-09	7.3E+00	8.81E-09
Indeno(1,2,3-cd)pyrene	16.94	1.00	1.18E-08	9.95E-09	NA	--	--	1.01E-09	4.26E-10	1.44E-09	7.3E-01	1.05E-09
Benzo(b)fluoranthene	28.99	1.00	2.02E-08	1.70E-08	NA	--	--	1.73E-09	7.29E-10	2.46E-09	7.3E-01	1.80E-09
Benzo(k)fluoranthene	2.332	1.00	1.62E-09	1.37E-09	NA	--	--	1.39E-10	5.87E-11	1.98E-10	7.3E-02	1.44E-11
Acenaphthylene	0.661	1.00	4.60E-10	3.88E-10	6.00E-02	7.67E-09	6.47E-09	3.95E-11	1.66E-11	5.61E-11	NA	--
Benzo(a)pyrene	29.505	1.00	2.06E-08	1.73E-08	NA	--	--	1.76E-09	7.42E-10	2.50E-09	7.3E+00	1.83E-08
Chrysene	29.321	1.00	2.04E-08	1.72E-08	NA	--	--	1.75E-09	7.38E-10	2.49E-09	7.3E-03	1.82E-11
Benz(a)anthracene	29.287	1.00	2.04E-08	1.72E-08	NA	--	--	1.75E-09	7.37E-10	2.49E-09	7.3E-01	1.81E-09
Arsenic	7.225	1.00	5.03E-09	4.24E-09	3.00E-04	1.68E-05	1.41E-05	4.31E-10	1.82E-10	6.13E-10	1.5E+00	9.20E-10
Lead	261.3	1.00	1.82E-07	1.53E-07	NA	--	--	1.56E-08	6.57E-09	2.22E-08	8.5E-03	1.88E-10
Vanadium	30.87	1.00	2.15E-08	1.81E-08	7.00E-05	3.07E-04	2.59E-04	1.84E-09	7.77E-10	2.62E-09	NA	--
TEQ mammal	0.003704	0.30	7.74E-13	6.52E-13	NA	--	--	6.63E-14	2.80E-14	9.43E-14	1.5E+05	1.41E-08
Totals						**HI:**	**3.32E-04**	**2.80E-04**				**4.97E-08**

Table A-A.2. Calculation of Dermal Exposures and Risks for Adolescent Teenager and Adult Visitors to the General Area of the Oxbow

Receptor:	Visitor
Age:	Adolescent Teenager (13-18); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	General Area Oxbow
Exposure Pathway:	Dermal Contact
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Adolescent CTE	Adolescent RME	Adult CTE	Adult RME	Units
Unit conversion factor	CF	1.0E-06	1.0E-06	1.0E-06	1.0E-06	kg/mg
Adherence factor	AF	0.01	0.07	0.01	0.07	mg/cm^2-day
Exposure frequency	EF	3	12	3	12	day/yr
Exposure duration	ED	6	6	3	24	yr
Surface Area	SA	1297	2274	1308	2479	cm^2
Averaging time - noncancer	ATn	2190	2190	1095	8760	day
Averaging time - cancer	ATc	25550	25550	25550	25550	day
Body weight	BW	59	59	70	70	kg
DAD intake factor	**DADif**	**1.81E-09**	**8.87E-08**	**1.63E-09**	**8.16E-08**	**1/day**
LDAD intake factor	**LDADif**	**1.66E-10**	**7.60E-09**	**6.67E-11**	**2.79E-08**	**1/day**

Equations for Risk Calculations

Non-Cancer

DADif = CF x AF x F_s x EF x ED x SA / (ATn x BW)

DAD = Csoil x ABSd x DADif

HQ = DAD / RfD

HI = Sum(HQcopc$_a$ + HQcopc$_i$,...)

Cancer

LDADif = CF x AF x F_s x EF x ED x SA / (ATc x BW)

LDAD = LDADif x Csoil x ABSd

Total LDAD = LDADchild + LDADadolescent + LDADadult

CR = Total LDAD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (95% UCL) (mg/kg)	ABSd (unitless)	DAD - RME (mg/kg-day) Adolescent	DAD - RME (mg/kg-day) Adult	Chronic Dermal RfD (mg/kg-day)	HQ- RME (unitless) Adolescent	HQ- RME (unitless) Adult	LDAD - RME (mg/kg-day) Adolescent	LDAD - RME (mg/kg-day) Adult	LDAD - RME (mg/kg-day) Total ADD	Dermal Cancer Slope Factor (mg/kg-day)$^{-1}$	CR_{total} RME (unitless)
Aroclor 1254	0.2163	0.14	2.69E-09	2.47E-09	2.00E-05	1.34E-04	1.23E-04	2.30E-10	8.46E-10	1.08E-09	2.0E+00	2.15E-09
Endrin Aldehyde	0.004018	0.10	3.58E-11	3.27E-11	3.00E-05	1.19E-06	1.09E-06	3.05E-12	1.12E-11	1.43E-11	1.7E+01	2.43E-10
Endosulfan Sulfate	0.001068	0.10	9.47E-12	8.70E-12	6.00E-03	1.58E-09	1.45E-09	8.12E-13	2.98E-12	3.80E-12	NA	--
Aroclor 1268	0.02999	0.14	3.72E-10	3.42E-10	NA	--	--	3.19E-11	1.17E-10	1.49E-10	NA	--
gamma-Chlordane	0.01456	0.04	5.17E-11	4.75E-11	5.00E-04	1.03E-07	9.49E-08	4.43E-12	1.63E-11	2.07E-11	3.5E-01	7.25E-12
Endrin Ketone	0.003504	0.10	3.11E-11	2.86E-11	3.00E-05	1.04E-06	9.52E-07	2.66E-12	9.79E-12	1.25E-11	1.7E+01	2.12E-10
alpha-Chlordane	0.04483	0.04	1.59E-10	1.46E-10	5.00E-04	3.18E-07	2.92E-07	1.36E-11	5.01E-11	6.37E-11	3.5E-01	2.23E-11
Endosulfan II	0.001496	0.10	1.33E-11	1.22E-11	6.00E-03	2.21E-09	2.03E-09	1.14E-12	4.18E-12	5.32E-12	NA	--
Chlordane	0.1125	0.04	3.99E-10	3.67E-10	5.00E-04	7.98E-07	7.34E-07	3.42E-11	1.26E-10	1.60E-10	3.5E-01	5.60E-11
Endosulfan I	0.001298	0.10	1.15E-11	1.06E-11	6.00E-03	1.92E-09	1.76E-09	9.87E-13	3.63E-12	4.61E-12	NA	--
Di-n-octyl Phthalate	0.03705	0.10	3.29E-10	3.02E-10	2.00E-02	1.64E-08	1.51E-08	2.82E-11	1.04E-10	1.32E-10	1.4E-02	1.84E-12
Dibenz(a,h)anthracene	4.144	0.13	4.78E-08	4.39E-08	NA	--	--	4.10E-09	1.51E-08	1.91E-08	7.3E+00	1.40E-07
Carbazole	3.747	0.10	3.32E-08	3.05E-08	NA	--	--	2.85E-09	1.05E-08	1.33E-08	2.0E-02	2.66E-10
Naphthalene	2.011	0.13	2.32E-08	2.13E-08	2.00E-02	1.16E-06	1.07E-06	1.99E-09	7.31E-09	9.29E-09	NA	--
Phenanthrene	37.068	0.13	4.27E-07	3.93E-07	3.00E-01	1.42E-06	1.31E-06	3.66E-08	1.35E-07	1.71E-07	NA	--
Dimethyl Phthalate	0.1366	0.10	1.21E-09	1.11E-09	8.00E-01	1.51E-09	1.39E-09	1.04E-10	3.82E-10	4.86E-10	NA	--
Benzo(g,h,i)perylene	14.224	0.13	1.64E-07	1.51E-07	NA	--	--	1.41E-08	5.17E-08	6.57E-08	7.3E+00	4.80E-07
Indeno(1,2,3-cd)pyrene	16.94	0.13	1.95E-07	1.79E-07	NA	--	--	1.67E-08	6.15E-08	7.83E-08	7.3E-01	5.71E-08
Benzo(b)fluoranthene	28.99	0.13	3.34E-07	3.07E-07	NA	--	--	2.87E-08	1.05E-07	1.34E-07	7.3E-01	9.78E-08
Benzo(k)fluoranthene	2.332	0.13	2.69E-08	2.47E-08	NA	--	--	2.30E-09	8.47E-09	1.08E-08	7.3E-02	7.87E-10
Acenaphthylene	0.661	0.13	7.62E-09	7.00E-09	6.00E-02	1.27E-07	1.17E-07	6.53E-10	2.40E-09	3.05E-09	NA	--
Benzo(a)pyrene	29.505	0.13	3.40E-07	3.13E-07	NA	--	--	2.92E-08	1.07E-07	1.36E-07	7.3E+00	9.95E-07
Chrysene	29.321	0.13	3.38E-07	3.11E-07	NA	--	--	2.90E-08	1.07E-07	1.35E-07	7.3E-03	9.89E-10
Benz(a)anthracene	29.287	0.13	3.38E-07	3.10E-07	NA	--	--	2.89E-08	1.06E-07	1.35E-07	7.3E-01	9.88E-08
Arsenic	7.225	0.03	1.92E-08	1.77E-08	3.00E-04	6.41E-05	5.89E-05	1.65E-09	6.06E-09	7.70E-09	1.5E+00	1.16E-08
Lead	261.3	0.00	2.32E-08	2.13E-08	NA	--	--	1.99E-09	7.30E-09	9.29E-09	8.5E-03	7.89E-11
Vanadium	30.87	0.01	2.74E-08	2.52E-08	1.82E-06	1.50E-02	1.38E-02	2.35E-09	8.63E-09	1.10E-08	NA	--
TEQ mammal	0.003704	0.03	9.86E-12	9.06E-12	NA	--	--	8.45E-13	3.11E-12	3.95E-12	1.5E+05	5.92E-07
Total					HI:	**1.62E-02**	**1.40E-02**					**2.48E-06**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (95% UCL) (mg/kg)	ABSd (unitless)	DAD - CTE (mg/kg-day) Adolescent	DAD - CTE (mg/kg-day) Adult	Chronic Dermal RfD (mg/kg-day)	HQ- CTE (unitless) Adolescent	HQ- CTE (unitless) Adult	LDAD - CTE (mg/kg-day) Adolescent	LDAD - CTE (mg/kg-day) Adult	LDAD - CTE (mg/kg-day) Total ADD	Dermal Cancer Slope Factor (mg/kg-day)$^{-1}$	CR_{total} CTE (unitless)
Aroclor 1254	0.2163	0.14	5.47E-11	4.64E-11	2.00E-05	2.74E-06	2.32E-06	4.69E-12	1.99E-12	6.68E-12	2.0E+00	1.34E-11
Endrin Aldehyde	0.004018	0.10	7.26E-13	6.16E-13	3.00E-05	2.42E-08	2.05E-08	6.22E-14	2.64E-14	8.86E-14	1.7E+01	1.51E-12
Endosulfan Sulfate	0.001068	0.10	1.93E-13	1.64E-13	6.00E-03	3.22E-11	2.73E-11	1.65E-14	7.02E-15	2.36E-14	NA	--
Aroclor 1268	0.02999	0.14	7.59E-12	6.44E-12	NA	--	--	6.50E-13	2.76E-13	9.26E-13	NA	--
gamma-Chlordane	0.01456	0.04	1.05E-12	8.93E-13	5.00E-04	2.10E-09	1.79E-09	9.02E-14	3.83E-14	1.28E-13	3.5E-01	4.50E-14
Endrin Ketone	0.003504	0.10	6.33E-13	5.37E-13	3.00E-05	2.11E-08	1.79E-08	5.43E-14	2.30E-14	7.73E-14	1.7E+01	1.31E-12
alpha-Chlordane	0.04483	0.04	3.24E-12	2.75E-12	5.00E-04	6.48E-09	5.50E-09	2.78E-13	1.18E-13	3.96E-13	3.5E-01	1.38E-13
Endosulfan II	0.001496	0.10	2.70E-13	2.29E-13	6.00E-03	4.51E-11	3.82E-11	2.32E-14	9.83E-15	3.30E-14	NA	--
Chlordane	0.1125	0.04	8.13E-12	6.90E-12	5.00E-04	1.63E-08	1.38E-08	6.97E-13	2.96E-13	9.93E-13	3.5E-01	3.47E-13
Endosulfan I	0.001298	0.10	2.35E-13	1.99E-13	6.00E-03	3.91E-11	3.32E-11	2.01E-14	8.53E-15	2.86E-14	NA	--
Di-n-octyl Phthalate	0.03705	0.10	6.69E-12	5.68E-12	2.00E-02	3.35E-10	2.84E-10	5.74E-13	2.43E-13	8.17E-13	1.4E-02	1.14E-14
Dibenz(a,h)anthracene	4.144	0.13	9.73E-10	8.26E-10	NA	--	--	8.34E-11	3.54E-11	1.19E-10	7.3E+00	8.68E-10
Carbazole	3.747	0.10	6.77E-10	5.75E-10	NA	--	--	5.80E-11	2.46E-11	8.27E-11	2.0E-02	1.65E-12
Naphthalene	2.011	0.13	4.72E-10	4.01E-10	2.00E-02	2.36E-08	2.00E-08	4.05E-11	1.72E-11	5.77E-11	NA	--
Phenanthrene	37.068	0.13	8.71E-09	7.39E-09	3.00E-01	2.90E-08	2.46E-08	7.46E-10	3.17E-10	1.06E-09	NA	--
Dimethyl Phthalate	0.1366	0.10	2.47E-11	2.09E-11	8.00E-01	3.09E-11	2.62E-11	2.12E-12	8.98E-13	3.01E-12	NA	--
Benzo(g,h,i)perylene	14.224	0.13	3.34E-09	2.84E-09	NA	--	--	2.86E-10	1.22E-10	4.08E-10	7.3E+00	2.98E-09
Indeno(1,2,3-cd)pyrene	16.94	0.13	3.98E-09	3.38E-09	NA	--	--	3.41E-10	1.45E-10	4.86E-10	7.3E-01	3.55E-10
Benzo(b)fluoranthene	28.99	0.13	6.81E-09	5.78E-09	NA	--	--	5.84E-10	2.48E-10	8.31E-10	7.3E-01	6.07E-10
Benzo(k)fluoranthene	2.332	0.13	5.48E-10	4.65E-10	NA	--	--	4.70E-11	1.99E-11	6.69E-11	7.3E-02	4.88E-12
Acenaphthylene	0.661	0.13	1.55E-10	1.32E-10	6.00E-02	2.59E-09	2.20E-09	1.33E-11	5.65E-12	1.90E-11	NA	--
Benzo(a)pyrene	29.505	0.13	6.93E-09	5.88E-09	NA	--	--	5.94E-10	2.52E-10	8.46E-10	7.3E+00	6.18E-09
Chrysene	29.321	0.13	6.89E-09	5.85E-09	NA	--	--	5.90E-10	2.51E-10	8.41E-10	7.3E-03	6.14E-12
Benz(a)anthracene	29.287	0.13	6.88E-09	5.84E-09	NA	--	--	5.90E-10	2.50E-10	8.40E-10	7.3E-01	6.13E-10
Arsenic	7.225	0.03	3.92E-10	3.32E-10	3.00E-04	1.31E-06	1.11E-06	3.36E-11	1.42E-11	4.78E-11	1.5E+00	7.17E-11
Lead	261.3	0.00	4.72E-10	4.01E-10	NA	--	--	4.05E-11	1.72E-11	5.76E-11	8.5E-03	4.90E-13
Vanadium	30.87	0.01	5.58E-10	4.73E-10	1.82E-06	3.06E-04	2.60E-04	4.78E-11	2.03E-11	6.81E-11	NA	--
TEQ mammal	0.003704	0.03	2.01E-13	1.70E-13	NA	--	--	1.72E-14	7.30E-15	2.45E-14	1.5E+05	3.68E-09
Totals					HI:	**3.11E-04**	**2.64E-04**					**1.54E-08**

Table A-A.3. Calculation of Ingestion Exposures and Risks for Child, Adolescent, and Adult Visitors to the Human Health Exposure Area of the Oxbow

Receptor:	Visitor
Age:	Child (1-6 yrs); Adolescent (7-18 yrs); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	Human Use Exposure Area
Exposure Pathway:	Ingestion
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Child CTE	Child RME	Adolescent CTE	Adolescent RME	Adult CTE	Adult RME	Units
Soil ingestion rate	IR	50	100	10	50	10	50	mg/day
Fraction soil ingested from Site	F_S	0.5	0.5	0.5	0.5	0.5	0.5	unitless
Exposure frequency	EF	18	39	18	39	18	39	day/yr
Exposure duration	ED	2	6	3	12	4	12	yr
Averaging time - noncancer	ATn	730	2,190	1,095	4,380	1,460	4,380	day
Averaging time - cancer	ATc	25,550	25,550	25,550	25,550	25,550	25,550	day
Body weight	BW	15	15	45	45	70	70	kg
Unit conversion factor	CF	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	kg/mg
ADD intake factor	**ADDif**	**8.2E-08**	**3.6E-07**	**5.5E-09**	**5.9E-08**	**3.5E-09**	**3.8E-08**	**1/day**
LADD intake factor	**LADDif**	**2.3E-09**	**3.1E-08**	**2.3E-10**	**1.0E-08**	**2.0E-10**	**6.5E-09**	**1/day**

Equations for Risk Calculations

Non-Cancer

ADDif = IR x F_S x EF x ED x CF/ (ATn x BW)

ADD = Csoil x RBA x ADDif

HQ = ADD / RfD

HI = Sum($HQcopc_n$ + HQcopc,...)

Cancer

LADDif = IR x F_S x EF x ED x CF/ (ATc x BW)

LADD = Csoil x RBA x LADDif

Total LADD = LADDchild + LADDadolescent + LADDadult

CR = Total LADD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (95% UCL) (mg/kg)	RBA (unitless)	ADD - RME (mg/kg-day) Child	ADD - RME (mg/kg-day) Adolescent	ADD - RME (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- RME (unitless) Child	HQ- RME (unitless) Adolescent	HQ- RME (unitless) Adult	LADD - RME (mg/kg-day) Child	LADD - RME (mg/kg-day) Adolescent	LADD - RME (mg/kg-day) Adult	LADD - RME (mg/kg-day) Total LADD	Oral Cancer Slope Factor (mg/kg-day)$^{-1}$	CR RME (unitless)
alpha-Chlordane	0.000162	1.00	5.8E-11	9.6E-12	6.2E-12	5.0E-04	1.2E-07	1.9E-08	1.2E-08	4.9E-12	1.6E-12	1.1E-12	7.7E-12	3.5E-01	2.7E-12
gamma-Chlordane	0.000123	1.00	4.4E-11	7.3E-12	4.7E-12	5.0E-04	8.8E-08	1.5E-08	9.4E-09	3.8E-12	1.3E-12	8.0E-13	5.8E-12	3.5E-01	2.0E-12
Endosulfan I	0.0000612	1.00	2.2E-11	3.6E-12	2.3E-12	6.0E-03	3.6E-09	6.1E-10	3.9E-10	1.9E-12	6.2E-13	4.0E-13	2.9E-12	NA	--
Endosulfan Sulfate	0.000343	1.00	1.2E-10	2.0E-11	1.3E-11	6.0E-03	2.0E-08	3.4E-09	2.2E-09	1.0E-11	3.5E-12	2.2E-12	1.6E-11	NA	--
Benzo(a)pyrene	0.04163	1.00	1.5E-08	2.5E-09	1.6E-09	NA	--	--	--	1.3E-09	4.2E-10	2.7E-10	2.0E-09	7.3E+00	1.4E-08
Carbazole	0.005705	1.00	2.0E-09	3.4E-10	2.2E-10	NA	--	--	--	1.7E-10	5.8E-11	3.7E-11	2.7E-10	2.0E-02	5.4E-12
Benzo(g,h,i)perylene	0.03655	1.00	1.3E-08	2.2E-09	1.4E-09	NA	--	--	--	1.1E-09	3.7E-10	2.4E-10	1.7E-09	7.3E+00	1.3E-08
Acenaphthylene	0.01146	1.00	4.1E-09	6.8E-10	4.4E-10	6.0E-02	6.8E-08	1.1E-08	7.3E-09	3.5E-10	1.2E-10	7.5E-11	5.4E-10	NA	--
Dimethyl Phthalate	0.02998	1.00	1.1E-08	1.8E-09	1.1E-09	8.0E-01	1.3E-08	2.2E-09	1.4E-09	9.2E-10	3.1E-10	2.0E-10	1.4E-09	NA	--
Phenanthrene	0.03954	1.00	1.4E-08	2.3E-09	1.5E-09	3.0E-01	4.7E-08	7.8E-09	5.0E-09	1.2E-09	4.0E-10	2.6E-10	1.9E-09	NA	--
Vanadium	20.21	1.00	7.2E-06	1.2E-06	7.7E-07	7.0E-05	1.0E-01	1.7E-02	1.1E-02	6.2E-07	2.1E-07	1.3E-07	9.5E-07	NA	--
Arsenic	4.24	1.00	1.5E-06	2.5E-07	1.6E-07	3.0E-04	5.0E-03	8.4E-04	5.4E-04	1.3E-07	4.3E-08	2.8E-08	2.0E-07	1.5E+00	3.0E-07
TEQ mammal	0.00000521	0.30	5.6E-13	9.3E-14	6.0E-14	NA	--	--	--	4.8E-14	1.6E-14	1.0E-14	7.4E-14	1.5E+05	1.1E-08
Totals						**HI:**	**1.1E-01**	**1.8E-02**	**1.2E-02**						**3.4E-07**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (95% UCL) (mg/kg)	RBA (unitless)	ADD - CTE (mg/kg-day) Child	ADD - CTE (mg/kg-day) Adolescent	ADD - CTE (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- CTE (unitless) Child	HQ- CTE (unitless) Adolescent	HQ- CTE (unitless) Adult	LADD - CTE (mg/kg-day) Child	LADD - CTE (mg/kg-day) Adolescent	LADD - CTE (mg/kg-day) Adult	LADD - CTE (mg/kg-day) Total LADD	Oral Cancer Slope Factor (mg/kg-day)$^{-1}$	CR CTE (unitless)
alpha-Chlordane	0.000162	1.00	1.3E-11	8.9E-13	5.7E-13	5.0E-04	2.7E-08	1.8E-09	1.1E-09	3.8E-13	3.8E-14	3.3E-14	4.5E-13	3.5E-01	1.6E-13
gamma-Chlordane	0.000123	1.00	1.0E-11	6.7E-13	4.3E-13	5.0E-04	2.0E-08	1.3E-09	8.7E-10	2.9E-13	2.9E-14	2.5E-14	3.4E-13	3.5E-01	1.2E-13
Endosulfan I	0.0000612	1.00	5.0E-12	3.4E-13	2.2E-13	6.0E-03	8.4E-10	5.6E-11	3.6E-11	1.4E-13	1.4E-14	1.2E-14	1.7E-13	NA	--
Endosulfan Sulfate	0.000343	1.00	2.8E-11	1.9E-12	1.2E-12	6.0E-03	4.7E-09	3.1E-10	2.0E-10	8.1E-13	8.1E-14	6.9E-14	9.6E-13	NA	--
Benzo(a)pyrene	0.04163	1.00	3.4E-09	2.3E-10	1.5E-10	NA	--	--	--	9.8E-11	9.8E-12	8.4E-12	1.2E-10	7.3E+00	8.5E-10
Carbazole	0.005705	1.00	4.7E-10	3.1E-11	2.0E-11	NA	--	--	--	1.3E-11	1.3E-12	1.1E-12	1.6E-11	2.0E-02	3.2E-13
Benzo(g,h,i)perylene	0.03655	1.00	3.0E-09	2.0E-10	1.3E-10	NA	--	--	--	8.6E-11	8.6E-12	7.4E-12	1.0E-10	7.3E+00	7.4E-10
Acenaphthylene	0.01146	1.00	9.4E-10	6.3E-11	4.0E-11	6.0E-02	1.6E-08	1.0E-09	6.7E-10	2.7E-11	2.7E-12	2.3E-12	3.2E-11	NA	--
Dimethyl Phthalate	0.02998	1.00	2.5E-09	1.6E-10	1.1E-10	8.0E-01	3.1E-09	2.1E-10	1.3E-10	7.0E-11	7.0E-12	6.0E-12	8.3E-11	NA	--
Phenanthrene	0.03954	1.00	3.2E-09	2.2E-10	1.4E-10	3.0E-01	1.1E-08	7.2E-10	4.6E-10	9.3E-11	9.3E-12	8.0E-12	1.1E-10	NA	--
Vanadium	20.21	1.00	1.7E-06	1.1E-07	7.1E-08	7.0E-05	2.4E-02	1.6E-03	1.0E-03	4.7E-08	4.7E-09	4.1E-09	5.6E-08	NA	--
Arsenic	4.24	1.00	3.5E-07	2.3E-08	1.5E-08	3.0E-04	1.2E-03	7.7E-05	5.0E-05	1.0E-08	1.0E-09	8.5E-10	1.2E-08	1.5E+00	1.8E-08
TEQ mammal	0.00000521	0.30	1.3E-13	8.6E-15	5.5E-15	NA	--	--	--	3.7E-15	3.7E-16	3.1E-16	4.4E-15	1.5E+05	6.5E-10
Totals						**HI:**	**2.5E-02**	**1.7E-03**	**1.1E-03**						**2.0E-08**

Table A-A.4. Calculation of Dermal Exposures and Risks for Child, Adolescent, and Adult Visitors to the Human Health Exposure Area of the Oxbow

Receptor:	Visitor
Age:	Child (1-6 yrs); Adolescent (7-18 yrs); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	Human Use Exposure Area
Exposure Pathway:	Dermal Contact
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Child		Adolescent		Adult		Units
		CTE	RME	CTE	RME	CTE	RME	
Unit conversion factor	CF	1.0E-06	1.0E-06	1.0E-06	1.0E-06	1.0E-06	1.0E-06	kg/mg
Adherence factor	AF	0.04	0.2	0.01	0.07	0.01	0.07	mg/cm^2-day
Exposure frequency	EF	18	39	18	39	18	39	day/yr
Exposure duration	ED	2	6	3	12	4	12	yr
Surface Area	SA	1727	1727	3522	3522	4849	4849	cm^2
Averaging time - noncancer	ATn	730	2190	1095	4380	1460	4380	day
Averaging time - cancer	ATc	25550	25550	25550	25550	25550	25550	day
Body weight	BW	15	15	45	45	70	70	kg
DAD intake factor	**DADif**	**2.27E-07**	**2.46E-06**	**3.86E-08**	**5.85E-07**	**3.42E-08**	**5.18E-07**	**1/day**
LDAD intake factor	**LDADif**	**6.49E-09**	**2.11E-07**	**1.65E-09**	**1.00E-07**	**1.95E-09**	**8.88E-08**	**1/day**

Equations for Risk Calculations

Non-Cancer

DADif = CF x AF x EF x ED x SA / (ATn x BW)
DAD = Csoil x ABSd x DADif
HQ = DAD / RfD
HI = Sum($HQcopc_n$ + $HQcopc_i$,...)

Cancer

LDADif = CF x AF x EF x ED x SA / (ATc x BW)
LDAD = LDADif x Csoil x ABSd
Total LDAD = LDADchild + LDADadolescent + LDADadult
CR = Total LDAD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (95% UCL) (mg/kg)	ABSd (unitless)	DAD - RME (mg/kg-day)			Chronic Dermal RfD	HQ- RME (unitless)			LDAD - RME (mg/kg-day)				Dermal Cancer Slope Factor	CR_{total} CTE
			Child	Adolescent	Adult	(mg/kg-day)	Child	Adolescent	Adult	Child	Adolescent	Adult	Total LDAD	$(mg/kg\text{-}day)^{-1}$	(unitless)
alpha-Chlordane	0.000162	0.04	1.59E-11	3.79E-12	3.36E-12	5.00E-04	3.19E-08	7.59E-09	6.71E-09	1.37E-12	6.50E-13	5.76E-13	2.59E-12	3.5E-01	9.07E-13
gamma-Chlordane	0.000123	0.04	1.21E-11	2.88E-12	2.55E-12	5.00E-04	2.42E-08	5.76E-09	5.10E-09	1.04E-12	4.94E-13	4.37E-13	1.97E-12	3.5E-01	6.89E-13
Endosulfan I	0.0000612	0.10	1.51E-11	3.58E-12	3.17E-12	6.00E-03	2.51E-09	5.97E-10	5.28E-10	1.29E-12	6.14E-13	5.44E-13	2.45E-12	NA	--
Endosulfan Sulfate	0.000343	0.10	8.44E-11	2.01E-11	1.78E-11	6.00E-03	1.41E-08	3.35E-09	2.96E-09	7.23E-12	3.44E-12	3.05E-12	1.37E-11	NA	--
Benzo(a)pyrene	0.04163	0.13	1.33E-08	3.17E-09	2.80E-09	NA	--	--	--	1.14E-09	5.43E-10	4.81E-10	2.17E-09	7.3E+00	1.58E-08
Carbazole	0.005705	0.10	1.40E-09	3.34E-10	2.96E-10	NA	--	--	--	1.20E-10	5.73E-11	5.07E-11	2.28E-10	2.0E-02	4.56E-12
Benzo(g,h,i)perylene	0.03655	0.13	1.17E-08	2.78E-09	2.46E-09	NA	--	--	--	1.00E-09	4.77E-10	4.22E-10	1.90E-09	7.3E+00	1.39E-08
Acenaphthylene	0.01146	0.13	3.67E-09	8.72E-10	7.72E-10	6.00E-02	6.11E-08	1.45E-08	1.29E-08	3.14E-10	1.50E-10	1.32E-10	5.96E-10	NA	--
Dimethyl Phthalate	0.02998	0.10	7.38E-09	1.76E-09	1.55E-09	8.00E-01	9.22E-09	2.19E-09	1.94E-09	6.32E-10	3.01E-10	2.66E-10	1.20E-09	NA	--
Phenanthrene	0.03954	0.13	1.26E-08	3.01E-09	2.66E-09	3.00E-01	4.22E-08	1.00E-08	8.88E-09	1.08E-09	5.16E-10	4.57E-10	2.06E-09	NA	--
Vanadium	20.21	0.01	4.97E-07	1.18E-07	1.05E-07	1.82E-06	2.73E-01	6.50E-02	5.75E-02	4.26E-08	2.03E-08	1.80E-08	8.09E-08	NA	--
Arsenic	4.24	0.03	3.13E-07	7.45E-08	6.59E-08	3.00E-04	1.04E-03	2.48E-04	2.20E-04	2.68E-08	1.28E-08	1.13E-08	5.09E-08	1.5E+00	7.63E-08
TEQ mammal	0.00000521	0.03	3.85E-13	9.15E-14	8.10E-14	NA	--	--	--	3.30E-14	1.57E-14	1.39E-14	6.25E-14	1.5E+05	9.38E-09
Total						**HI:**	**2.74E-01**	**6.53E-02**	**5.78E-02**						**1.15E-07**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (95% UCL) (mg/kg)	ABSd (unitless)	DAD - CTE (mg/kg-day)			Chronic Dermal RfD	HQ- CTE (unitless)			LDAD - CTE (mg/kg-day)				Dermal Cancer Slope Factor	CR_{total} CTE
			Child	Adolescent	Adult	(mg/kg-day)	Child	Adolescent	Adult	Child	Adolescent	Adult	Total LDAD	$(mg/kg\text{-}day)^{-1}$	(unitless)
alpha-Chlordane	0.000162	0.04	1.47E-12	2.50E-13	2.21E-13	5.00E-04	2.94E-09	5.00E-10	4.43E-10	4.20E-14	1.07E-14	1.26E-14	6.54E-14	3.5E-01	2.29E-14
gamma-Chlordane	0.000123	0.04	1.12E-12	1.90E-13	1.68E-13	5.00E-04	2.23E-09	3.80E-10	3.36E-10	3.19E-14	8.14E-15	9.60E-15	4.97E-14	3.5E-01	1.74E-14
Endosulfan I	0.0000612	0.10	1.39E-12	2.36E-13	2.09E-13	6.00E-03	2.32E-10	3.94E-11	3.48E-11	3.97E-14	1.01E-14	1.19E-14	6.18E-14	NA	--
Endosulfan Sulfate	0.000343	0.10	7.79E-12	1.32E-12	1.17E-12	6.00E-03	1.30E-09	2.21E-10	1.95E-10	2.23E-13	5.67E-14	6.70E-14	3.46E-13	NA	--
Benzo(a)pyrene	0.04163	0.13	1.23E-09	2.09E-10	1.85E-10	NA	--	--	--	3.51E-11	8.95E-12	1.06E-11	5.46E-11	7.3E+00	3.99E-10
Carbazole	0.005705	0.10	1.30E-10	2.20E-11	1.95E-11	NA	--	--	--	3.70E-12	9.44E-13	1.11E-12	5.76E-12	2.0E-02	1.15E-13
Benzo(g,h,i)perylene	0.03655	0.13	1.08E-09	1.83E-10	1.62E-10	NA	--	--	--	3.08E-11	7.86E-12	9.28E-12	4.80E-11	7.3E+00	3.50E-10
Acenaphthylene	0.01146	0.13	3.38E-10	5.75E-11	5.09E-11	6.00E-02	5.64E-09	9.58E-10	8.48E-10	9.67E-12	2.46E-12	2.91E-12	1.50E-11	NA	--
Dimethyl Phthalate	0.02998	0.10	6.81E-10	1.16E-10	1.02E-10	8.00E-01	8.51E-10	1.45E-10	1.28E-10	1.95E-11	4.96E-12	5.85E-12	3.03E-11	NA	--
Phenanthrene	0.03954	0.13	1.17E-09	1.98E-10	1.76E-10	3.00E-01	3.89E-09	6.61E-10	5.85E-10	3.34E-11	8.50E-12	1.00E-11	5.19E-11	NA	--
Vanadium	20.21	0.01	4.59E-08	7.80E-09	6.90E-09	1.82E-06	2.52E-02	4.29E-03	3.79E-03	1.31E-09	3.34E-10	3.95E-10	2.04E-09	NA	--
Arsenic	4.24	0.03	2.89E-08	4.91E-09	4.35E-09	3.00E-04	9.63E-05	1.64E-05	1.45E-05	8.25E-10	2.10E-10	2.48E-10	1.28E-09	1.5E+00	1.93E-09
TEQ mammal	0.00000521	0.03	3.55E-14	6.03E-15	5.34E-15	NA	--	--	--	1.01E-15	2.59E-16	3.05E-16	1.58E-15	1.5E+05	2.37E-10
Total						**HI:**	**2.53E-02**	**4.30E-03**	**3.81E-03**						**2.91E-09**

Table A-A.5. Calculation of Ingestion Exposures and Risks for Adolescent Teenager and Adult Visitors to the Northeast Lyman Mill Pond Floodplain Soils

Receptor:	Visitor
Age:	Adolescent Teenager (13-18); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	NE Lyman Mill Pond Area
Exposure Pathway	Ingestion
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Adolescent CTE	Adolescent RME	Adult CTE	Adult RME	Units
Soil ingestion rate	IR	10	50	10	50	mg/day
Fraction soil ingested from Site	F_S	0.5	0.5	0.5	0.5	unitless
Exposure frequency	EF	3	12	3	12	day/yr
Exposure duration	ED	6	6	3	24	yr
Averaging time - noncancer	ATn	2190	2190	1095	8760	day
Averaging time - cancer	ATc	25550	25550	25550	25550	day
Body weight	BW	59	59	70	70	kg
Unit conversion factor	CF	1.00E-06	1.00E-06	1.00E-06	1.00E-06	kg/mg
ADD intake factor	**ADDif**	**7.0E-10**	**1.4E-08**	**5.9E-10**	**1.2E-08**	**1/day**
LADD intake factor	**LADDif**	**6.0E-11**	**1.2E-09**	**2.5E-11**	**4.0E-09**	**1/day**

Equations for Risk Calculations

Non-Cancer

ADDif = IR x F_S x EF x ED x CF / (ATn x BW)
ADD = Csoil x RBA x ADDif
HQ = ADD / RfD
HI = Sum($HQcopc_n$ + $HQcopc_i$,...)

Cancer

LADDif = IR x F_S x EF x ED x CF / (ATc x BW)
LADD = Csoil x RBA x LADDif
Total LADD = LADDchild + LADDadolescent + LADDadult
CR = Total LADD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Max) (mg/kg)	RBA (unitless)	ADD - RME (mg/kg-day) Adolescent	ADD - RME (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- RME (unitless) Adolescent	HQ- RME (unitless) Adult	LADD - RME (mg/kg-day) Adolescent	LADD - RME (mg/kg-day) Adult	LADD - RME (mg/kg-day) Total LADD	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR RME (unitless)
alpha-Chlordane	0.03	1.00	4.18E-10	3.52E-10	5.0E-04	8.36E-07	7.05E-07	3.58E-11	1.21E-10	1.57E-10	3.5E-01	5.48E-11
Aroclor 1254	0.36	1.00	5.02E-09	4.23E-09	2.0E-05	2.51E-04	2.11E-04	4.30E-10	1.45E-09	1.88E-09	2.0E+00	3.76E-09
Aroclor 1268	0.054	1.00	7.52E-10	6.34E-10	NA	--	--	6.45E-11	2.17E-10	2.82E-10	NA	--
Chlordane	0.54	1.00	7.52E-09	6.34E-09	5.0E-04	1.50E-05	1.27E-05	6.45E-10	2.17E-09	2.82E-09	3.5E-01	9.87E-10
delta-BHC	0.00029	1.00	4.04E-12	3.41E-12	3.0E-04	1.35E-08	1.14E-08	3.46E-13	1.17E-12	1.51E-12	1.1E+00	1.67E-12
Endosulfan II	0.0075	1.00	1.04E-10	8.81E-11	6.0E-03	1.74E-08	1.47E-08	8.96E-12	3.02E-11	3.91E-11	NA	--
Endosulfan Sulfate	0.00053	1.00	7.38E-12	6.22E-12	6.0E-03	1.23E-09	1.04E-09	6.33E-13	2.13E-12	2.77E-12	NA	--
Endrin Aldehyde	0.0023	1.00	3.20E-11	2.70E-11	3.0E-05	1.07E-06	9.00E-07	2.75E-12	9.26E-12	1.20E-11	1.7E+01	2.04E-10
Endrin Ketone	0.0019	1.00	2.65E-11	2.23E-11	3.0E-05	8.82E-07	7.44E-07	2.27E-12	7.65E-12	9.92E-12	1.7E+01	1.69E-10
gamma-Chlordane	0.045	1.00	6.27E-10	5.28E-10	5.0E-04	1.25E-06	1.06E-06	5.37E-11	1.81E-10	2.35E-10	3.5E-01	8.22E-11
Acenaphthylene	0.72	1.00	1.00E-08	8.45E-09	6.0E-02	1.67E-07	1.41E-07	8.60E-10	2.90E-09	3.76E-09	NA	--
Benz(a)anthracene	3.1	1.00	4.32E-08	3.64E-08	NA	--	--	3.70E-09	1.25E-08	1.62E-08	7.3E-01	1.18E-08
Benzo(a)pyrene	3.9	1.00	5.43E-08	4.58E-08	NA	--	--	4.66E-09	1.57E-08	2.04E-08	7.3E+00	1.49E-07
Benzo(b)fluoranthene	5	1.00	6.97E-08	5.87E-08	NA	--	--	5.97E-09	2.01E-08	2.61E-08	7.3E-01	1.91E-08
Benzo(g,h,i)perylene	2.5	1.00	3.48E-08	2.94E-08	NA	--	--	2.99E-09	1.01E-08	1.30E-08	7.3E+00	9.53E-08
Benzo(k)fluoranthene	1.7	1.00	2.37E-08	2.00E-08	NA	--	--	2.03E-09	6.84E-09	8.87E-09	7.3E-02	6.48E-10
Carbazole	0.57	1.00	7.94E-09	6.69E-09	NA	--	--	6.81E-10	2.29E-09	2.98E-09	2.0E-02	5.95E-11
Dibenz(a,h)anthracene	0.68	1.00	9.47E-09	7.98E-09	NA	--	--	8.12E-10	2.74E-09	3.55E-09	7.3E+00	2.59E-08
Dimethyl Phthalate	0.13	1.00	1.81E-09	1.53E-09	8.0E-01	2.26E-09	1.91E-09	1.55E-10	5.23E-10	6.79E-10	NA	--
Indeno(1,2,3-cd)pyrene	2.8	1.00	3.90E-08	3.29E-08	NA	--	--	3.34E-09	1.13E-08	1.46E-08	7.3E-01	1.07E-08
Phenanthrene	5	1.00	6.97E-08	5.87E-08	3.0E-01	2.32E-07	1.96E-07	5.97E-09	2.01E-08	2.61E-08	NA	--
Arsenic	18.4	1.00	2.56E-07	2.16E-07	3.0E-04	8.54E-04	7.20E-04	2.20E-08	7.41E-08	9.60E-08	1.5E+00	1.44E-07
Vanadium	52.3	1.00	7.29E-07	6.14E-07	7.0E-05	1.04E-02	8.77E-03	6.24E-08	2.11E-07	2.73E-07	NA	--
TEQ mammal	0.0126416	0.30	5.28E-11	4.45E-11	NA	--	--	4.53E-12	1.53E-11	1.98E-11	1.5E+05	2.97E-06
Totals						**HI:**	**1.15E-02**	**9.72E-03**				**3.43E-06**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Mean) (mg/kg)	RBA (unitless)	ADD - CTE (mg/kg-day) Adolescent	ADD - CTE (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- CTE (unitless) Adolescent	HQ- CTE (unitless) Adult	LADD - CTE (mg/kg-day) Adolescent	LADD - CTE (mg/kg-day) Adult	LADD - CTE (mg/kg-day) Total LADD	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR CTE (unitless)
alpha-Chlordane	0.01098	1.00	7.65E-12	6.45E-12	5.0E-04	1.53E-08	1.29E-08	6.56E-13	2.76E-13	9.32E-13	3.5E-01	3.26E-13
Aroclor 1254	0.172	1.00	1.20E-10	1.01E-10	2.0E-05	5.99E-06	5.05E-06	1.03E-11	4.33E-12	1.46E-11	2.0E+00	2.92E-11
Aroclor 1268	0.01259	1.00	8.77E-12	7.39E-12	NA	--	--	7.52E-13	3.17E-13	1.07E-12	NA	--
Chlordane	0.175	1.00	1.22E-10	1.03E-10	5.0E-04	2.44E-07	2.05E-07	1.04E-11	4.40E-12	1.49E-11	3.5E-01	5.20E-12
delta-BHC	0.000173	1.00	1.21E-13	1.02E-13	3.0E-04	4.02E-10	3.39E-10	1.03E-14	4.35E-15	1.47E-14	1.1E+00	1.61E-14
Endosulfan II	0.002867	1.00	2.00E-12	1.68E-12	6.0E-03	3.33E-10	2.81E-10	1.71E-13	7.21E-14	2.43E-13	NA	--
Endosulfan Sulfate	0.003659	1.00	2.55E-12	2.15E-12	6.0E-03	4.25E-10	3.58E-10	2.18E-13	9.21E-14	3.11E-13	NA	--
Endrin Aldehyde	0.000968	1.00	6.74E-13	5.68E-13	3.0E-05	2.25E-08	1.89E-08	5.78E-14	2.44E-14	8.21E-14	1.7E+01	1.40E-12
Endrin Ketone	0.001121	1.00	7.81E-13	6.58E-13	3.0E-05	2.60E-08	2.19E-08	6.69E-14	2.82E-14	9.51E-14	1.7E+01	1.62E-12
gamma-Chlordane	0.01904	1.00	1.33E-11	1.12E-11	5.0E-04	2.65E-08	2.24E-08	1.14E-12	4.79E-13	1.62E-12	3.5E-01	5.66E-13
Acenaphthylene	0.374	1.00	2.61E-10	2.20E-10	6.0E-02	4.34E-09	3.66E-09	2.23E-11	9.41E-12	3.17E-11	NA	--
Benz(a)anthracene	1.79	1.00	1.25E-09	1.05E-09	NA	--	--	1.07E-10	4.50E-11	1.52E-10	7.3E-01	1.11E-10
Benzo(a)pyrene	2.206	1.00	1.54E-09	1.30E-09	NA	--	--	1.32E-10	5.55E-11	1.87E-10	7.3E+00	1.37E-09
Benzo(b)fluoranthene	2.876	1.00	2.00E-09	1.69E-09	NA	--	--	1.72E-10	7.24E-11	2.44E-10	7.3E-01	1.78E-10
Benzo(g,h,i)perylene	1.51	1.00	1.05E-09	8.86E-10	NA	--	--	9.02E-11	3.80E-11	1.28E-10	7.3E+00	9.35E-10
Benzo(k)fluoranthene	0.916	1.00	6.38E-10	5.38E-10	NA	--	--	5.47E-11	2.30E-11	7.77E-11	7.3E-02	5.67E-12
Carbazole	0.264	1.00	1.84E-10	1.55E-10	NA	--	--	1.58E-11	6.64E-12	2.24E-11	2.0E-02	4.48E-13
Dibenz(a,h)anthracene	0.385	1.00	2.68E-10	2.26E-10	NA	--	--	2.30E-11	9.69E-12	3.27E-11	7.3E+00	2.39E-10
Dimethyl Phthalate	0.0546	1.00	3.80E-11	3.21E-11	8.0E-01	4.75E-11	4.01E-11	3.26E-12	1.37E-12	4.63E-12	NA	--
Indeno(1,2,3-cd)pyrene	1.592	1.00	1.11E-09	9.35E-10	NA	--	--	9.50E-11	4.01E-11	1.35E-10	7.3E-01	9.86E-11
Phenanthrene	1.948	1.00	1.36E-09	1.14E-09	3.0E-01	4.52E-09	3.81E-09	1.16E-10	4.90E-11	1.65E-10	NA	--
Arsenic	5.8	1.00	4.04E-09	3.41E-09	3.0E-04	1.35E-05	1.14E-05	3.46E-10	1.46E-10	4.92E-10	1.5E+00	7.38E-10
Vanadium	24.58	1.00	1.71E-08	1.44E-08	7.0E-05	2.45E-04	2.06E-04	1.47E-09	6.18E-10	2.09E-09	NA	--
TEQ mammal	0.00404	0.30	8.44E-13	7.12E-13	NA	--	--	7.24E-14	3.05E-14	1.03E-13	1.5E+05	1.54E-08
Totals						**HI:**	**2.64E-04**	**2.23E-04**				**1.91E-08**

Table A-A.6. Calculation of Dermal Exposures and Risks for Adolescent Teenager and Adult Visitors to the Northeast Lyman Mill Pond Floodplain Soils

Receptor:	Visitor
Age:	Adolescent Teenager (13-18); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	NE Lyman Mill Pond Area
Exposure Pathway:	Dermal Contact
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Adolescent CTE	Adolescent RME	Adult CTE	Adult RME	Units
Unit conversion factor	CF	1.0E-06	1.0E-06	1.0E-06	1.0E-06	kg/mg
Adherence factor	AF	0.01	0.07	0.01	0.07	mg/cm^2-day
Exposure frequency	EF	3	12	3	12	day/yr
Exposure duration	ED	6	6	3	24	yr
Surface Area	SA	1297	2274	1306	2479	cm^2
Averaging time - noncancer	ATn	2190	2190	1095	8760	day
Averaging time - cancer	ATc	25550	25550	25550	25550	day
Body weight	BW	59	59	70	70	kg
DAD intake factor	**DADif**	**1.81E-09**	**8.87E-08**	**1.53E-09**	**8.15E-08**	**1/day**
LDAD intake factor	**LDADif**	**1.55E-10**	**7.60E-09**	**6.57E-11**	**2.79E-08**	**1/day**

Equations for Risk Calculations

Non-Cancer

DADif = CF x AF x F_S x EF x ED x SA / (ATn x BW)

DAD = Csoil x ABSd x DADif

HQ = DAD / RfD

HI = Sum($HQcopc_n$ + $HQcopc_i$,...)

Cancer

LDADif = CF x AF x F_S x EF x ED x SA / (ATc x BW)

LDAD = LDADif x Csoil x ABSd

Total LDAD = LDADchild + LDADadolescent + LDADadult

CR = Total LDAD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Max) (mg/kg)	ABSd (unitless)	DAD - RME (mg/kg-day) Adolescent	DAD - RME (mg/kg-day) Adult	Chronic Dermal RfD (mg/kg-day)	HQ- RME (unitless) Adolescent	HQ- RME (unitless) Adult	LDAD - RME (mg/kg-day) Adolescent	LDAD - RME (mg/kg-day) Adult	LDAD - RME (mg/kg-day) Total LDAD	Dermal Cancer Slope Factor (mg/kg-day)$^{-1}$	CR_{total} RME (unitless)
alpha-Chlordane	0.03	0.04	1.06E-10	9.78E-11	5.0E-04	2.13E-07	1.96E-07	9.12E-12	3.35E-11	4.27E-11	3.5E-01	1.49E-11
Aroclor 1254	0.36	0.14	4.47E-09	4.11E-09	2.0E-05	2.24E-04	2.05E-04	3.83E-10	1.41E-09	1.79E-09	2.0E+00	3.58E-09
Aroclor 1268	0.054	0.14	6.71E-10	6.16E-10	NA	--	--	5.75E-11	2.11E-10	2.69E-10	NA	--
Chlordane	0.54	0.04	1.92E-09	1.76E-09	5.0E-04	3.83E-06	3.52E-06	1.64E-10	6.04E-10	7.68E-10	3.5E-01	2.69E-10
delta-BHC	0.00029	0.04	1.03E-12	9.45E-13	3.0E-04	3.43E-09	3.15E-09	8.82E-14	3.24E-13	4.12E-13	1.1E+00	4.54E-13
Endosulfan II	0.0075	0.10	6.65E-11	6.11E-11	6.0E-03	1.11E-08	1.02E-08	5.70E-12	2.10E-11	2.67E-11	NA	--
Endosulfan Sulfate	0.00053	0.10	4.70E-12	4.32E-12	6.0E-03	7.84E-10	7.20E-10	4.03E-13	1.48E-12	1.88E-12	NA	--
Endrin Aldehyde	0.0023	0.10	2.04E-11	1.87E-11	3.0E-05	6.80E-07	6.25E-07	1.75E-12	6.43E-12	8.18E-12	1.7E+01	1.39E-10
Endrin Ketone	0.0019	0.10	1.69E-11	1.55E-11	3.0E-05	5.62E-07	5.16E-07	1.44E-12	5.31E-12	6.75E-12	1.7E+01	1.15E-10
gamma-Chlordane	0.045	0.04	1.60E-10	1.47E-10	5.0E-04	3.19E-07	2.93E-07	1.37E-11	5.03E-11	6.40E-11	3.5E-01	2.24E-11
Acenaphthylene	0.72	0.13	8.30E-09	7.63E-09	6.0E-02	1.38E-07	1.27E-07	7.12E-10	2.62E-09	3.33E-09	NA	--
Benz(a)anthracene	3.1	0.13	3.57E-08	3.28E-08	NA	--	--	3.06E-09	1.13E-08	1.43E-08	7.3E-01	1.05E-08
Benzo(a)pyrene	3.9	0.13	4.50E-08	4.13E-08	NA	--	--	3.85E-09	1.42E-08	1.80E-08	7.3E+00	1.32E-07
Benzo(b)fluoranthene	5	0.13	5.77E-08	5.30E-08	NA	--	--	4.94E-09	1.82E-08	2.31E-08	7.3E-01	1.69E-08
Benzo(g,h,i)perylene	2.5	0.13	2.88E-08	2.65E-08	NA	--	--	2.47E-09	9.08E-09	1.16E-08	7.3E+00	8.43E-08
Benzo(k)fluoranthene	1.7	0.13	1.96E-08	1.80E-08	NA	--	--	1.68E-09	6.18E-09	7.86E-09	7.3E-02	5.73E-10
Carbazole	0.57	0.10	5.06E-09	4.65E-09	NA	--	--	4.33E-10	1.59E-09	2.03E-09	2.0E-02	4.05E-11
Dibenz(a,h)anthracene	0.68	0.13	7.84E-09	7.20E-09	NA	--	--	6.72E-10	2.47E-09	3.14E-09	7.3E+00	2.29E-08
Dimethyl Phthalate	0.13	0.10	1.15E-09	1.06E-09	8.0E-01	1.44E-09	1.32E-09	9.88E-11	3.63E-10	4.62E-10	NA	--
Indeno(1,2,3-cd)pyrene	2.8	0.13	3.23E-08	2.97E-08	NA	--	--	2.77E-09	1.02E-08	1.29E-08	7.3E-01	9.45E-09
Phenanthrene	5	0.13	5.77E-08	5.30E-08	3.0E-01	1.92E-07	1.77E-07	4.94E-09	1.82E-08	2.31E-08	NA	--
Arsenic	18.4	0.03	4.90E-08	4.50E-08	3.0E-04	1.63E-04	1.50E-04	4.20E-09	1.54E-08	1.96E-08	1.5E+00	2.94E-08
Vanadium	52.3	0.01	4.64E-08	4.26E-08	1.8E-06	2.55E-02	2.34E-02	3.98E-09	1.46E-08	1.86E-08	NA	--
TEQ mammal	0.0126416	0.03	3.36E-11	3.09E-11	NA	--	--	2.88E-12	1.06E-11	1.35E-11	1.5E+05	2.02E-06
Totals					**HI:**	**2.59E-02**	**2.38E-02**					**2.33E-06**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Mean) (mg/kg)	ABSd (unitless)	DAD - CTE (mg/kg-day) Adolescent	DAD - CTE (mg/kg-day) Adult	Chronic Dermal RfD (mg/kg-day)	HQ- CTE (unitless) Adolescent	HQ- CTE (unitless) Adult	LDAD - CTE (mg/kg-day) Adolescent	LDAD - CTE (mg/kg-day) Adult	LDAD - CTE (mg/kg-day) Total ADD	Dermal Cancer Slope Factor (mg/kg-day)$^{-1}$	CR_{total} CTE (unitless)
alpha-Chlordane	0.00005	0.04	3.61E-15	3.07E-15	5.0E-04	7.23E-12	6.13E-12	3.10E-16	1.31E-16	4.41E-16	3.5E-01	1.54E-16
Aroclor 1254	0.00135	0.14	3.41E-13	2.90E-13	2.0E-05	1.71E-08	1.45E-08	2.93E-14	1.24E-14	4.17E-14	2.0E+00	8.34E-14
Aroclor 1268	0.00105	0.14	2.66E-13	2.25E-13	NA	--	--	2.28E-14	9.66E-15	3.24E-14	NA	--
Chlordane	0.0024	0.04	1.73E-13	1.47E-13	5.0E-04	3.47E-10	2.94E-10	1.49E-14	6.31E-15	2.12E-14	3.5E-01	7.41E-15
delta-BHC	0.000037	0.04	2.67E-15	2.27E-15	3.0E-04	8.91E-12	7.57E-12	2.29E-16	9.73E-17	3.26E-16	1.1E+00	3.59E-16
Endosulfan II	0.00007	0.10	1.26E-14	1.07E-14	6.0E-03	2.11E-12	1.79E-12	1.08E-15	4.60E-16	1.54E-15	NA	--
Endosulfan Sulfate	0.000055	0.10	9.94E-15	8.43E-15	6.0E-03	1.66E-12	1.41E-12	8.52E-16	3.61E-16	1.21E-15	NA	--
Endrin Aldehyde	0.00006	0.10	1.08E-14	9.20E-15	3.0E-05	3.61E-10	3.07E-10	9.29E-16	3.94E-16	1.32E-15	1.7E+01	2.25E-14
Endrin Ketone	0.0000465	0.10	8.40E-15	7.13E-15	3.0E-05	2.80E-10	2.38E-10	7.20E-16	3.06E-16	1.03E-15	1.7E+01	1.74E-14
gamma-Chlordane	0.00021	0.04	1.52E-14	1.29E-14	5.0E-04	3.04E-11	2.58E-11	1.30E-15	5.52E-16	1.85E-15	3.5E-01	6.49E-16
Acenaphthylene	0.0018	0.13	4.23E-13	3.59E-13	6.0E-02	7.05E-12	5.98E-12	3.62E-14	1.54E-14	5.16E-14	NA	--
Benz(a)anthracene	0.01	0.13	2.35E-12	1.99E-12	NA	--	--	2.01E-13	8.54E-14	2.87E-13	7.3E-01	2.09E-13
Benzo(a)pyrene	0.014	0.13	3.29E-12	2.79E-12	NA	--	--	2.82E-13	1.20E-13	4.01E-13	7.3E+00	2.93E-12
Benzo(b)fluoranthene	0.019	0.13	4.46E-12	3.79E-12	NA	--	--	3.83E-13	1.62E-13	5.45E-13	7.3E-01	3.98E-13
Benzo(g,h,i)perylene	0.011	0.13	2.58E-12	2.19E-12	NA	--	--	2.21E-13	9.40E-14	3.15E-13	7.3E+00	2.30E-12
Benzo(k)fluoranthene	0.0071	0.13	1.67E-12	1.42E-12	NA	--	--	1.43E-13	6.07E-14	2.04E-13	7.3E-02	1.49E-14
Carbazole	0.0021	0.10	3.79E-13	3.22E-13	NA	--	--	3.25E-14	1.38E-14	4.63E-14	2.0E-02	9.26E-16
Dibenz(a,h)anthracene	0.0026	0.13	6.11E-13	5.18E-13	NA	--	--	5.23E-14	2.22E-14	7.46E-14	7.3E+00	5.44E-13
Dimethyl Phthalate	0.0005	0.10	9.03E-14	7.67E-14	8.0E-01	1.13E-13	9.58E-14	7.74E-15	3.29E-15	1.10E-14	NA	--
Indeno(1,2,3-cd)pyrene	0.011	0.13	2.58E-12	2.19E-12	NA	--	--	2.21E-13	9.40E-14	3.15E-13	7.3E-01	2.30E-13
Phenanthrene	0.0089	0.13	2.09E-12	1.77E-12	3.0E-01	6.97E-12	5.91E-12	1.79E-13	7.60E-14	2.55E-13	NA	--
Arsenic	2	0.03	1.08E-10	9.20E-11	3.0E-04	3.61E-07	3.07E-07	9.29E-12	3.94E-12	1.32E-11	1.5E+00	1.99E-11
Vanadium	9	0.01	1.63E-10	1.38E-10	1.8E-06	8.93E-05	7.58E-05	1.39E-11	5.91E-12	1.99E-11	NA	--
TEQ mammal	0.00001496	0.03	8.11E-16	6.88E-16	NA	--	--	6.95E-17	2.95E-17	9.90E-17	1.5E+05	1.49E-11
Total					**HI:**	**8.97E-05**	**7.62E-05**					**4.15E-11**

Table A-A.7. Calculation of Ingestion Exposures and Risks for Adolescent Teenager and Adult Visitors to the Assapumpsett Brook Floodplain Soils

Receptor:	Visitor
Age:	Adolescent Teenager (13-18); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	Assapumpset Brook Area
Exposure Pathway:	Ingestion
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Adolescent CTE	Adolescent RME	Adult CTE	Adult RME	Units
Soil ingestion rate	IR	10	50	10	50	mg/day
Fraction soil ingested from Site	F_S	0.5	0.5	0.5	0.5	unitless
Exposure frequency	EF	3	12	3	12	day/yr
Exposure duration	ED	6	6	3	24	yr
Averaging time - noncancer	ATn	2190	2190	1095	8760	day
Averaging time - cancer	ATc	25550	25550	25550	25550	day
Body weight	BW	59	59	70	70	kg
Unit conversion factor	CF	1.00E-06	1.00E-06	1.00E-06	1.00E-06	kg/mg
ADD intake factor	**ADDif**	**7.0E-10**	**1.4E-08**	**5.9E-10**	**1.2E-08**	**1/day**
LADD intake factor	**LADDif**	**6.0E-11**	**1.2E-09**	**2.5E-11**	**4.0E-09**	**1/day**

Equations for Risk Calculations

Non-Cancer

ADDif = IR x F_S x EF x ED x CF/ (ATn x BW)

ADD = Csoil x RBA x ADDif

HQ = ADD / RfD

HI = Sum($HQcopc_a$ + $HQcopc_i$,...)

Cancer

LADDif = IR x F_S x EF x ED x CF/ (ATc x BW)

LADD = Csoil x RBA x LADDif

Total LADD = LADDchild + LADDadolescent + LADDadult

CR = Total LADD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Max) (mg/kg)	RBA (unitless)	ADD - RME (mg/kg-day) Adolescent	ADD - RME (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- RME (unitless) Adolescent	HQ- RME (unitless) Adult	LADD - RME (mg/kg-day) Adolescent	LADD - RME (mg/kg-day) Adult	LADD - RME (mg/kg-day) Total LADD	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR RME (unitless)
alpha-Chlordane	0.0064	1.00	8.92E-11	7.51E-11	5.0E-04	1.78E-07	1.50E-07	7.64E-12	2.58E-11	3.34E-11	3.5E-01	1.17E-11
gamma-Chlordane	0.013	1.00	1.81E-10	1.53E-10	5.0E-04	3.62E-07	3.05E-07	1.55E-11	5.23E-11	6.79E-11	3.5E-01	2.38E-11
Endosulfan Sulfate	0.0023	1.00	3.20E-11	2.70E-11	6.0E-03	5.34E-09	4.50E-09	2.75E-12	9.26E-12	1.20E-11	NA	--
Chlordane	0.064	1.00	8.92E-10	7.51E-10	5.0E-04	1.78E-06	1.50E-06	7.64E-11	2.58E-10	3.34E-10	3.5E-01	1.17E-10
Aroclor 1260	0.28	1.00	3.90E-09	3.29E-09	2.0E-05	1.95E-04	1.64E-04	3.34E-10	1.13E-09	1.46E-09	2.0E+00	2.92E-09
Endrin Aldehyde	0.0016	1.00	2.23E-11	1.88E-11	3.0E-05	7.43E-07	6.26E-07	1.91E-12	6.44E-12	8.35E-12	1.7E+01	1.42E-10
Aroclor 1254	0.25	1.00	3.48E-09	2.94E-09	2.0E-05	1.74E-04	1.47E-04	2.99E-10	1.01E-09	1.30E-09	2.0E+00	2.61E-09
Carbazole	0.053	1.00	7.38E-10	6.22E-10	NA	--	--	6.33E-11	2.13E-10	2.77E-10	2.0E-02	5.53E-12
Benzo(g,h,i)perylene	0.51	1.00	7.10E-09	5.99E-09	NA	--	--	6.09E-10	2.05E-09	2.66E-09	7.3E+00	1.94E-08
Phenanthrene	0.57	1.00	7.94E-09	6.69E-09	3.0E-01	2.65E-08	2.23E-08	6.81E-10	2.29E-09	2.98E-09	NA	--
Dimethyl Phthalate	0.07	1.00	9.75E-10	8.22E-10	8.0E-01	1.22E-09	1.03E-09	8.36E-11	2.82E-10	3.65E-10	NA	--
Indeno(1,2,3-cd)pyrene	0.53	1.00	7.38E-09	6.22E-09	NA	--	--	6.33E-10	2.13E-09	2.77E-09	7.3E-01	2.02E-09
Benzo(a)pyrene	0.67	1.00	9.33E-09	7.87E-09	NA	--	--	8.00E-10	2.70E-09	3.50E-09	7.3E+00	2.55E-08
Benzo(b)fluoranthene	0.91	1.00	1.27E-08	1.07E-08	NA	--	--	1.09E-09	3.66E-09	4.75E-09	7.3E-01	3.47E-09
Acenaphthylene	0.14	1.00	1.95E-09	1.64E-09	6.0E-02	3.25E-08	2.74E-08	1.67E-10	5.64E-10	7.31E-10	NA	--
Dibenz(a,h)anthracene	0.12	1.00	1.67E-09	1.41E-09	NA	--	--	1.43E-10	4.83E-10	6.26E-10	7.3E+00	4.57E-09
Benz(a)anthracene	0.59	1.00	8.22E-09	6.93E-09	NA	--	--	7.05E-10	2.38E-09	3.08E-09	7.3E-01	2.25E-09
Arsenic	13.7	1.00	1.91E-07	1.61E-07	3.0E-04	6.36E-04	5.36E-04	1.64E-08	5.52E-08	7.15E-08	1.5E+00	1.07E-07
Vanadium	22.8	1.00	3.18E-07	2.68E-07	7.0E-05	4.54E-03	3.82E-03	2.72E-08	9.18E-08	1.19E-07	NA	--
TEQ mammal	0.0001392	0.30	5.82E-13	4.90E-13	NA	--	--	4.99E-14	1.68E-13	2.18E-13	1.5E+05	3.27E-08
Totals					**HI:**	**5.55E-03**	**4.67E-03**					**2.03E-07**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Mean) (mg/kg)	RBA (unitless)	ADD - CTE (mg/kg-day) Adolescent	ADD - CTE (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- CTE (unitless) Adolescent	HQ- CTE (unitless) Adult	LADD - CTE (mg/kg-day) Adolescent	LADD - CTE (mg/kg-day) Adult	LADD - CTE (mg/kg-day) Total LADD	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR CTE (unitless)
alpha-Chlordane	0.0046	1.00	3.20E-12	2.70E-12	5.0E-04	6.41E-09	5.40E-09	2.75E-13	1.16E-13	3.90E-13	3.5E-01	1.37E-13
gamma-Chlordane	0.00875	1.00	6.09E-12	5.14E-12	5.0E-04	1.22E-08	1.03E-08	5.22E-13	2.20E-13	7.43E-13	3.5E-01	2.60E-13
Endosulfan Sulfate	0.001178	1.00	8.21E-13	6.92E-13	6.0E-03	1.37E-10	1.15E-10	7.03E-14	2.96E-14	1.00E-13	NA	--
Chlordane	0.053	1.00	3.69E-11	3.11E-11	5.0E-04	7.38E-08	6.22E-08	3.16E-12	1.33E-12	4.50E-12	3.5E-01	1.57E-12
Aroclor 1260	0.186	1.00	1.30E-10	1.09E-10	2.0E-05	6.48E-06	5.46E-06	1.11E-11	4.68E-12	1.58E-11	2.0E+00	3.16E-11
Endrin Aldehyde	0.001003	1.00	6.99E-13	5.89E-13	3.0E-05	2.33E-08	1.96E-08	5.99E-14	2.52E-14	8.51E-14	1.7E+01	1.45E-12
Aroclor 1254	0.1505	1.00	1.05E-10	8.84E-11	2.0E-05	5.24E-06	4.42E-06	8.99E-12	3.79E-12	1.28E-11	2.0E+00	2.55E-11
Carbazole	0.0405	1.00	2.82E-11	2.38E-11	NA	--	--	2.42E-12	1.02E-12	3.44E-12	2.0E-02	6.87E-14
Benzo(g,h,i)perylene	0.385	1.00	2.68E-10	2.26E-10	NA	--	--	2.30E-11	9.69E-12	3.27E-11	7.3E+00	2.39E-10
Phenanthrene	0.37	1.00	2.58E-10	2.17E-10	3.0E-01	8.59E-10	7.24E-10	2.21E-11	9.31E-12	3.14E-11	NA	--
Dimethyl Phthalate	0.059	1.00	4.11E-11	3.46E-11	8.0E-01	5.14E-11	4.33E-11	3.52E-12	1.48E-12	5.01E-12	NA	--
Indeno(1,2,3-cd)pyrene	0.385	1.00	2.68E-10	2.26E-10	NA	--	--	2.30E-11	9.69E-12	3.27E-11	7.3E-01	2.39E-11
Benzo(a)pyrene	0.48	1.00	3.34E-10	2.82E-10	NA	--	--	2.87E-11	1.21E-11	4.07E-11	7.3E+00	2.97E-10
Benzo(b)fluoranthene	0.66	1.00	4.60E-10	3.87E-10	NA	--	--	3.94E-11	1.66E-11	5.60E-11	7.3E-01	4.09E-11
Acenaphthylene	0.107	1.00	7.45E-11	6.28E-11	6.0E-02	1.24E-09	1.05E-09	6.39E-12	2.69E-12	9.08E-12	NA	--
Dibenz(a,h)anthracene	0.087	1.00	6.06E-11	5.11E-11	NA	--	--	5.19E-12	2.19E-12	7.38E-12	7.3E+00	5.39E-11
Benz(a)anthracene	0.405	1.00	2.82E-10	2.38E-10	NA	--	--	2.42E-11	1.02E-11	3.44E-11	7.3E-01	2.51E-11
Arsenic	9.5	1.00	6.62E-09	5.58E-09	3.0E-04	2.21E-05	1.86E-05	5.67E-10	2.39E-10	8.06E-10	1.5E+00	1.21E-09
Vanadium	17.85	1.00	1.24E-08	1.05E-08	7.0E-05	1.78E-04	1.50E-04	1.07E-09	4.49E-10	1.51E-09	NA	--
TEQ mammal	0.00009397	0.30	1.96E-14	1.66E-14	NA	--	--	1.68E-15	7.09E-16	2.39E-15	1.5E+05	3.59E-10
Totals					**HI:**	**2.12E-04**	**1.78E-04**					**2.31E-09**

Table A-A.8. Calculation of Dermal Exposures and Risks for Adolescent Teenager and Adult Visitors to the Assapumpsett Brook Floodplain Soils

Receptor:	Visitor
Age:	Adolescent Teenager (13-18); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	Assapumpset Brook Area
Exposure Pathway:	Dermal Contact
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Adolescent CTE	Adolescent RME	Adult CTE	Adult RME	Units
Unit conversion factor	CF	1.0E-06	1.0E-06	1.0E-06	1.0E-06	kg/mg
Adherence factor	AF	0.01	0.07	0.01	0.07	mg/cm^2-day
Exposure frequency	EF	3	12	3	12	day/yr
Exposure duration	ED	6	6	3	24	yr
Surface Area	SA	1297	2274	1306	2479	cm^2
Averaging time - noncancer	ATn	2190	2190	1095	8760	day
Averaging time - cancer	ATc	25550	25550	25550	25550	day
Body weight	BW	59	59	70	70	kg
DAD intake factor	**DADif**	**1.81E-09**	**8.87E-08**	**1.53E-09**	**8.16E-08**	**1/day**
LDAD intake factor	**LDADif**	**1.55E-10**	**7.60E-09**	**6.57E-11**	**2.79E-08**	**1/day**

Equations for Risk Calculations

Non-Cancer

DADif = CF x AF x F_S x EF x ED x SA / (ATn x BW)

DAD = Csoil x ABSd x DADif

HQ = DAD / RfD

HI = Sum($HQcopc_n$ + $HQcopc_n$...)

Cancer

LDADif = CF x AF x F_S x EF x ED x SA / (ATc x BW)

LDAD = LDADif x Csoil x ABSd

Total LDAD = LDADchild + LDADadolescent + LDADadult

CR = Total LDAD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Max) (mg/kg)	ABSd (unitless)	DAD - RME (mg/kg-day) Adolescent	DAD - RME (mg/kg-day) Adult	Chronic Dermal RfD (mg/kg-day)	HQ- RME (unitless) Adolescent	HQ- RME (unitless) Adult	LDAD - RME (mg/kg-day) Adolescent	LDAD - RME (mg/kg-day) Adult	LDAD - RME (mg/kg-day) Total LDAD	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR_{total} RME (unitless)
alpha-Chlordane	0.0064	0.04	2.27E-11	2.09E-11	5.0E-04	4.54E-08	4.17E-08	1.95E-12	7.15E-12	9.10E-12	3.5E-01	3.18E-12
gamma-Chlordane	0.013	0.04	4.61E-11	4.24E-11	5.0E-04	9.22E-08	8.48E-08	3.95E-12	1.45E-11	1.85E-11	3.5E-01	6.47E-12
Endosulfan Sulfate	0.0023	0.10	2.04E-11	1.87E-11	6.0E-03	3.40E-09	3.12E-09	1.75E-12	6.43E-12	8.18E-12	NA	--
Chlordane	0.064	0.04	2.27E-10	2.09E-10	5.0E-04	4.54E-07	4.17E-07	1.95E-11	7.15E-11	9.10E-11	3.5E-01	3.18E-11
Aroclor 1260	0.28	0.14	3.48E-09	3.19E-09	2.0E-05	1.74E-04	1.60E-04	2.98E-10	1.10E-09	1.39E-09	2.0E+00	2.79E-09
Endrin Aldehyde	0.0016	0.10	1.42E-11	1.30E-11	3.0E-05	4.73E-07	4.35E-07	1.22E-12	4.47E-12	5.69E-12	1.7E+01	9.67E-11
Aroclor 1254	0.25	0.14	3.10E-09	2.85E-09	2.0E-05	1.55E-04	1.43E-04	2.66E-10	9.78E-10	1.24E-09	2.0E+00	2.49E-09
Carbazole	0.053	0.10	4.70E-10	4.32E-10	NA	--	--	4.03E-11	1.48E-10	1.88E-10	2.0E-02	3.77E-12
Benzo(g,h,i)perylene	0.51	0.13	5.88E-09	5.40E-09	NA	--	--	5.04E-10	1.85E-09	2.36E-09	7.3E+00	1.72E-08
Phenanthrene	0.57	0.13	6.57E-09	6.04E-09	3.0E-01	2.19E-08	2.01E-08	5.63E-10	2.07E-09	2.63E-09	NA	--
Dimethyl Phthalate	0.07	0.10	6.21E-10	5.71E-10	8.0E-01	7.76E-10	7.13E-10	5.32E-11	1.96E-10	2.49E-10	NA	--
Indeno(1,2,3-cd)pyrene	0.53	0.13	6.11E-09	5.62E-09	NA	--	--	5.24E-10	1.93E-09	2.45E-09	7.3E-01	1.79E-09
Benzo(a)pyrene	0.67	0.13	7.73E-09	7.10E-09	NA	--	--	6.62E-10	2.43E-09	3.10E-09	7.3E+00	2.26E-08
Benzo(b)fluoranthene	0.91	0.13	1.05E-08	9.64E-09	NA	--	--	8.99E-10	3.31E-09	4.21E-09	7.3E-01	3.07E-09
Acenaphthylene	0.14	0.13	1.61E-09	1.48E-09	6.0E-02	2.69E-08	2.47E-08	1.38E-10	5.09E-10	6.47E-10	NA	--
Dibenz(a,h)anthracene	0.12	0.13	1.38E-09	1.27E-09	NA	--	--	1.19E-10	4.36E-10	5.55E-10	7.3E+00	4.05E-09
Benz(a)anthracene	0.59	0.13	6.80E-09	6.25E-09	NA	--	--	5.83E-10	2.14E-09	2.73E-09	7.3E-01	1.99E-09
Arsenic	13.7	0.03	3.65E-08	3.35E-08	3.0E-04	1.22E-04	1.12E-04	3.12E-09	1.15E-08	1.46E-08	1.5E+00	2.19E-08
Vanadium	22.8	0.01	2.02E-08	1.86E-08	1.8E-06	1.11E-02	1.02E-02	1.73E-09	6.37E-09	8.10E-09	NA	--
TEQ mammal	0.0001392	0.03	3.70E-13	3.40E-13	NA	--	--	3.17E-14	1.17E-13	1.48E-13	1.5E+05	2.23E-08
Total					HI:	**1.16E-02**	**1.06E-02**					**1.00E-07**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Mean) (mg/kg)	ABSd (unitless)	DAD - CTE (mg/kg-day) Adolescent	DAD - CTE (mg/kg-day) Adult	Chronic Dermal RfD (mg/kg-day)	HQ- CTE (unitless) Adolescent	HQ- CTE (unitless) Adult	LDAD - CTE (mg/kg-day) Adolescent	LDAD - CTE (mg/kg-day) Adult	LDAD - CTE (mg/kg-day) Total LDAD	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR_{total} CTE (unitless)
alpha-Chlordane	0.0046	0.04	3.32E-13	2.82E-13	5.0E-04	6.65E-10	5.64E-10	2.85E-14	1.21E-14	4.06E-14	3.5E-01	1.42E-14
gamma-Chlordane	0.00875	0.04	6.32E-13	5.37E-13	5.0E-04	1.26E-09	1.07E-09	5.42E-14	2.30E-14	7.72E-14	3.5E-01	2.70E-14
Endosulfan Sulfate	0.001178	0.10	2.13E-13	1.81E-13	6.0E-03	3.55E-11	3.01E-11	1.82E-14	7.74E-15	2.60E-14	NA	--
Chlordane	0.053	0.04	3.83E-12	3.25E-12	5.0E-04	7.66E-09	6.50E-09	3.28E-13	1.39E-13	4.68E-13	3.5E-01	1.64E-13
Aroclor 1260	0.186	0.14	4.70E-11	3.99E-11	2.0E-05	2.35E-06	2.00E-06	4.03E-12	1.71E-12	5.74E-12	2.0E+00	1.15E-11
Endrin Aldehyde	0.001003	0.10	1.81E-13	1.54E-13	3.0E-05	6.04E-09	5.13E-09	1.55E-14	6.59E-15	2.21E-14	1.7E+01	3.76E-13
Aroclor 1254	0.1505	0.14	3.81E-11	3.23E-11	2.0E-05	1.90E-06	1.62E-06	3.26E-12	1.38E-12	4.65E-12	2.0E+00	9.30E-12
Carbazole	0.0405	0.10	7.32E-12	6.21E-12	NA	--	--	6.27E-13	2.66E-13	8.93E-13	2.0E-02	1.79E-14
Benzo(g,h,i)perylene	0.385	0.13	9.04E-11	7.67E-11	NA	--	--	7.75E-12	3.29E-12	1.10E-11	7.3E+00	8.06E-11
Phenanthrene	0.37	0.13	8.69E-11	7.38E-11	3.0E-01	2.90E-10	2.46E-10	7.45E-12	3.16E-12	1.06E-11	NA	--
Dimethyl Phthalate	0.059	0.10	1.07E-11	9.05E-12	8.0E-01	1.33E-11	1.13E-11	9.14E-13	3.88E-13	1.30E-12	NA	--
Indeno(1,2,3-cd)pyrene	0.385	0.13	9.04E-11	7.67E-11	NA	--	--	7.75E-12	3.29E-12	1.10E-11	7.3E-01	8.06E-12
Benzo(a)pyrene	0.48	0.13	1.13E-10	9.57E-11	NA	--	--	9.66E-12	4.10E-12	1.38E-11	7.3E+00	1.00E-10
Benzo(b)fluoranthene	0.66	0.13	1.55E-10	1.32E-10	NA	--	--	1.33E-11	5.64E-12	1.89E-11	7.3E-01	1.38E-11
Acenaphthylene	0.107	0.13	2.51E-11	2.13E-11	6.0E-02	4.19E-10	3.56E-10	2.15E-12	9.14E-13	3.07E-12	NA	--
Dibenz(a,h)anthracene	0.087	0.13	2.04E-11	1.73E-11	NA	--	--	1.75E-12	7.43E-13	2.49E-12	7.3E+00	1.82E-11
Benz(a)anthracene	0.405	0.13	9.51E-11	8.07E-11	NA	--	--	8.15E-12	3.46E-12	1.16E-11	7.3E-01	8.48E-12
Arsenic	9.5	0.03	5.15E-10	4.37E-10	3.0E-04	1.72E-06	1.46E-06	4.41E-11	1.87E-11	6.29E-11	1.5E+00	9.43E-11
Vanadium	17.85	0.01	3.23E-10	2.74E-10	1.8E-06	1.77E-04	1.50E-04	2.76E-11	1.17E-11	3.94E-11	NA	--
TEQ mammal	0.00009397	0.03	5.09E-15	4.32E-15	NA	--	--	4.37E-16	1.85E-16	6.22E-16	1.5E+05	9.33E-11
Totals					HI:	**1.83E-04**	**1.55E-04**					**4.39E-10**

Table A-A.9. Calculation of Ingestion Exposures and Risks for Adolescent Teenager and Adult Visitors to the Southeast Lyman Mill Pond Floodplain Soils

Receptor:	Visitor
Age:	Adolescent Teenager (13-18); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	SE Lyman Mill Pond Area
Exposure Pathway:	Ingestion
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Adolescent CTE	Adolescent RME	Adult CTE	Adult RME	Units
Soil ingestion rate	IR	10	50	10	50	mg/day
Fraction soil ingested from Site	F_S	0.5	0.5	0.5	0.5	unitless
Exposure frequency	EF	3	12	3	12	day/yr
Exposure duration	ED	6	6	3	24	yr
Averaging time - noncancer	ATn	2190	2190	1095	8760	day
Averaging time - cancer	ATc	25550	25550	25550	25550	day
Body weight	BW	59	59	70	70	kg
Unit conversion factor	CF	1.00E-06	1.00E-06	1.00E-06	1.00E-06	kg/mg
ADD intake factor	**ADDif**	**7.0E-10**	**1.4E-08**	**5.9E-10**	**1.2E-08**	**1/day**
LADD intake factor	**LADDif**	**6.0E-11**	**1.2E-09**	**2.5E-11**	**4.0E-09**	**1/day**

Equations for Risk Calculations

Non-Cancer

ADDif = IR x F_S x EF x ED x CF/ (ATn x BW)

ADD = Csoil x RBA x ADDif

HQ = ADD / RfD

HI = Sum($HQcopc_n$ + $HQcopc_i$...)

Cancer

LADDif = IR x F_S x EF x ED x CF/ (ATc x BW)

LADD = Csoil x RBA x LADDif

Total LADD = LADDchild + LADDadolescent + LADDadult

CR = Total LADD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Max) (mg/kg)	RBA (unitless)	ADD - RME (mg/kg-day) Adolescent	ADD - RME (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- RME (unitless) Adolescent	HQ- RME (unitless) Adult	LADD - RME (mg/kg-day) Adolescent	LADD - RME (mg/kg-day) Adult	LADD - RME (mg/kg-day) Total LADD	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR RME (unitless)
alpha-Chlordane	0.00032	1.00	4.46E-12	3.76E-12	5.0E-04	8.92E-09	7.51E-09	3.82E-13	1.29E-12	1.67E-12	3.5E-01	5.85E-13
gamma-Chlordane	0.00028	1.00	3.90E-12	3.29E-12	5.0E-04	7.80E-09	6.58E-09	3.34E-13	1.13E-12	1.46E-12	3.5E-01	5.12E-13
Chlordane	0.0058	1.00	8.08E-11	6.81E-11	5.0E-04	1.62E-07	1.36E-07	6.93E-12	2.33E-11	3.03E-11	3.5E-01	1.06E-11
Endosulfan Sulfate	0.0012	1.00	1.67E-11	1.41E-11	6.0E-03	2.79E-09	2.35E-09	1.43E-12	4.83E-12	6.26E-12	NA	--
Carbazole	0.049	1.00	6.83E-10	5.75E-10	NA	--	--	5.85E-11	1.97E-10	2.56E-10	2.0E-02	5.12E-12
Benz(a)anthracene	0.3	1.00	4.18E-09	3.52E-09	NA	--	--	3.58E-10	1.21E-09	1.57E-09	7.3E-01	1.14E-09
Dibenz(a,h)anthracene	0.079	1.00	1.10E-09	9.28E-10	NA	--	--	9.43E-11	3.18E-10	4.12E-10	7.3E+00	3.01E-09
Benzo(a)pyrene	0.41	1.00	5.71E-09	4.81E-09	NA	--	--	4.90E-10	1.65E-09	2.14E-09	7.3E+00	1.56E-08
Phenanthrene	0.37	1.00	5.15E-09	4.34E-09	3.0E-01	1.72E-08	1.45E-08	4.42E-10	1.49E-09	1.93E-09	NA	--
Benzo(g,h,i)perylene	0.35	1.00	4.88E-09	4.11E-09	NA	--	--	4.18E-10	1.41E-09	1.83E-09	7.3E+00	1.33E-08
Indeno(1,2,3-cd)pyrene	0.37	1.00	5.15E-09	4.34E-09	NA	--	--	4.42E-10	1.49E-09	1.93E-09	7.3E-01	1.41E-09
Benzo(b)fluoranthene	0.58	1.00	8.08E-09	6.81E-09	NA	--	--	6.93E-10	2.33E-09	3.03E-09	7.3E-01	2.21E-09
Acenaphthylene	0.24	1.00	3.34E-09	2.82E-09	6.0E-02	5.57E-08	4.70E-08	2.87E-10	9.66E-10	1.25E-09	NA	--
Dimethyl Phthalate	0.028	1.00	3.90E-10	3.29E-10	8.0E-01	4.88E-10	4.11E-10	3.34E-11	1.13E-10	1.46E-10	NA	--
Arsenic	6.3	1.00	8.78E-08	7.40E-08	3.0E-04	2.93E-04	2.47E-04	7.52E-09	2.54E-08	3.29E-08	1.5E+00	4.93E-08
Vanadium	13.5	1.00	1.88E-07	1.59E-07	7.0E-05	2.69E-03	2.26E-03	1.61E-08	5.43E-08	7.05E-08	NA	--
TEQ mammal	0.00001496	0.30	6.25E-14	5.27E-14	NA	--	--	5.36E-15	1.81E-14	2.34E-14	1.5E+05	3.51E-09
Totals					**HI:**	**2.98E-03**	**2.51E-03**					**8.96E-08**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Mean) (mg/kg)	RBA (unitless)	ADD - CTE (mg/kg-day) Adolescent	ADD - CTE (mg/kg-day) Adult	Chronic Oral RfD (mg/kg-day)	HQ- CTE (unitless) Adolescent	HQ- CTE (unitless) Adult	LADD - CTE (mg/kg-day) Adolescent	LADD - CTE (mg/kg-day) Adult	LADD - CTE (mg/kg-day) Total LADD	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR CTE (unitless)
alpha-Chlordane	0.000243	1.00	1.69E-13	1.43E-13	5.0E-04	3.39E-10	2.85E-10	1.45E-14	6.11E-15	2.06E-14	3.5E-01	7.22E-15
gamma-Chlordane	0.000415	1.00	2.89E-13	2.44E-13	5.0E-04	5.78E-10	4.87E-10	2.48E-14	1.04E-14	3.52E-14	3.5E-01	1.23E-14
Chlordane	0.005275	1.00	3.67E-12	3.10E-12	5.0E-04	7.35E-09	6.19E-09	3.15E-13	1.33E-13	4.48E-13	3.5E-01	1.57E-13
Endosulfan Sulfate	0.000628	1.00	4.37E-13	3.69E-13	6.0E-03	7.29E-11	6.14E-11	3.75E-14	1.58E-14	5.33E-14	NA	--
Carbazole	0.02645	1.00	1.84E-11	1.55E-11	NA	--	--	1.58E-12	6.66E-13	2.24E-12	2.0E-02	4.49E-14
Benz(a)anthracene	0.1615	1.00	1.12E-10	9.48E-11	NA	--	--	9.64E-12	4.06E-12	1.37E-11	7.3E-01	1.00E-11
Dibenz(a,h)anthracene	0.0426	1.00	2.97E-11	2.50E-11	NA	--	--	2.54E-12	1.07E-12	3.62E-12	7.3E+00	2.64E-11
Benzo(a)pyrene	0.226	1.00	1.57E-10	1.33E-10	NA	--	--	1.35E-11	5.69E-12	1.92E-11	7.3E+00	1.40E-10
Phenanthrene	0.1965	1.00	1.37E-10	1.15E-10	3.0E-01	4.56E-10	3.85E-10	1.17E-11	4.94E-12	1.67E-11	NA	--
Benzo(g,h,i)perylene	0.191	1.00	1.33E-10	1.12E-10	NA	--	--	1.14E-11	4.81E-12	1.62E-11	7.3E+00	1.18E-10
Indeno(1,2,3-cd)pyrene	0.203	1.00	1.41E-10	1.19E-10	NA	--	--	1.21E-11	5.11E-12	1.72E-11	7.3E-01	1.26E-11
Benzo(b)fluoranthene	0.3155	1.00	2.20E-10	1.85E-10	NA	--	--	1.88E-11	7.94E-12	2.68E-11	7.3E-01	1.95E-11
Acenaphthylene	0.128	1.00	8.92E-11	7.51E-11	6.0E-02	1.49E-09	1.25E-09	7.64E-12	3.22E-12	1.09E-11	NA	--
Dimethyl Phthalate	0.01425	1.00	9.93E-12	8.37E-12	8.0E-01	1.24E-11	1.05E-11	8.51E-13	3.59E-13	1.21E-12	NA	--
Arsenic	6.15	1.00	4.28E-09	3.61E-09	3.0E-04	1.43E-05	1.20E-05	3.67E-10	1.55E-10	5.22E-10	1.5E+00	7.83E-10
Vanadium	10.3	1.00	7.17E-09	6.05E-09	7.0E-05	1.02E-04	8.64E-05	6.15E-10	2.59E-10	8.74E-10	NA	--
TEQ mammal	0.000007778	0.30	1.63E-15	1.37E-15	NA	--	--	1.39E-16	5.87E-17	1.98E-16	1.5E+05	2.97E-11
Totals					**HI:**	**1.17E-04**	**9.84E-05**					**1.14E-09**

Table A-A.10. Calculation of Dermal Exposures and Risks for Adolescent Teenager and Adult Visitors to the Southeast Lyman Pond Floodplain Soils

Receptor:	Visitor
Age:	Adolescent Teenager (13-18); Adult (>18 yrs)
Medium:	Floodplain Soil
Operable Unit	SE Lyman Mill Pond Area
Exposure Pathway:	Dermal Contact
Time Frame:	Current and Future

Exposure Assumptions

Parameter	Abbrev	Adolescent CTE	Adolescent RME	Adult CTE	Adult RME	Units
Unit conversion factor	CF	1.0E-06	1.0E-06	1.0E-06	1.0E-06	kg/mg
Adherence factor	AF	0.01	0.07	0.01	0.07	mg/cm^2-day
Exposure frequency	EF	3	12	3	12	day/yr
Exposure duration	ED	6	6	3	24	yr
Surface Area	SA	1297	2274	1306	2479	cm^2
Averaging time - noncancer	ATn	2190	2190	1095	8760	day
Averaging time - cancer	ATc	25550	25550	25550	25550	day
Body weight	BW	59	59	70	70	kg
DAD intake factor	**DADif**	**1.81E-09**	**8.87E-08**	**1.53E-09**	**8.15E-08**	**1/day**
LDAD intake factor	**LDADif**	**1.55E-10**	**7.60E-09**	**6.57E-11**	**2.79E-08**	**1/day**

Equations for Risk Calculations

Non-Cancer

DADif = CF x AF x F_S x EF x ED x SA / (ATn x BW)

DAD = Csoil x ABSd x DADif

HQ = DAD / RfD

HI = Sum($HQcopc_n$ + $HQcopc_i$,...)

Cancer

LDADif = CF x AF x F_S x EF x ED x SA / (ATc x BW)

LDAD = LDADif x Csoil x ABSd

Total LDAD = LDADchild + LDADadolescent + LDADadult

CR = Total LDAD x SF

RME Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Max) (mg/kg)	ABSd (unitless)	DAD - RME (mg/kg-day) Adolescent	DAD - RME (mg/kg-day) Adult	Chronic Dermal RfD (mg/kg-day)	HQ- RME (unitless) Adolescent	HQ- RME (unitless) Adult	LDAD - RME (mg/kg-day) Adolescent	LDAD - RME (mg/kg-day) Adult	LDAD - RME (mg/kg-day) Total LDAD	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR_{total} RME (unitless)
alpha-Chlordane	0.00032	0.04	1.14E-12	1.04E-12	5.0E-04	2.27E-09	2.09E-09	9.73E-14	3.58E-13	4.55E-13	3.5E-01	1.59E-13
gamma-Chlordane	0.00028	0.04	9.93E-13	9.13E-13	5.0E-04	1.99E-09	1.83E-09	8.52E-14	3.13E-13	3.98E-13	3.5E-01	1.39E-13
Chlordane	0.0058	0.04	2.06E-11	1.89E-11	5.0E-04	4.12E-08	3.78E-08	1.76E-12	6.48E-12	8.25E-12	3.5E-01	2.89E-12
Endosulfan Sulfate	0.0012	0.10	1.06E-11	9.78E-12	6.0E-03	1.77E-09	1.63E-09	9.12E-13	3.35E-12	4.27E-12	NA	--
Carbazole	0.049	0.10	4.35E-10	3.99E-10	NA	--	--	3.73E-11	1.37E-10	1.74E-10	2.0E-02	3.48E-12
Benz(a)anthracene	0.3	0.13	3.46E-09	3.18E-09	NA	--	--	2.97E-10	1.09E-09	1.39E-09	7.3E-01	1.01E-09
Dibenz(a,h)anthracene	0.079	0.13	9.11E-10	8.37E-10	NA	--	--	7.81E-11	2.87E-10	3.65E-10	7.3E+00	2.66E-09
Benzo(a)pyrene	0.41	0.13	4.73E-09	4.34E-09	NA	--	--	4.05E-10	1.49E-09	1.89E-09	7.3E+00	1.38E-08
Phenanthrene	0.37	0.13	4.27E-09	3.92E-09	3.0E-01	1.42E-08	1.31E-08	3.66E-10	1.34E-09	1.71E-09	NA	--
Benzo(g,h,i)perylene	0.35	0.13	4.04E-09	3.71E-09	NA	--	--	3.46E-10	1.27E-09	1.62E-09	7.3E+00	1.18E-08
Indeno(1,2,3-cd)pyrene	0.37	0.13	4.27E-09	3.92E-09	NA	--	--	3.66E-10	1.34E-09	1.71E-09	7.3E-01	1.25E-09
Benzo(b)fluoranthene	0.58	0.13	6.69E-09	6.15E-09	NA	--	--	5.73E-10	2.11E-09	2.68E-09	7.3E-01	1.96E-09
Acenaphthylene	0.24	0.13	2.77E-09	2.54E-09	6.0E-02	4.61E-08	4.24E-08	2.37E-10	8.72E-10	1.11E-09	NA	--
Dimethyl Phthalate	0.028	0.10	2.48E-10	2.28E-10	8.0E-01	3.10E-10	2.85E-10	2.13E-11	7.82E-11	9.95E-11	NA	--
Arsenic	6.3	0.03	1.68E-08	1.54E-08	3.0E-04	5.59E-05	5.13E-05	1.44E-09	5.28E-09	6.72E-09	1.5E+00	1.01E-08
Vanadium	13.5	0.01	1.20E-08	1.10E-08	1.8E-06	6.58E-03	6.05E-03	1.03E-09	3.77E-09	4.80E-09	NA	--
TEQ mammal	0.00001496	0.03	3.98E-14	3.66E-14	NA	--	--	3.41E-15	1.25E-14	1.60E-14	1.5E+05	2.39E-09
Total					**HI:**	**6.64E-03**	**6.10E-03**					**4.50E-08**

CTE Exposure and Risk Calculations

Chemicals of Potential Concern	Csoil (Mean) (mg/kg)	ABSd (unitless)	DAD - CTE (mg/kg-day) Adolescent	DAD - CTE (mg/kg-day) Adult	Chronic Dermal RfD (mg/kg-day)	HQ- CTE (unitless) Adolescent	HQ- CTE (unitless) Adult	LDAD - CTE (mg/kg-day) Adolescent	LDAD - CTE (mg/kg-day) Adult	LDAD - CTE (mg/kg-day) Total LDAD	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	CR_{total} CTE (unitless)
alpha-Chlordane	0.000243	0.04	1.76E-14	1.49E-14	5.0E-04	3.51E-11	2.98E-11	1.51E-15	6.39E-16	2.14E-15	3.5E-01	7.50E-16
gamma-Chlordane	0.000415	0.04	3.00E-14	2.55E-14	5.0E-04	6.00E-11	5.09E-11	2.57E-15	1.09E-15	3.66E-15	3.5E-01	1.28E-15
Chlordane	0.005275	0.04	3.81E-13	3.24E-13	5.0E-04	7.62E-10	6.47E-10	3.27E-14	1.39E-14	4.65E-14	3.5E-01	1.63E-14
Endosulfan Sulfate	0.000628	0.10	1.13E-13	9.63E-14	6.0E-03	1.89E-11	1.61E-11	9.73E-15	4.13E-15	1.39E-14	NA	--
Carbazole	0.02645	0.10	4.78E-12	4.06E-12	NA	--	--	4.10E-13	1.74E-13	5.83E-13	2.0E-02	1.17E-14
Benz(a)anthracene	0.1615	0.13	3.79E-11	3.22E-11	NA	--	--	3.25E-12	1.38E-12	4.63E-12	7.3E-01	3.38E-12
Dibenz(a,h)anthracene	0.0426	0.13	1.00E-11	8.49E-12	NA	--	--	8.58E-13	3.64E-13	1.22E-12	7.3E+00	8.92E-12
Benzo(a)pyrene	0.226	0.13	5.31E-11	4.51E-11	NA	--	--	4.55E-12	1.93E-12	6.48E-12	7.3E+00	4.73E-11
Phenanthrene	0.1965	0.13	4.62E-11	3.92E-11	3.0E-01	1.54E-10	1.31E-10	3.96E-12	1.68E-12	5.63E-12	NA	--
Benzo(g,h,i)perylene	0.191	0.13	4.49E-11	3.81E-11	NA	--	--	3.85E-12	1.63E-12	5.48E-12	7.3E+00	4.00E-11
Indeno(1,2,3-cd)pyrene	0.203	0.13	4.77E-11	4.05E-11	NA	--	--	4.09E-12	1.73E-12	5.82E-12	7.3E-01	4.25E-12
Benzo(b)fluoranthene	0.3155	0.13	7.41E-11	6.29E-11	NA	--	--	6.35E-12	2.70E-12	9.05E-12	7.3E-01	6.60E-12
Acenaphthylene	0.128	0.13	3.01E-11	2.55E-11	6.0E-02	5.01E-10	4.25E-10	2.58E-12	1.09E-12	3.67E-12	NA	--
Dimethyl Phthalate	0.01425	0.10	2.57E-12	2.19E-12	8.0E-01	3.22E-12	2.73E-12	2.21E-13	9.37E-14	3.14E-13	NA	--
Arsenic	6.15	0.03	3.33E-10	2.83E-10	3.0E-04	1.11E-06	9.43E-07	2.86E-11	1.21E-11	4.07E-11	1.5E+00	6.10E-11
Vanadium	10.3	0.01	1.86E-10	1.58E-10	1.8E-06	1.02E-04	8.68E-05	1.60E-11	6.77E-12	2.27E-11	NA	--
TEQ mammal	0.000007778	0.03	4.22E-16	3.58E-16	NA	--	--	3.61E-17	1.53E-17	5.15E-17	1.5E+05	7.72E-12
Total					**HI:**	**1.03E-04**	**8.77E-05**					**1.79E-10**

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APPENDIX B

Centredale Manor Restoration Project Site
Streamlined Ecological Risk Analysis
Oxbow Area and Lyman Mill Pond
Flood Plain Soils

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Table B-3.14. Calculation of Hazard Quotients: Short-tailed Shrew, Terrestrial Plants, Assapumpset Brook Area

Table B-3.15. Calculation of Hazard Quotients: Short-tailed Shrew, Invertebrate Ingestion, Assapumpset Brook Area

Table B-5.1. Summary of Hazard Quotients Using NOAEL-Based RTVs: Short-tailed Shrew, Oxbow Area

Table B-5.2. Summary of Hazard Quotients Using NOAEL-Based RTVs: Short-tailed Shrew, Northeast Lyman Mill Pond Area

Table B-5.3. Summary of Hazard Quotients Using NOAEL-Based RTVs: Short-tailed Shrew, Southeast Lyman Mill Pond Area

Table B-5.4. Summary of Hazard Quotients Using NOAEL-Based RTVs: Short-tailed Shrew, Assapumpset Brook Area

Table B-5.5. Summary of Hazard Quotients Using LOAEL-Based RTVs: Short-tailed Shrew, Oxbow Area

Table B-5.6. Summary of Hazard Quotients Using LOAEL-Based RTVs: Short-tailed Shrew, Northeast Lyman Mill Pond Area

Table B-5.7. Summary of Hazard Quotients Using LOAEL-Based RTVs: Short-tailed Shrew, Southeast Lyman Mill Pond Area

Table B-5.8. Summary of Hazard Quotients Using LOAEL-Based RTVs: Short-tailed Shrew, Assapumpset Brook Area

Table B-5.9. Incremental Risk Ratio Summary for Short-tailed Shrew - NOAEL- and LOAEL-Based TRVs

ACRONYMS AND ABBREVIATIONS

AE	Assessment endpoint
BERA	baseline ecological risk assessment
BHHRA	baseline human health risk assessment
BSAF	biota-soil accumulation factor
BW	body weight
CBR	Critical body residue
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	conversion factor
CMRP	Centredale Manor Restoration Project
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
ED	exposure duration
EDI	estimated daily intake
EF	exposure frequency
EPC	exposure point concentration
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IR	ingestion rate
LEA	Loureiro Engineering Associates
LOAEL	lowest observable adverse effect level
NOAEL	no observable adverse effect level
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
SFF	site foraging frequency
SVOCs	semi-volatile organic compounds
TCDD	tetrachlorodibenzo-p-dioxin
TEF	toxic equivalency factor

TEQ	toxicity equivalency
TOC	total organic carbon
TRV	toxicity reference value
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

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EXECUTIVE SUMMARY

This streamlined ecological assessment has been prepared using data collected from a supplemental investigation conducted in 2010 of the Centredale Manor Restoration Project Superfund Site (CMRP Site) in North Providence, Rhode Island. The 2010 supplemental sampling program included the collection of soil sampling data from four areas adjacent to the Lyman Mill Reach of the Woonasquatucket River and Lyman Mill Pond. The sampling was conducted for Emhart Industries by Integral Consulting, Inc. (Integral) and Loureiro Engineering Associates (LEA)), in accordance with the Administrative Settlement and Order on Consent for the Centredale Manor Restoration Project Superfund Site, CERCLA Docket Number: 01-2010-0045, as amended (USEPA 2010).

The purpose of this ecological analysis is to provide a focused update of the U.S. Environmental Protection's (USEPA's) 2006 Addendum to the Interim Final Baseline Risk Assessment (BERA): Oxbow Area (Oxbow Addendum) by applying the more robust 2010 soil sampling data to USEPA's risk model for the most sensitive receptor evaluated in the Agency's assessment, the short-tailed shrew.

The four ecological exposure areas evaluated in the streamlined ecological assessment are:

1. flood plain soils within the Oxbow area;
2. flood plain soils in the northeastern portion of Lyman Mill Pond, east of the Oxbow area;
3. the emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond); and
4. the flood plain soil in the southeastern portion of Lyman Mill Pond.

The Oxbow Addendum addressed ecological risk questions concerning potential exposures to contamination in the forested flood plain soils of the Oxbow. USEPA compared estimated exposure to chemicals of potential ecological concern (COPEC) in receptors to critical body residues (CBRs) or toxicity reference values (TRVs). The nature of contamination in the Oxbow area was represented in USEPA's analysis by four soil and three sediment samples, collected in 2004. Of the invertebrate and vermivorous wildlife species modeled by USEPA, the ecological receptor estimated to be most at risk from exposures to TEQ-mammal contamination in Oxbow floodplain soil was the short-tailed shrew.

In this streamlined analysis, exposures and risks were assessed only for the most sensitive receptor in USEPA's analysis. Short-tailed shrew exposures to chemicals of potential ecological concern were estimated to occur through incidental ingestion of surface soil, as well as through dietary consumption of plants and soil-borne invertebrates. With the exception of exposure

point concentrations, which were based on the 2010 sampling data in this analysis, all exposure assumptions and models used by USEPA in the Oxbow Addendum assessment were applied in this assessment.

For each exposure area, hazard quotients were calculated for each COPEC and then summed to provide an area-specific hazard index. As in the USEPA assessment, hazard quotients were estimated using both NOAEL- and LOAEL-based toxicity reference values. The incremental ecological risk above upstream background risk, computed as a ratio of site-specific risk to upstream risk, was also computed for each area. This ratio is termed the "incremental hazard index." For this assessment, the ecological risk to the short-tailed shrew computed for Greystone Mill Pond flood plain soils as presented in the USEPA BERA (1995) were used to represent upstream background. The LOAEL- and NOAEL-based incremental hazard indices for the short-tailed shrew are summarized in Table ES-1.

As shown in Table ES-1, the incremental, LOAEL- and NOAEL- based hazard indices were less than one for the floodplain soil in the southeast Lyman Mill Pond and Assapumpset Brook areas, indicating that these areas are comparable or lower than background and do not pose a significant incremental ecological risk to the short-tailed shrew.

The incremental, LOAEL-based hazard index for the Oxbow area is 1.0, while the NOAEL-based incremental hazard index for the Oxbow area is 1.1. Since the ratios are equal to or nearly equal to 1.0, this demonstrates that the theoretical risk to the short-tailed shrew is not significantly different at the Oxbow area when compared to upstream background, indicating that risks to this area are not significantly elevated in comparison to background. Therefore, no mitigation of risk in this area is required. Nonetheless, limited remediation of the northeastern portion of the Oxbow area may be considered for purposes of reducing the potential for redistribution of surface soil contamination, which, due to the topography of this specific area, receives intermittent floodwaters from the Woonasquatucket River.

The incremental, LOAEL-based hazard index for the flood plain soil in the northeastern portion of Lyman Mill Pond is 2.5 while the NOAEL-based hazard index for this area is 3.8. These ratios are substantially higher than 1.0, suggesting that the theoretical risk to the short-tailed shrew at the northeastern portion of Lyman Mill Pond is significantly different (higher) when compared to upstream background. Consequently, mitigation of risks in this area may be warranted.

B.1 INTRODUCTION

This streamlined ecological risk analysis has been prepared using data collected from a supplemental investigation of the Centredale Manor Restoration Project Superfund Site (CMRP Site) in North Providence, Rhode Island, which included the collection of soil sampling data from four areas adjacent to the Lyman Mill Reach of the Woonasquatucket River and Lyman Mill Pond. The sampling was conducted for Emhart Industries, Inc. (Emhart) by Integral Consulting, Inc. (Integral) and Loureiro Engineering Associates (LEA), in accordance with the Administrative Settlement and Order on Consent for the Centredale Manor Restoration Project Superfund Site, CERCLA Docket Number: 01-2010-0045, as amended (USEPA, 2010).

The four areas sampled in 2010 that are considered in this ecological analysis include:

1. The forested wetland and upland soils in the Oxbow area,
2. The flood plain soils in the northeastern portion of Lyman Mill Pond, east of the Oxbow area,
3. The emergent wetland and flood plain soil at the confluence of Assapumpset Brook and the Woonasquatucket River (western shore of Lyman Mill Pond), and
4. The flood plain soil in the southeastern portion of Lyman Mill Pond.

Figure B-1.1 shows the general location of the area of study for this report, and Figure B-1.2 identifies the above listed areas evaluated herein.

In 2006, the United States Environmental Protection Agency (USEPA) published the Addendum to the Interim Final Baseline Risk Assessment: Oxbow Area (Oxbow Addendum), which included a baseline ecological risk assessment (BERA) for the first area identified above (Oxbow area). USEPA's Oxbow Addendum evaluated ecological risks to soil invertebrates, American woodcock, short-tailed shrew, and raccoon, based on four soil and three sediment samples collected from the Oxbow area in 2004. The Oxbow Addendum focused on a limited portion of the Oxbow area, and did not assess areas 2 through 4 listed above.

In 2006, Emhart submitted comments that noted several deficiencies with USEPA's ecological assessment and conclusions (AMEC 2006). The most significant issue raised by was the paucity of soil sampling data used by USEPA to assess the large area of the Oxbow (AMEC 2006).

As a means of better characterizing the Oxbow area as well as the other flood plain areas identified above (areas 2 through 4), Emhart proposed to conduct a supplemental investigation of the Lyman Mill Reach Stream Sediment and Flood Plain Soils (Integral 2010a). Sampling of the four subject areas was conducted by Integral and LEA in September, October and

November of 2010. The sampling, validation, and assessment of data from the supplemental investigation provided in the subject of the Field Sampling and Data Report: 2010 Supplemental Investigation of the Lyman Mill Reach Sediment and Flood Plain Soils (Integral 2011).

B.1.1 OBJECTIVE

The purpose of this Appendix is to present a streamlined assessment of the potential risks to ecological receptors that utilize the four distinct areas identified above. These ecological exposure areas are shown on Figure A-1.2.

This streamlined analysis evaluates a 'worst-case' ecological receptor, the short-tailed shrew, which is the receptor predicted in the Oxbow Addendum (USEPA 2006) to incur the greatest risks compared to risks computed for invertebrates, vermivorous avian, and omnivorous mammalian populations. Ultimately, the objective of this assessment is to provide worst-case predictions of ecological risks for each of the four exposure areas listed above. The risk estimates computed for these areas are then compared to USEPA's risk estimate for the upstream Greystone Mill Pond area (USEPA 2004). This comparison takes the form of an incremental risk evaluation. The information can then be used to assess the potential need for and scope of any remediation efforts within the study areas.

B.1.2 DOCUMENT ORGANIZATION

The remainder of the streamlined ecological analysis includes the following components:

- Section 2 – Problem Formulation, which includes descriptions of the environmental settings, the selection and characterizations of the compounds of potential ecological concern (COPECs), and the sources and migration of contaminants;
- Section 3 - Exposure Assessment, which characterizes the exposure areas, pathways, and receptors and quantifies the potential exposures to the identified receptors;
- Section 4 - Effects Assessment, which characterizes the contaminant exposure levels that are associated with adverse toxicological effects for the COPECs; and,
- Section 5 – Risk Characterization, which quantifies the relationship between the estimated exposures and the ecological effects to provide risk estimates for the ecological receptors
- Section 6 – Summary of Uncertainties, which presents a description of factors contributing to the uncertainty in the risk estimates presented in Section 5.

B.2 PROBLEM FORMULATION

The problem formulation articulates the major environmental issues of a site and describes the scope and goals of the risk assessment. This section presents the environmental setting and describes how contamination is expected to behave in the study environment, what ecological receptors might be exposed to contamination, what pathways of exposure might exist, and how ecological risks might be measured and assessed.

B.2.1 ENVIRONMENTAL SETTING

This streamlined ecological assessment addresses the Oxbow area flood plain habitats and environs described in Section 2.1, Environmental Setting, of the Oxbow Addendum (USEPA 2006). This assessment also provides a streamlined analysis of ecological risks on the three other flood plain areas of Lyman Mill Reach, Lyman Mill Pond, and Assapumpset Brook, as described in Section B.1. Though smaller in size, these three additional flood plain areas share similar habitat features as those found in the Oxbow area. The northeast and southeast Lyman Mill Pond areas from which the flood plain soil samples were taken sport understory and mature tree vegetation (birch, dogwood, willow, and red maple species) established in soil terrain similar to that found in the forested wetland portions of the Oxbow area. In the Assapumpset Brook area, sample station SS_G-31 is located in a similar setting as described for the northeast Lyman Mill Pond area, while sample station SS_G-32 is located in a fringe palustrine emergent wetland area, dominated by grass and weed species.

B.2.2 SOURCES AND MIGRATION OF CONTAMINANTS

COPECs present in the areas evaluated may have been introduced to the environment from releases that occurred upstream of the study area. These releases may have resulted in contamination of the Woonasquatucket River surface water and sediment under non-flood conditions. During high flow events, COPECs may have been carried by suspended solids in the water column to the Lyman Mill Reach flood plain, including the Oxbow area; the northeastern portion of Lyman Mill Pond; and, to a much lesser extent, the flood plain at the confluence of Assapumpset Brook and the Woonasquatucket River. Water turbulence in the flood plain is reduced, which may allow the suspended solids to settle onto the flood plain soil.

Another source of COPECs to the study area may be the partial breaches of Allendale Dam in 1991 and 2001, which may have resulted in contaminated sediment transport and deposition to the subject area in a manner consistent with that described above. It is also possible that contaminants were transported on suspended particles via Lyman Mill Pond flood backwater, with subsequent deposition onto the soil surface.

For certain areas, contaminants may have been placed along with the placement of fill. Evidence of fill was noted near samples SS_G-10, SS_G-12, and SS_G-13.

Contaminants in the Assapumpset Brook flood plain soil may have been transported to this area from the Assapumpset Brook watershed via historic releases of contaminants to this brook and/or secondary releases during Assapumpset Brook flood events.

COPECs adsorbed to particles that may have settled out might have resulted in the contamination of the soil and sediment, as described in the 2010 supplemental investigation report (Integral 2011).

A description of the samples collected and data generated for the flood plain areas evaluated in this analysis are described in Sections 4 and 7 of Integral (2011).

B.2.3 POTENTIAL ECOLOGICAL RECEPTORS

Soil-borne invertebrates (e.g., earthworms) and wildlife species that prey on them could be exposed to contaminants in floodplain soil directly, or by consuming contaminated prey and vegetation. The Oxbow Addendum evaluated a range of potential ecological receptor species, including flood plain invertebrates, amphibians, birds, and omnivorous and vermivorous terrestrial mammals (USEPA 2006). The Oxbow Addendum also considered exposures to wildlife through ingestion of terrestrial plants. However, potential risks to the plants themselves were considered to be of secondary concern, and were not assessed.

This streamlined ecological analysis considers and evaluates exposures and risks to the most sensitive of the species assessed in the Oxbow Addendum, the vermivorous short-tailed shrew.

B.2.4 ECOLOGICAL EXPOSURE PATHWAYS

Ecological receptors may be exposed to site-related contaminants through several 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 (e.g., soil, water) or indirectly through prey consumption. USEPA evaluated exposure pathways for receptors representing a range of trophic levels: direct contact with flood plain 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. Because the objective of this streamlined analysis is to update estimated risks for the most sensitive receptor, the only exposure pathways included in this analysis are the incidental ingestion of soil, and the consumption of plants and invertebrates by the short-tailed shrew.

B.2.5 SUMMARY OF DATA

This assessment relies on data collected during the 2010 supplemental investigation. In addition to providing data on specific areas under investigation that could plausibly be visited by human users, the majority of the soil sample stations for this investigation were located randomly within the four sub-areas described above to provide general soil contaminant characterizations where no, or limited, data had been available previously. The 2010 supplemental investigation resulted in the collection of surface soil samples at 38 locations, which provides a reasonable assessment of the extent of soil contamination within the areas being evaluated in this ecological analysis (Integral 2011).

Data from previous investigations are inadequate for a comprehensive assessment of potential ecological risks because they are available only for very limited portions of the Oxbow area and do not address three of the four areas being evaluated. Though some data have been collected in the Oxbow during previous investigations, the depth of these samples (0-0.5′) does not allow the full potential depth range for earthworms and shrews (0-2′) (USEPA, 2006). In addition, the analytical parameters evaluated in previously collected samples differ by sample, limiting the comparability of the data.

Given that the data collected in 2010 cover all four exposure areas of interest, are spatially more robust than previously collected data, are representative of the 0-1′ surface soil interval at all locations and 0-2′ at a subset of locations, and are uniform in terms of the analyses conducted on those samples, this streamlined ecological analysis relies on the 2010 surface soil sampling data.

A summary of the surface soil sampling data for the exposure areas is provided in Section 7 of the 2010 supplemental investigation report (Integral 2011).

B.2.6 CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN (COPEC) SELECTION

This section describes the selection of ecological risk contaminants of potential concern (COPECs) for surface soil. The purpose of the COPEC selection process is to focus the analysis on the chemicals that most contribute to potential ecological risks. The selection of a chemical as a COPEC is not limited to whether that chemical is related to the historical operations of the Site; rather, it is based on evidence of its presence in an environmental medium that may be a source of exposure. As noted above, COPECs were identified based on the chemical data set from the 2010 supplemental investigation. COPECs were selected for each of the four exposure areas evaluated in this streamlined assessment.

Tables B-2.1 through B-2.4 present the minimum, maximum and mean concentrations, as well as detection frequencies, reported for each analyte detected at least once within the top two feet

of floodplain soils in each area. COPECs were identified for each area based on comparisons of the maximum detected concentrations reported for the soil samples in each area to the risk-based screening concentrations reported in Table D-3 of the BERA (USEPA, 2004). All analytes with maximum concentrations exceeding screening benchmark concentrations were retained as COPECs to estimate total area-specific risks.

The exception to this approach was the selection of dioxin and furan congeners. Individual dioxin and furan congeners and homologue groups were not retained as COPECs in any area. Rather, exposures and risks to these compounds were assessed based on the mammalian toxic equivalency (TEQ – mammal) approach. For this analysis, background concentrations were not considered in the selection of COPECs.

COPECs selected for evaluation in this screening level ecological assessment are presented in Table B-2.5. COPECs at each area include metals, pesticides, PCBs (Aroclors), semi-volatile compounds (SVOCs), and dioxins and furans. With the exception of SVOCs, the COPECs evaluated in this assessment are comparable to those identified in USEPA's Oxbow ecological addendum (USEPA 2006).

B.2.7 ASSESSMENT AND MEASUREMENT ENDPOINTS

Assessment endpoints (AEs) are explicit expressions of actual environmental values (i.e., ecological resources) that are to be protected at the site (USEPA 1997). Adverse effects on these ecological resources could manifest impairment to overall ecosystem function, an outcome that is of direct concern to risk management activities and decisions. AEs are used to focus the risk assessment on the particular components of an ecosystem that might be more affected by site-related contamination when compared to background conditions. As discussed below, the AEs selected by USEPA to support the objectives of the Oxbow Addendum, this streamlined analysis focuses solely on a higher trophic-level AE, the maintenance of vermivorous mammal populations consistent with background.

Measurement endpoints are quantifiable ecological characteristics that, to the extent possible, are linked to the valued characteristic chosen as the assessment endpoint (USEPA, 1997). Measurement endpoints are used to derive quantitative estimates of potential effects; these quantifications form the foundation for extrapolation to assessment endpoint evaluations.

The AE chosen for evaluation in this streamlined assessment is the maintenance of vermivorous mammal populations consistent with background. This analysis is designed to determine if doses of COPECs ingested by vermivorous wildlife, as represented by the short-tailed shrew, will exceed potential risks that are greater than those to shrews in background environs (e.g., Greystone Mill). The measurement endpoint applied to evaluate incremental risk to this endpoint receptor is the comparison of potential ecological risks at the four study areas with

risks from upstream areas (incremental risk) based on estimated ingestion doses in vermivorous wildlife with toxicity risk values (TRVs).

B.3 EXPOSURE ASSESSMENT

The exposure assessment provides a characterization of the relevant exposure areas, exposure pathways, and receptors, leading to the estimation of potential contaminant exposures. Four exposure areas were evaluated in this analysis, including the general Oxbow area, the Northeast Lyman Mill Pond flood plain area, the floodplain soils and emergent wetland at the confluence of the Assapumpset and Woonasquatucket Rivers, and the floodplain soils of the Southeastern portion of Lyman Mill Pond. The exposure assessment provided by USEPA for the upstream background area (Greystone Mill Pond) was not updated in this analysis, but is applied in the Risk Characterization to provide a comparison of site- versus non-site-related ecological risks.

B.3.1 EXPOSURE POINT CONCENTRATIONS

Exposure point concentrations (EPCs) for the Oxbow and Northeast Lyman Mill Pond flood plain areas were based on the arithmetic averages of each analytical parameter detected in the flood plain soils in the surface to 2-foot horizon. Thirty four soil samples were taken from the 0 – 1′ and 1 - 2′ depths in the Oxbow flood plain soils and six soil samples were taken from the same depths in the Northeast Lyman Mill Pond flood plain soils.

For the calculation of the mean concentrations in this analysis, sampling results that were reported as 'non-detect' were assigned concentration values of one half the analytical detection limit. The maximum concentrations of each analytical parameter detected in floodplain soil samples in the Assapumpset Brook and Southeast Lyman Mill Pond areas were selected as the exposure point concentrations for this streamlined analysis. As can be seen in Figure B-1.2, two 0 – 1′ soil samples were taken from each of these areas. The soil EPCs used in this risk analysis are presented in Table B-2.5.

To support the estimation of exposures to the short-tailed shrew through consumption of food, EPCs were also developed for terrestrial plant and terrestrial invertebrates using the bioaccumulation factors (BAFs) and biota soil accumulation factors (BSAFs) presented in the USEPA BERA (USEPA 2004). Specifically, EPCs for terrestrial plant tissue were calculated using the literature-based BAFs reported in Table J-1 of the BERA. Earthworm tissue EPCs were derived using site-derived BSAFs reported in Table J-8 of the BERA or, if BSAFs were unavailable, EPCs for earthworm tissue were derived using literature-based BAFs reported in Table J-1 of the BERA. These BAFs and BSAFs are presented in Table B-2.6 of this Appendix B.

B.3.2 EXPOSURE MODELS AND PARAMETERS

Four potential soil exposure areas were identified for this assessment. For this analysis, it was assumed that short-tail shrew habitat is available in each of these areas and that the exposure

routes and opportunities are the same in each area. Thus, the same exposure models and assumptions are used to estimate short-tailed shrew exposures in each area. Only the EPCs differ between the four exposure area models. The exposure models applied to the shrew analysis by USEPA in the Oxbow ecological risk assessment are consistent with USEPA guidance for ecological risk assessment (USEPA 1997). These same exposure models are adopted in this analysis.

Estimated Daily Intakes (EDIs) of COPECs, expressed as milligrams of contaminant per kilogram body weight ingested on a daily basis (mg/kg-day), were calculated for the short-tailed shrew using the following dose model:

$$EDI = \frac{((EPC_{soil} \times IR_{soil}) + (EPC_{food} \times IR_{food} \times P_{food})) \times SFF \times EF}{BW}$$

where:

EDI	=	Estimated daily intake, the amount of chemical taken in by the receptor (mg chemical per kg body weight per day)
EPC_{soil}	=	Exposure point concentration, the chemical concentration in soil contacted over the exposure period (mg/kg soil)
IR_{soil}	=	Ingestion rate of soil per unit time or event (kg/day)
EPC_{food}	=	Exposure point concentration, the chemical concentration in food ingested over the exposure period (mg/kg earthworm)
IR_{food}	=	Ingestion rate of food per unit time (kg/day)
P_{food}	=	Percent food in diet (unitless)
SFF	=	Site foraging frequency (unitless)
EF	=	Exposure frequency, describes how often exposure occurs (unitless)
BW	=	Body weight, the average body weight over the exposure period (kg)

As described in Section B.3.1., the BAFs and BSAFs applied in USEPA's BERA also were adopted in this analysis to estimate EPCs for terrestrial plants and invertebrate prey species (e.g., earthworm) tissue. Specifically, the following equation was used to estimate COPEC concentrations in plant tissue to evaluate indirect (consumption) exposures to short-tailed shrew:

$$C_{plant} = BAF * C_{soil}$$

where:

C_{plant}	= chemical concentration in terrestrial plant tissue (μg/g – ww)
BAF	= literature-based bioaccumulation factor
C_{soil}	= maximum chemical concentration in floodplain soil (μg/g - dw)

The following equation, which utilizes BSAFs derived from USEPA's study of co-located earthworm tissue and soil sample results at the site, was used to estimate earthworm tissue EPCs for the evaluation of prey consumption exposures:

$$C_{earthworm} = BSAF * C_{soil} * \%lipid / \%TOC$$

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)

If BSAFs were not available for a particular COPEC, then the following equation was used to calculate an earthworm EPC:

$$C_{earthworm} = BAF * C_{soil}$$

where:

C_{plant}	= chemical concentration in terrestrial plant tissue (μg/g – ww)
BAF	= literature-based bioaccumulation factor
C_{soil}	= maximum chemical concentration in floodplain soil (μg/g - dw)

Exposure parameters for the soil, plant, and earthworm ingestion exposure pathways are summarized in Tables B-3.1 through B-3.3, respectively. The short-tailed shrew exposure equations and results for each exposure route (e.g., soil ingestion, consumption of plant tissue, and consumption of earthworms) within each area are presented in Tables B-3.4 through B-3.15.

B.4 EFFECTS ASSESSMENT

The relationship between the dose of COPEC administered or received and the potential incidence of adverse effects in an ecological endpoint receptor is expressed by the toxicity reference value (TRV). The TRVs applied in this assessment to derive hazard estimates, no observed adverse affect levels (NOAELs) and lowest observed adverse effect levels (LOAELs), were adopted from Table D-4 of USEPA BERA (USEPA 2004) and are presented in Table B.2.6.

B.5 RISK CHARACTERIZATION

In the Risk Characterization, the results of the exposure modeling for each COPEC are compared to the NOAEL- and LOAEL-based TRVs for the COPEC to provide risk estimates, which are expressed as hazard quotients (HQs):

$$HQ = EDI / TRV$$

where:

HQ	= hazard quotient (unitless)
EDI	= estimated daily intake (mg/kg-day)
TRV	= toxicity reference value (mg/kg-day)

The NOAEL-based COPEC-specific HQs for each short-tailed shrew exposure route (e.g., soil ingestion, plant consumption, and earthworm consumption), as well as for all exposure routes combined, are presented in Tables B-5.1 though B-5.4. Similarly, the exposure route-specific and exposure routes-combined LOAEL-based HQs for these areas are presented in Attachment B, Tables B-5.5 through B-5.8.

In this analysis, a hazard index (HI) for each exposure area was calculated by summing the HQs for all COPECs assessed for that area. The HI is calculated using the following formula:

$$HI = HQ_1 + HQ_2 + \ldots + HQ_i$$

where:

HI	=	hazard index (unitless)
HQ_i	=	the hazard quotient for the ith COPEC

The area-specific NOAEL-based HIs are presented in Tables B-5.1 through B-5.4 and the LOAEL-based HI's are presented in Tables B-5.5-B-5.8.

In order to determine if the computed HI's differ significantly from background exposure to chemicals, the area-specific risk results are compared to those calculated by USEPA (2004) using the same exposure assumptions for the upriver background Greystone Mill Pond area. Specifically, the area-specific HIs are compared to the HI calculated for the short-tailed shrew at Greystone Mill Pond (upriver background area). This comparison is presented as the ratio of

the HI computed for each area divided by the HI from Greystone Mill Pond. These ratios are presented in Table B-5.9.

The following subsections describe the ecological assessment results for each area. Those COPEC-specific HQs that contribute the most to the total area HI are highlighted and the HIs are compared to those calculated by USEPA (2004) for the Greystone Mill Pond background area.

Oxbow area Flood Plain Soil

Hazard quotients for each exposure route, as well as for all routes combined for the short-tailed shrew in the Oxbow Area habitat were calculated based on comparisons of exposure estimates to NOAEL- and LOAEL-based TRVs and are presented in Tables B-5.1 and B-5.5, respectively.

The NOAEL- and LOAEL-based HI for the Oxbow area flood plain soils is 146 and 16, respectively. These HIs are very comparable to the NOAEL- and LOAEL-based HI for Greystone Mill Pond, which are 130 and 16, respectively. As shown in Table B-5.9, the ratio of NOAEL-based HI between the Oxbow area and Greystone Mill Pond is 1.1, while the LOAEL-based HI ratio is 1.0. Since the ratios are equal to or nearly equal to 1.0, this demonstrates that the theoretical risk to the short-tailed shrew is not significantly different at the Oxbow area when compared to upstream background.

Northeastern Portion of Lyman Mill Pond

Hazard quotient and hazard index estimates for the short-tailed shrew in the Northeast Lyman Mill Pond Area habitat, calculated based on comparisons of exposure estimates to NOAEL- and LOAEL-based TRVs, are presented in Tables B-5.2 and B-5.6, respectively.

The NOAEL- and LOAEL-based HI for the flood plain soil in the northeastern portion of Lyman Mill Pond is 387 and 40, respectively. Table B-5.9 shows that the ratio of NOAEL-based HI between the flood plain soil in the northeastern portion of Lyman Mill Pond and Greystone Mill Pond is 3.0, while the LOAEL-based HI ratio is 2.5. These ratios suggest that the theoretical risk to the short-tailed shrew at the northeastern portion of Lyman Mill Pond is significantly different (higher) when compared to upstream background.

Southeastern Portion of Lyman Mill Pond

Hazard quotient and hazard index estimates for the short-tailed shrew in the southeast Lyman Mill Pond flood plain soils, calculated based on comparisons of exposure estimates to NOAEL- and LOAEL-based TRVs, are presented in Tables B-5.3 and B-5.7.

The NOAEL- and LOAEL-based HI for the flood plain soil in the southeastern portion of Lyman Mill Pond is 51 and 5, respectively. As summarized in Table B-5.9,

the ratio of NOAEL-based HI between the flood plain soil in the southeastern portion of Lyman Mill Pond and Greystone Mill Pond is 0.39, while the LOAEL-based HI ratio is 0.38. These ratios suggest that the theoretical risk to the short-tailed shrew at the southeastern portion of Lyman Mill Pond is lower when compared to upstream background.

Flood Plain soils at the Confluence of Assapumpset Brook

Hazard quotient and hazard index estimates for the short-tailed shrew in the flood plain soils at the confluence of Assapumpset Brook , calculated based on comparisons of exposure estimates to NOAEL- and LOAEL-based TRVs, are presented in Tables B-5.4 and B-5.8.

The NOAEL- and LOAEL-based HI for the flood plain soil in the flood plain soils at the confluence of Assapumpset Brook is 77 and 13, respectively. As shown in Table B-5.9, the ratio of NOAEL-based HI between the flood plain soil in the southeastern portion of Lyman Mill Pond and Greystone Mill Pond is 0.59, while the LOAEL-based HI ratio is 0.81. These ratios suggest that the theoretical risk to the short-tailed shrew at the flood plain soils at the confluence of Assapumpset Brook is lower when compared to upstream background.

B.6 UNCERTAINTY ANALYSIS

This streamlined ecological risk assessment utilized the same point estimate approach to calculate risk as was applied by USEPA in the Oxbow Addendum and the 2004 interim BERA. The method relies on single, fixed input values (i.e., point estimates) to represent exposure and toxicity parameters in the risk assessment equations. The output of this approach is a single value of risk for each exposure pathway within each habitat area.

Point estimates are based on a considerable number of assumptions conservative (overestimates) and do not characterize the variability inherent in population exposures and responses, or the uncertainty associated with the assumptions made (USEPA 1989, 2001). As a result, there is a potentially high degree of uncertainty in the characterization of risk at this Site. In fact, this uncertainty in point estimate risk predictions was demonstrated in the 2004 BERA where the comparison of the results of the deterministic assessment of risks to invertebrates, which predicted an HQ of 120, was compared to the results of the soil invertebrate community study, which found the site invertebrate community health to be comparable to and indistinguishable from upriver background invertebrate community health. Therefore, to place risk estimates in perspective, it is necessary to examine generic and site-specific uncertainties associated with the assessment.

Within many of the steps of the risk assessment process, assumptions are made due to a lack of absolute scientific knowledge concerning needed input. Some of the assumptions are supported by considerable scientific evidence, while others have less support. Every assumption introduces some degree of uncertainty into the risk assessment process. Conservative assumptions are made throughout the risk assessment to ensure that ecological health is protected. Therefore, when all of the assumptions are combined, it is much more likely that actual risks, if any, are overestimated rather than underestimated. The assumptions that introduce the greatest amount of uncertainty in this risk assessment are discussed in the following sections.

B.6.1 UNCERTAINTIES IN THE PROBLEM FORMULATION

During the problem formulation step, benchmark receptors are selected, COPECs are selected for inclusion in the quantitative risk assessment, and spatial boundaries of the exposure area are defined.

B.6.1.1 Uncertainty in the Selection of Receptors of Concern

USEPA's 2006 Oxbow Area Addendum evaluated soil receptor species expected to receive elevated exposures to contaminants that bioaccumulate in Oxbow floodplain habitat. Of the soil invertebrates and omnivorous and vermivorous wildlife assessed by USEPA, the short-

tailed shrew was chosen for evaluation in this streamlined assessment because this receptor reported the highest risk estimates associated with estimated dioxin TEQ mammal exposures modeled by USEPA. No formal census or biological survey was conducted by field staff during the 2010 supplemental investigation, and no other confirmations were made that the short-tailed shrew inhabits the Oxbow or the other three flood plain areas evaluated in this assessment. However, anecdotal observations support the concern that the Oxbow and Lyman Mill Pond floodplain soils that were the subject of the supplemental sampling might remain saturated through large portions of the year, making these areas less-than-suitable for a vibrant shrew community.

Given that the only exposure variables that were changed between USEPA's and this analysis are the COPEC selection and the EPCs, the reanalysis of the most sensitive receptor using the additional data should provide a similarly conservative update to USEPA's prior analysis. Nonetheless, when evaluating the results of this assessment during risk management phases of this project, consideration should be given to the fact that the receptors evaluated in this assessment have not been confirmed to be present or representative of actual study area ecological receptor populations.

B.6.1.2 Uncertainty in the Identification and Selection of COPECs

Uncertainties in the identification and selection of COPECs stem from two areas: 1) the adequacy of the sampling design and data analysis in providing adequate chemical characterization of the media to which receptors might be exposed; and, 2) the adequacy of the toxicological reference values in characterizing exposure concentrations that might result in risks to ecological receptors.

The lateral extent of sampling during the 2010 supplemental investigation vastly improved the adequacy of the characterization over previous investigations. However, a majority of soil sampling locations were characterized for only the 0-1′ interval. This fact introduces uncertainty into the EPCs used in the exposure modeling because the full 0-2′ depth of interest is not fully characterized. However, sampling data strongly suggests that the 1-2′ sampling interval contains lower concentrations of COPECs when compared to the 0-1′ sampling interval. Thus, it is nearly certain that had data from the 1-2′ sampling interval been available, the EPCs used in this assessment would have been lower, which would have led to lower NOAEL- and LOAEL-based HQs. Therefore, the results presented for the four study areas likely overestimate the potential exposure.

Additionally, the number of flood plain soil samples obtained at the southeastern portion of Lyman Mill Pond and at the confluence with Assapumpset Brook does not support the calculation of average estimates, so maximum concentrations were used for EPCs in these areas. These maximum values likely overstate the average exposures that might be encountered by ecological receptors in these areas.

B.6.2 UNCERTAINTIES IN EXPOSURE ASSESSMENT

In Section 4.2 of the Oxbow Addendum, USEPA qualifies the use of the generic exposure models and exposure parameters to characterize actual exposures to Oxbow wildlife populations. All of the exposure parameters adopted in USEPA's models, except for the soil EPCs, are derived from the literature. Inputs such as body weight, ingestion rates of plants, soil and invertebrates, and the plant bioaccumulation potentials of each COPEC in these consumption compartments have no site-specificity. Moreover, the inputs selected by USEPA do not allow for consideration of the substantial variability in the study area populations, or in the environmental fate of the COPECs in study area soils and vegetation. While the application of BSAFs to the determination of COPEC exposures through earthworm consumption does bring site-specificity to this portion of the equations, the most conservative soil organic carbon content was used to calculate these values.

Although USEPA states that the use of literature-derived exposure parameters could result in an under- as well as an over-estimation of typical exposures encountered by the study area receptors, the uncertainty likely results in over-estimating the potential risks.

B.6.3 UNCERTAINTIES IN THE ECOLOGICAL EFFECTS ASSESSMENT

The toxicity values identified by USEPA in the Oxbow Addendum (2006) were adopted in this streamlined ecological risk assessment. As is outlined by USEPA, there are several uncertainties associated with characterizing the potential ecological toxicities of the COPECs through the application of literature- and laboratory-derived toxicity reference values. First, while TRVs for most COPECs are derived from chronic toxicity studies, some (Aroclor 1254, benzo(a)pyrene) have been extrapolated from shorter-termed exposure studies. Often an uncertainty factor is applied to this extrapolation, rendering the derived TRV to be a conservative estimate of toxicity. Similarly, in some ecotoxicity studies NOAELs are not observed and must be derived from LOAEL data. This derivation is accomplished using conservative uncertainty factors. The use of these factors results in overstated toxicity, and subsequently, a finding of ecological risk.

USEPA (2006) also points out that there is uncertainty associated with the extrapolation of literature-based (and, particularly, with laboratory-based) toxicity data to equivalent measurement endpoints for receptors at the Site, given that toxicity study exposure conditions do not mimic field exposure conditions.

B.6.4 UNCERTAINTIES IN THE RISK CHARACTERIZATION

The major area of uncertainty in the risk characterization process is the combination of upper-bound exposure estimates with upper-bound toxicity estimates, resulting in an over-estimation

of risks. As USEPA acknowledges in the Oxbow Addendum (2006), the interpretation of the HQ and HI results requires an understanding of the impact of the multi-layered application of conservative assumptions underlying the risk calculations. Accordingly, HQs greater than one do not indicate that substantial population- or community-level harm is occurring.

Another factor that contributes to over-estimating risk is assuming additivity in calculating HIs. This approach generally is believed to overestimate the potential for ecological impacts due to simultaneous exposure to multiple COPECs. However, given that multiple COPECs might impact different endpoints, the assumed additive effects do not necessarily occur.

B.7 CONCLUSIONS

This streamlined ecological risk analysis provides a focused update of the USEPA's 2006 Addendum to the Interim Final Baseline Risk Assessment: Oxbow Area. Incremental ecological risks associated with contamination in flood plain soils located in four areas adjacent to the Lyman Mill Reach of the Woonasquatucket River and to Lyman Mill Pond were estimated by applying the more robust 2010 soil sampling data to USEPA's risk model for the most sensitive receptor, the short-tailed shrew and comparing results to those from Greystone Mill Pond. The Greystone Mill Pond floodplain soils were used by USEPA (1995) in its BERA to represent upstream background.

In performing the assessment, it was found that potential ecological risks to the short-tailed shrew in the Oxbow area soils and the floodplain soils at the southeastern portion of Lyman Mill Pond and at the confluence with Assapumpset Brook are either lower than or comparable to the potential risks posed by upstream soils at Greystone Mill Pond. Consequently, these study areas do not pose a significant incremental ecological risk to the short-tailed shrew, and no mitigation of risks is required. Nonetheless, limited remediation of the northeastern portion of the Oxbow area may be considered for purposes of reducing the potential for redistribution of surface soil contamination, which, due to the topography of this specific area, receives intermittent floodwaters from the Woonasquatucket River.

The potential ecological risk to short-tailed shrews in flood plain soils in the northeastern portion of Lyman Mill Pond are substantially higher than in Greystone Mill Pond, and risk mitigation may be appropriate.

B.8 REFERENCES

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FIGURES

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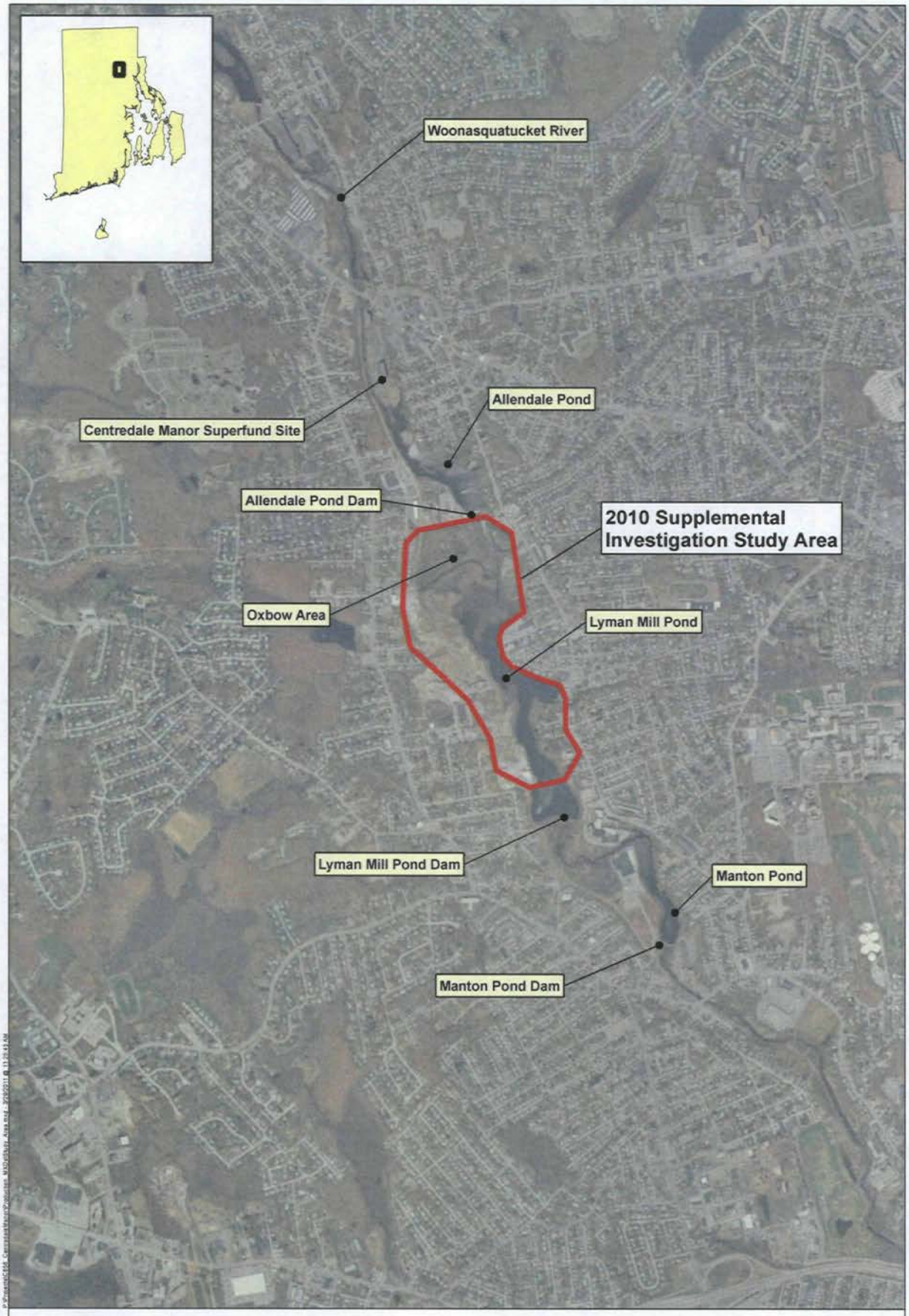

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Figure B-1.1.
2010 Supplemental Investigation Study Area

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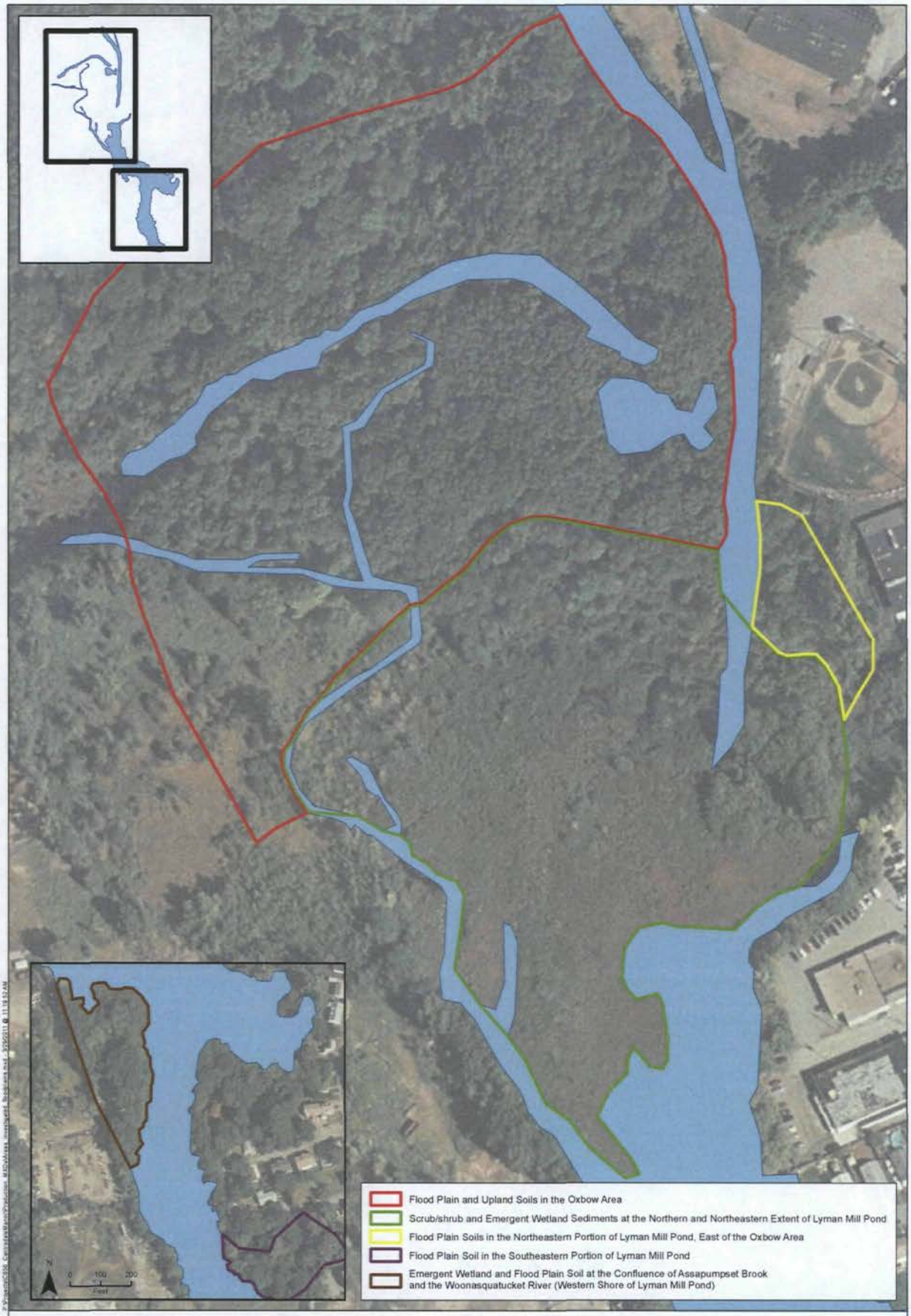

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Figure B-1.2.
Areas Investigated in the 2010 Supplemental Investigation

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TABLES

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Table B-ES-1. Incremental Hazard Index Summary for Short-tailed Shrew - NOAEL- and LOAEL-Based TRVs

	Greystone[a]	General Oxbow		NE Lyman		SE Lyman		Assapumpset Brook	
Hazard Basis	HI	HI	Inc HI	HI	Inc HI	HI	Inc HI	HI	Inc HI
NOAEL-Based	130	146	1.1	387	3.0	51	0.39	77	0.59
LOAEL-Based	16	16	1.0	40	2.5	6	0.38	13	0.81

a. Greystone 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.

Table B-2.1. COPC Screening - Oxbow Exposure Area (0-2' soil)

Parameter	CASNO	Class	Freq of Det	Percent Det	Min Detected	Max Detected	Units	Max Detected (mg/kg)	Soil Screening Benchmark (mg/kg)	Retain as a COPEC?
Aroclor 1254	11097-69-1	PESTP	13/34	38	7.7	570	UG/KG_DRY	0.57	0.092	YES
Endrin Aldehyde	7421-93-4	PESTP	9/34	26	0.23	11	UG/KG_DRY	0.011	0.054	No
4,4'-DDE	72-55-9	PESTP	28/34	82	0.4	14	UG/KG_DRY	0.014	0.0025	YES
4,4'-DDD	72-54-8	PESTP	7/34	21	0.13	3	UG/KG_DRY	0.003	0.0025	YES
Endrin	72-20-8	PESTP	5/34	15	0.25	1.6	UG/KG_DRY	0.0016	0.001	YES
Endosulfan Sulfate	1031-07-8	PESTP	6/34	18	0.28	0.97	UG/KG_DRY	0.00097	0.1	No
Dieldrin	60-57-1	PESTP	11/34	32	0.22	17	UG/KG_DRY	0.017	0.0005	YES
gamma-BHC (Lindane)	58-89-9	PESTP	5/34	15	0.18	2.3	UG/KG_DRY	0.0023	0.00005	YES
Aroclor 1260	11096-82-5	PESTP	5/34	15	62	120	UG/KG_DRY	0.12	0.028	YES
Methoxychlor	72-43-5	PESTP	1/34	3	2.4	2.4	UG/KG_DRY	0.0024	0.1	No
Aroclor 1268	11100-14-4	PESTP	3/34	9	24	38	UG/KG_DRY	0.038	0.028	YES
gamma-Chlordane	5566-34-7	PESTP	23/34	68	0.098	74	UG/KG_DRY	0.074	0.1	No
Endrin Ketone	53494-70-5	PESTP	7/34	21	0.16	2.3	UG/KG_DRY	0.0023	0.1	No
alpha-Chlordane	5103-71-9	PESTP	18/34	53	0.1	85	UG/KG_DRY	0.085	0.1	No
4,4'-DDT	50-29-3	PESTP	29/34	85	0.35	78	UG/KG_DRY	0.078	0.0025	YES
Endosulfan II	33213-65-9	PESTP	2/34	6	0.34	1.7	UG/KG_DRY	0.0017	0.1	No
beta-BHC	319-85-7	PESTP	2/34	6	5.1	5.3	UG/KG_DRY	0.0053	0.001	YES
alpha-BHC	319-84-6	PESTP	5/34	15	0.12	1.5	UG/KG_DRY	0.0015	0.0025	No
Chlordane	57-74-9	PESTP	11/34	32	3.9	570	UG/KG_DRY	0.57	0.1	YES
Heptachlor Epoxide	1024-57-3	PESTP	7/34	21	0.085	11	UG/KG_DRY	0.011	0.043	No
Endosulfan I	959-98-8	PESTP	4/34	12	0.13	2.8	UG/KG_DRY	0.0028	0.1	No
Heptachlor	76-44-8	PESTP	3/34	9	1.3	4.2	UG/KG_DRY	0.0042	0.039	No
Pyrene	129-00-0	OS	34/34	100	13	90000	UG/KG_DRY	90	0.1	YES
Bis(2-ethylhexyl) Phthalate	117-81-7	OS	24/34	71	7.3	850	UG/KG_DRY	0.85	6.8	No
Di-n-octyl Phthalate	117-84-0	OS	1/34	3	62	62	UG/KG_DRY	0.062	58	No
Anthracene	120-12-7	OS	30/34	88	3.7	20000	UG/KG_DRY	20	0.1	YES
Fluorene	86-73-7	OS	26/34	76	1.1	7200	UG/KG_DRY	7.2	30	No
Dibenz(a,h)anthracene	53-70-3	OS	28/34	82	2.2	7300	UG/KG_DRY	7.3	0.0041	YES
Carbazole	86-74-8	OS	31/34	91	1.4	6800	UG/KG_DRY	6.8	61	No
2,4-Dinitrotoluene	121-14-2	OS	1/34	3	34	34	UG/KG_DRY	0.034	0.1	No
2,4,6-Trichlorophenol	88-06-2	OS	1/34	3	5.2	5.2	UG/KG_DRY	0.0052	5.1	No
Benzo(a)pyrene	50-32-8	OS	28/34	82	7	52000	UG/KG_DRY	52	0.021	YES
Butyl Benzyl Phthalate	85-68-7	OS	28/34	82	3.7	230	UG/KG_DRY	0.23	5.8	No
2-Methylnaphthalene	91-57-6	OS	10/34	29	2.5	1900	UG/KG_DRY	1.9	47	No

Table B-2.1. COPC Screening - Oxbow Exposure Area (0-2' soil)

Parameter	CASNO	Class	Freq of Det	Percent Det	Min Detected	Max Detected	Units	Max Detected (mg/kg)	Soil Screening Benchmark (mg/kg)	Retain as a COPEC?
Nitrobenzene	98-95-3	OS	4/34	12	16	3500	UG/KG_DRY	3.5	13	No
Dimethyl Phthalate	131-11-3	OS	13/34	38	30	160	UG/KG_DRY	0.16	5.8	No
Dibenzofuran	132-64-9	OS	17/34	50	1.3	4100	UG/KG_DRY	4.1	43	No
Benzo(g,h,i)perylene	191-24-2	OS	34/34	100	6.1	25000	UG/KG_DRY	25	1.3	YES
Indeno(1,2,3-cd)pyrene	193-39-5	OS	34/34	100	5.7	30000	UG/KG_DRY	30	0.0021	YES
Benzo(b)fluoranthene	205-99-2	OS	34/34	100	9.8	50000	UG/KG_DRY	50	0.0015	YES
Biphenyl	92-52-4	OS	2/34	6	2.4	430	UG/KG_DRY	0.43	6	No
Fluoranthene	206-44-0	OS	34/34	100	12	100000	UG/KG_DRY	100	0.1	YES
2,4,5-Trichlorophenol	95-95-4	OS	5/34	15	1.6	25	UG/KG_DRY	0.025	5.1	No
Benzo(k)fluoranthene	207-08-9	OS	34/34	100	4	19000	UG/KG_DRY	19	0.0015	YES
Chrysene	218-01-9	OS	34/34	100	6.4	52000	UG/KG_DRY	52	0.0021	YES
Naphthalene	91-20-3	OS	16/34	47	2.6	3800	UG/KG_DRY	3.8	No Bmark	YES
Acenaphthylene	208-96-8	OS	34/34	100	1.2	3600	UG/KG_DRY	3.6	47	No
Benzyl Alcohol	100-51-6	OS	10/34	29	3	58	UG/KG_DRY	0.058	0.71	No
Benz(a)anthracene	56-55-3	OS	34/34	100	5.6	52000	UG/KG_DRY	52	0.0082	YES
Benzaldehyde	100-52-7	OS	7/34	21	8.7	18	UG/KG_DRY	0.018	4.6	No
Benzoic Acid	65-85-0	OS	10/34	29	110	800	UG/KG_DRY	0.8	86	No
Phenol	108-95-2	OS	5/34	15	2.6	33	UG/KG_DRY	0.033	30	No
Acenaphthene	83-32-9	OS	17/34	50	1.8	7000	UG/KG_DRY	7	20	No
Diethyl Phthalate	84-66-2	OS	1/34	3	54	54	UG/KG_DRY	0.054	5.8	No
Di-n-butyl Phthalate	84-74-2	OS	3/34	9	8.4	10	UG/KG_DRY	0.01	58	No
Phenanthrene	85-01-8	OS	34/34	100	5.7	67000	UG/KG_DRY	67	0.1	YES
Cadmium	7440-43-9	M	28/34	82	0.04	2.1	MG/KG_DRY	2.1	1.7	YES
Nickel	7440-02-0	M	34/34	100	2	148	MG/KG_DRY	148	53	YES
Barium	7440-39-3	M	34/34	100	12	191	MG/KG_DRY	191	130	YES
Arsenic	7440-38-2	M	34/34	100	1.7	13.3	MG/KG_DRY	13.3	0.22	YES
Antimony	7440-36-0	M	25/34	74	0.12	1.33	MG/KG_DRY	1.33	0.045	YES
Thallium	7440-28-0	M	2/34	6	0.4	0.7	MG/KG_DRY	0.7	0.24	YES
Silver	7440-22-4	M	8/34	24	0.2	0.4	MG/KG_DRY	0.4	38	No
Beryllium	7440-41-7	M	34/34	100	0.24	1.92	MG/KG_DRY	1.92	0.77	YES
Molybdenum	7439-98-7	M	27/34	79	0.4	19.1	MG/KG_DRY	19.1	0.32	YES
Manganese	7439-96-5	M	34/34	100	39.7	2440	MG/KG_DRY	2440	100	YES
Cobalt	7440-48-4	M	34/34	100	0.75	10	MG/KG_DRY	10	0.13	YES
Chromium	7440-47-3	M	34/34	100	3.88	67.4	MG/KG_DRY	67.4	0.4	YES

Table B-2.1. COPC Screening - Oxbow Exposure Area (0-2' soil)

Parameter	CASNO	Class	Freq of Det	Percent Det	Min Detected	Max Detected	Units	Max Detected (mg/kg)	Soil Screening Benchmark (mg/kg)	Retain as a COPEC?
Copper	7440-50-8	M	34/34	100	3.6	151	MG/KG_DRY	151	0.71	YES
Vanadium	7440-62-2	M	34/34	100	11	45.2	MG/KG_DRY	45.2	0.72	YES
Zinc	7440-66-6	M	34/34	100	11.5	354	MG/KG_DRY	354	76	YES
Selenium	7782-49-2	M	33/34	97	0.2	2.2	MG/KG_DRY	2.2	0.34	YES
Lead	7439-92-1	M	34/34	100	9.8	792	MG/KG_DRY	792	20	YES
2,3,7,8-TCDD	1746-01-6	DIOX	34/34	100	0.717	14600	PG/G_DRY	0.0146	0.00000089	YES
1,2,3,7,8,9-HxCDD	19408-74-3	DIOX	24/34	71	0.286	18.2	PG/G_DRY	0.0000182	No Bmark	YES
Total TCDD	41903-57-5	DIOX	34/34	100	3.1	14900	PG/G_DRY	0.0149	No Bmark	YES
1,2,3,7,8,9-HxCDF	72918-21-9	DIOX	13/34	38	0.0653	1.7	PG/G_DRY	0.0000017	No Bmark	YES
1,2,3,4,7,8-HxCDF	70648-26-9	DIOX	33/34	97	0.272	13.6	PG/G_DRY	0.0000136	No Bmark	YES
1,2,3,4,6,7,8-HpCDF	67562-39-4	DIOX	34/34	100	1.54	150	PG/G_DRY	0.00015	No Bmark	YES
2,3,4,6,7,8-HxCDF	60851-34-5	DIOX	32/34	94	0.477	13.9	PG/G_DRY	0.0000139	No Bmark	YES
1,2,3,6,7,8-HxCDD	57653-85-7	DIOX	31/34	91	0.322	23.8	PG/G_DRY	0.0000238	No Bmark	YES
1,2,3,6,7,8-HxCDF	57117-44-9	DIOX	34/34	100	0.182	12	PG/G_DRY	0.000012	No Bmark	YES
1,2,3,7,8-PeCDF	57117-41-6	DIOX	30/34	88	0.163	6.36	PG/G_DRY	0.00000636	No Bmark	YES
Total TCDF	55722-27-5	DIOX	34/34	100	4.31	243	PG/G_DRY	0.000243	No Bmark	YES
Total HxCDF	55684-94-1	DIOX	34/34	100	2.66	330	PG/G_DRY	0.00033	No Bmark	YES
2,3,4,7,8-PeCDF	57117-31-4	DIOX	33/34	97	0.285	11.3	PG/G_DRY	0.0000113	No Bmark	YES
2,3,7,8-TCDF	51207-31-9	DIOX	34/34	100	0.374	14.1	PG/G_DRY	0.0000141	No Bmark	YES
Total PeCDF	30402-15-4	DIOX	34/34	100	3.35	358	PG/G_DRY	0.000358	No Bmark	YES
1,2,3,7,8-PeCDD	40321-76-4	DIOX	28/34	82	0.151	14.7	PG/G_DRY	0.0000147	No Bmark	YES
1,2,3,4,7,8-HxCDD	39227-28-6	DIOX	25/34	74	0.185	11.1	PG/G_DRY	0.0000111	No Bmark	YES
OCDF	39001-02-0	DIOX	34/34	100	1.72	274	PG/G_DRY	0.000274	No Bmark	YES
Total HpCDF	38998-75-3	DIOX	34/34	100	2.4	315	PG/G_DRY	0.000315	No Bmark	YES
Total HpCDD	37871-00-4	DIOX	34/34	100	6.64	979	PG/G_DRY	0.000979	No Bmark	YES
Total PeCDD	36088-22-9	DIOX	34/34	100	0.932	160	PG/G_DRY	0.00016	No Bmark	YES
1,2,3,4,6,7,8-HpCDD	35822-46-9	DIOX	34/34	100	3.24	555	PG/G_DRY	0.000555	No Bmark	YES
Total HxCDD	34465-46-8	DIOX	34/34	100	2.18	351	PG/G_DRY	0.000351	No Bmark	YES
OCDD	3268-87-9	DIOX	34/34	100	20.1	3700	PG/G_DRY	0.0037	No Bmark	YES
1,2,3,4,7,8,9-HpCDF	55673-89-7	DIOX	25/34	74	0.148	8.74	PG/G_DRY	0.00000874	No Bmark	YES
TEQ mammal	TEM	Diox	34/34	100	1.466	14633.1328	PG/G_DRY	0.014633133	No Bmark	YES

Table B-2.2. COPC Screening - Northeastern Lyman Mill Pond Flood Plain Soil Exposure Area (0-2' soil)

Parameter	CASNO	Class	Freq of Det	Percent Det	Min Detected	Max Detected	Units	Max Detected (mg/kg)	Soil Screening Benchmark (mg/kg)	Retain as a COPEC?
Endosulfan Sulfate	1031-07-8	PESTP	1/6	17	0.53	0.53	UG/KG_DRY	0.00053	0.1	No
4,4'-DDE	72-55-9	PESTP	6/6	100	0.26	11	UG/KG_DRY	0.011	0.0025	YES
4,4'-DDD	72-54-8	PESTP	4/6	67	1	6.4	UG/KG_DRY	0.0064	0.0025	YES
Endrin	72-20-8	PESTP	3/6	50	0.21	1.3	UG/KG_DRY	0.0013	0.001	YES
Aroclor 1268	11100-14-4	PESTP	1/6	17	54	54	UG/KG_DRY	0.054	0.028	YES
Endrin Aldehyde	7421-93-4	PESTP	2/6	33	1.8	2.3	UG/KG_DRY	0.0023	0.054	No
Chlordane	57-74-9	PESTP	6/6	100	2.4	540	UG/KG_DRY	0.54	0.1	YES
Aroclor 1254	11097-69-1	PESTP	5/6	83	40	360	UG/KG_DRY	0.36	0.092	YES
Heptachlor Epoxide	1024-57-3	PESTP	1/6	17	0.24	0.24	UG/KG_DRY	0.00024	0.043	No
gamma-Chlordane	5566-34-7	PESTP	6/6	100	0.21	45	UG/KG_DRY	0.045	0.1	No
Endrin Ketone	53494-70-5	PESTP	3/6	50	0.28	1.9	UG/KG_DRY	0.0019	0.1	No
alpha-Chlordane	5103-71-9	PESTP	5/6	83	1.6	30	UG/KG_DRY	0.03	0.1	No
4,4'-DDT	50-29-3	PESTP	4/6	67	5.4	42	UG/KG_DRY	0.042	0.0025	YES
Endosulfan II	33213-65-9	PESTP	2/6	33	3.6	7.5	UG/KG_DRY	0.0075	0.1	No
alpha-BHC	319-84-6	PESTP	3/6	50	0.18	0.27	UG/KG_DRY	0.00027	0.0025	No
delta-BHC	319-86-8	PESTP	1/6	17	0.29	0.29	UG/KG_DRY	0.00029	0.1	No
Heptachlor	76-44-8	PESTP	1/6	17	6.2	6.2	UG/KG_DRY	0.0062	0.039	No
Benzo(g,h,i)perylene	191-24-2	OS	6/6	100	11	2500	UG/KG_DRY	2.5	1.3	YES
Acenaphthene	83-32-9	OS	5/6	83	14	190	UG/KG_DRY	0.19	20	No
Dibenz(a,h)anthracene	53-70-3	OS	6/6	100	2.6	680	UG/KG_DRY	0.68	0.0041	YES
Phenanthrene	85-01-8	OS	6/6	100	8.9	5000	UG/KG_DRY	5	0.1	YES
Butyl Benzyl Phthalate	85-68-7	OS	2/6	33	35	410	UG/KG_DRY	0.41	5.8	No
2-Methylnaphthalene	91-57-6	OS	1/6	17	29	29	UG/KG_DRY	0.029	47	No
Fluorene	86-73-7	OS	5/6	83	16	350	UG/KG_DRY	0.35	30	No
Benz(a)anthracene	56-55-3	OS	6/6	100	10	3100	UG/KG_DRY	3.1	0.0082	YES
Indeno(1,2,3-cd)pyrene	193-39-5	OS	6/6	100	11	2800	UG/KG_DRY	2.8	0.0021	YES
Benzo(b)fluoranthene	205-99-2	OS	6/6	100	19	5000	UG/KG_DRY	5	0.0015	YES
Fluoranthene	206-44-0	OS	6/6	100	22	6600	UG/KG_DRY	6.6	0.1	YES
Benzo(k)fluoranthene	207-08-9	OS	6/6	100	7.1	1700	UG/KG_DRY	1.7	0.0015	YES
Acenaphthylene	208-96-8	OS	6/6	100	1.8	720	UG/KG_DRY	0.72	47	No
Chrysene	218-01-9	OS	6/6	100	15	3700	UG/KG_DRY	3.7	0.0021	YES
Carbazole	86-74-8	OS	6/6	100	2.1	570	UG/KG_DRY	0.57	61	No
Naphthalene	91-20-3	OS	2/6	33	37	84	UG/KG_DRY	0.084	No Bmark	YES
Benzo(a)pyrene	50-32-8	OS	6/6	100	14	3900	UG/KG_DRY	3.9	0.021	YES
Pyrene	129-00-0	OS	6/6	100	22	6800	UG/KG_DRY	6.8	0.1	YES
Anthracene	120-12-7	OS	6/6	100	2.7	1000	UG/KG_DRY	1	0.1	YES
Bis(2-ethylhexyl) Phthalate	117-81-7	OS	6/6	100	11	1300	UG/KG_DRY	1.3	6.8	No
Dimethyl Phthalate	131-11-3	OS	5/6	83	25	130	UG/KG_DRY	0.13	5.8	No
Dibenzofuran	132-64-9	OS	5/6	83	8.7	140	UG/KG_DRY	0.14	43	No
Cobalt	7440-48-4	M	6/6	100	1.1	7.3	MG/KG_DRY	7.3	0.13	YES

Table B-2.2. COPC Screening - Northeastern Lyman Mill Pond Flood Plain Soil Exposure Area (0-2' soil)

Parameter	CASNO	Class	Freq of Det	Percent Det	Min Detected	Max Detected	Units	Max Detected (mg/kg)	Soil Screening Benchmark (mg/kg)	Retain as a COPEC?
Antimony	7440-36-0	M	4/6	67	0.237	1.51	MG/KG_DRY	1.51	0.045	YES
Silver	7440-22-4	M	1/6	17	0.3	0.3	MG/KG_DRY	0.3	38	No
Nickel	7440-02-0	M	6/6	100	3.76	23.4	MG/KG_DRY	23.4	53	No
Molybdenum	7439-98-7	M	6/6	100	0.33	14.8	MG/KG_DRY	14.8	0.32	YES
Manganese	7439-96-5	M	6/6	100	178	831	MG/KG_DRY	831	100	YES
Lead	7439-92-1	M	6/6	100	9	308	MG/KG_DRY	308	20	YES
Barium	7440-39-3	M	6/6	100	14.8	113	MG/KG_DRY	113	130	No
Beryllium	7440-41-7	M	6/6	100	0.28	2.08	MG/KG_DRY	2.08	0.77	YES
Chromium	7440-47-3	M	6/6	100	4.3	92.6	MG/KG_DRY	92.6	0.4	YES
Copper	7440-50-8	M	6/6	100	5.8	92.7	MG/KG_DRY	92.7	0.71	YES
Vanadium	7440-62-2	M	6/6	100	4.6	52.3	MG/KG_DRY	52.3	0.72	YES
Zinc	7440-66-6	M	6/6	100	34.6	199	MG/KG_DRY	199	76	YES
Selenium	7782-49-2	M	4/6	67	0.1	1.5	MG/KG_DRY	1.5	0.34	YES
Arsenic	7440-38-2	M	5/6	83	2	18.4	MG/KG_DRY	18.4	0.22	YES
Cadmium	7440-43-9	M	6/6	100	0.05	2.4	MG/KG_DRY	2.4	1.7	YES
1,2,3,7,8,9-HxCDD	19408-74-3	DIOX	4/6	67	2.26	27.7	PG/G_DRY	0.0000277	No Bmark	YES
Total TCDF	55722-27-5	DIOX	6/6	100	0.13	252	PG/G_DRY	0.000252	No Bmark	YES
2,3,7,8-TCDD	1746-01-6	DIOX	6/6	100	14.9	12600	PG/G_DRY	0.0126	0.00000089	YES
Total PeCDF	30402-15-4	DIOX	6/6	100	1.47	410	PG/G_DRY	0.00041	No Bmark	YES
Total TCDD	41903-57-5	DIOX	6/6	100	15.3	12800	PG/G_DRY	0.0128	No Bmark	YES
1,2,3,7,8,9-HxCDF	72918-21-9	DIOX	2/6	33	1.62	1.73	PG/G_DRY	1.73E-06	No Bmark	YES
1,2,3,4,7,8-HxCDF	70648-26-9	DIOX	5/6	83	0.132	17.4	PG/G_DRY	0.0000174	No Bmark	YES
1,2,3,4,6,7,8-HpCDF	67562-39-4	DIOX	6/6	100	0.914	265	PG/G_DRY	0.000265	No Bmark	YES
2,3,4,6,7,8-HxCDF	60851-34-5	DIOX	5/6	83	2.57	24.4	PG/G_DRY	0.0000244	No Bmark	YES
1,2,3,6,7,8-HxCDD	57653-85-7	DIOX	4/6	67	3.34	40.5	PG/G_DRY	0.0000405	No Bmark	YES
1,2,3,6,7,8-HxCDF	57117-44-9	DIOX	5/6	83	0.107	20.9	PG/G_DRY	0.0000209	No Bmark	YES
1,2,3,7,8-PeCDF	57117-41-6	DIOX	6/6	100	0.079	6.91	PG/G_DRY	6.91E-06	No Bmark	YES
2,3,4,7,8-PeCDF	57117-31-4	DIOX	5/6	83	1.52	9.57	PG/G_DRY	9.57E-06	No Bmark	YES
1,2,3,4,7,8,9-HpCDF	55673-89-7	DIOX	5/6	83	1.5	14.3	PG/G_DRY	0.0000143	No Bmark	YES
2,3,7,8-TCDF	51207-31-9	DIOX	4/6	67	1.3	11.7	PG/G_DRY	0.0000117	No Bmark	YES
OCDD	3268-87-9	DIOX	6/6	100	18.5	6490	PG/G_DRY	0.00649	No Bmark	YES
1,2,3,7,8-PeCDD	40321-76-4	DIOX	5/6	83	0.928	9.57	PG/G_DRY	9.57E-06	No Bmark	YES
1,2,3,4,7,8-HxCDD	39227-28-6	DIOX	3/6	50	1.4	14	PG/G_DRY	0.000014	No Bmark	YES
OCDF	39001-02-0	DIOX	6/6	100	1.51	462	PG/G_DRY	0.000462	No Bmark	YES
Total HpCDF	38998-75-3	DIOX	6/6	100	1.61	555	PG/G_DRY	0.000555	No Bmark	YES
Total HpCDD	37871-00-4	DIOX	6/6	100	6.09	1640	PG/G_DRY	0.00164	No Bmark	YES
Total PeCDD	36088-22-9	DIOX	5/6	83	11.4	81.9	PG/G_DRY	0.0000819	No Bmark	YES
1,2,3,4,6,7,8-HpCDD	35822-46-9	DIOX	6/6	100	2.33	826	PG/G_DRY	0.000826	No Bmark	YES
Total HxCDD	34465-46-8	DIOX	6/6	100	0.815	299	PG/G_DRY	0.000299	No Bmark	YES
Total HxCDF	55684-94-1	DIOX	6/6	100	1.54	448	PG/G_DRY	0.000448	No Bmark	YES
TEQ mammal	TEM	DIOX	6/6	100	14.964713	12641.6199	PG/G_DRY	0.0126416	No Bmark	YES

Table B-2.3. COPC Screening - Southeastern Lyman Mill Pond Flood Plain Soil Exposure Area (0-1' soil)

Parameter	CASNO	Class	Freq of Det	Percent Det	Min Detected	Max Detected	Units	Max Detected (mg/kg)	Soil Screening Benchmark (mg/kg)	Retain as a COPEC?
Aroclor 1260	11096-82-5	PESTP	1/2	50	29	29	UG/KG_DRY	0.029	0.028	YES
4,4'-DDT	50-29-3	PESTP	2/2	100	1.2	52	UG/KG_DRY	0.052	0.0025	YES
alpha-Chlordane	5103-71-9	PESTP	1/2	50	0.32	0.32	UG/KG_DRY	0.00032	0.1	No
gamma-Chlordane	5566-34-7	PESTP	1/2	50	0.28	0.28	UG/KG_DRY	0.00028	0.1	No
Chlordane	57-74-9	PESTP	1/2	50	5.8	5.8	UG/KG_DRY	0.0058	0.1	No
Aroclor 1254	11097-69-1	PESTP	1/2	50	26	26	UG/KG_DRY	0.026	0.092	No
Methoxychlor	72-43-5	PESTP	1/2	50	0.76	0.76	UG/KG_DRY	0.00076	0.1	No
4,4'-DDD	72-54-8	PESTP	2/2	100	0.7	3.8	UG/KG_DRY	0.0038	0.0025	YES
4,4'-DDE	72-55-9	PESTP	2/2	100	1.1	36	UG/KG_DRY	0.036	0.0025	YES
Endosulfan Sulfate	1031-07-8	PESTP	1/2	50	1.2	1.2	UG/KG_DRY	0.0012	0.1	No
Carbazole	86-74-8	OS	2/2	100	3.9	49	UG/KG_DRY	0.049	61	No
Benzoic Acid	65-85-0	OS	2/2	100	96	960	UG/KG_DRY	0.96	86	No
Benz(a)anthracene	56-55-3	OS	2/2	100	23	300	UG/KG_DRY	0.3	0.0082	YES
Naphthalene	91-20-3	OS	1/2	50	25	25	UG/KG_DRY	0.025	No Bmark	YES
Dibenzofuran	132-64-9	OS	1/2	50	19	19	UG/KG_DRY	0.019	43	No
Benzyl Alcohol	100-51-6	OS	1/2	50	2.6	2.6	UG/KG_DRY	0.0026	0.71	No
Butyl Benzyl Phthalate	85-68-7	OS	1/2	50	4.2	4.2	UG/KG_DRY	0.0042	5.8	No
Dibenz(a,h)anthracene	53-70-3	OS	2/2	100	6.2	79	UG/KG_DRY	0.079	0.0041	YES
Pyrene	129-00-0	OS	2/2	100	51	650	UG/KG_DRY	0.65	0.1	YES
Benzo(a)pyrene	50-32-8	OS	2/2	100	42	410	UG/KG_DRY	0.41	0.021	YES
Phenanthrene	85-01-8	OS	2/2	100	23	370	UG/KG_DRY	0.37	0.1	YES
Benzo(g,h,i)perylene	191-24-2	OS	2/2	100	32	350	UG/KG_DRY	0.35	1.3	No
Indeno(1,2,3-cd)pyrene	193-39-5	OS	2/2	100	36	370	UG/KG_DRY	0.37	0.0021	YES
Benzo(b)fluoranthene	205-99-2	OS	2/2	100	51	580	UG/KG_DRY	0.58	0.0015	YES
Fluoranthene	206-44-0	OS	2/2	100	52	640	UG/KG_DRY	0.64	0.1	YES
Benzo(k)fluoranthene	207-08-9	OS	2/2	100	17	170	UG/KG_DRY	0.17	0.0015	YES
Acenaphthylene	208-96-8	OS	2/2	100	16	240	UG/KG_DRY	0.24	47	No
Chrysene	218-01-9	OS	2/2	100	36	450	UG/KG_DRY	0.45	0.0021	YES
Fluorene	86-73-7	OS	2/2	100	1.9	34	UG/KG_DRY	0.034	30	No
Bis(2-ethylhexyl) Phthalate	117-81-7	OS	1/2	50	17	17	UG/KG_DRY	0.017	6.8	No
Anthracene	120-12-7	OS	2/2	100	10	150	UG/KG_DRY	0.15	0.1	YES
Dimethyl Phthalate	131-11-3	OS	1/2	50	28	28	UG/KG_DRY	0.028	5.8	No
Chromium	7440-47-3	M	2/2	100	4.9	12.8	MG/KG_DRY	12.8	0.4	YES
Beryllium	7440-41-7	M	2/2	100	0.23	0.34	MG/KG_DRY	0.34	0.77	No
Barium	7440-39-3	M	2/2	100	37.6	105	MG/KG_DRY	105	130	No
Arsenic	7440-38-2	M	2/2	100	6	6.3	MG/KG_DRY	6.3	0.22	YES

Table B-2.3. COPC Screening - Southeastern Lyman Mill Pond Flood Plain Soil Exposure Area (0-1' soil)

Parameter	CASNO	Class	Freq of Det	Percent Det	Min Detected	Max Detected	Units	Max Detected (mg/kg)	Soil Screening Benchmark (mg/kg)	Retain as a COPEC?
Antimony	7440-36-0	M	2/2	100	0.131	3.18	MG/KG_DRY	3.18	0.045	YES
Silver	7440-22-4	M	1/2	50	0.4	0.4	MG/KG_DRY	0.4	38	No
Nickel	7440-02-0	M	2/2	100	5.16	28.6	MG/KG_DRY	28.6	53	No
Molybdenum	7439-98-7	M	2/2	100	0.53	1.06	MG/KG_DRY	1.06	0.32	YES
Manganese	7439-96-5	M	2/2	100	65.7	150	MG/KG_DRY	150	100	YES
Lead	7439-92-1	M	2/2	100	25	337	MG/KG_DRY	337	20	YES
Cobalt	7440-48-4	M	2/2	100	2.28	3.25	MG/KG_DRY	3.25	0.13	YES
Copper	7440-50-8	M	2/2	100	16.2	91.9	MG/KG_DRY	91.9	0.71	YES
Vanadium	7440-62-2	M	2/2	100	7.1	13.5	MG/KG_DRY	13.5	0.72	YES
Zinc	7440-66-6	M	2/2	100	67.2	188	MG/KG_DRY	188	76	YES
Selenium	7782-49-2	M	1/2	50	0.4	0.4	MG/KG_DRY	0.4	0.34	YES
Cadmium	7440-43-9	M	2/2	100	0.99	2.43	MG/KG_DRY	2.43	1.7	YES
1,2,3,7,8,9-HxCDD	19408-74-3	DIOX	2/2	100	0.621	3.77	PG/G_DRY	3.77E-06	No Bmark	YES
Total TCDF	55722-27-5	DIOX	2/2	100	6	135	PG/G_DRY	0.000135	No Bmark	YES
Total PeCDF	30402-15-4	DIOX	2/2	100	11.8	201	PG/G_DRY	0.000201	No Bmark	YES
2,3,7,8-TCDD	1746-01-6	DIOX	1/2	50	1.21	1.21	PG/G_DRY	1.21E-06	0.00000089	YES
Total TCDD	41903-57-5	DIOX	2/2	100	0.76	17.3	PG/G_DRY	0.0000173	No Bmark	YES
1,2,3,7,8,9-HxCDF	72918-21-9	DIOX	2/2	100	0.0642	3.53	PG/G_DRY	3.53E-06	No Bmark	YES
1,2,3,4,7,8-HxCDF	70648-26-9	DIOX	2/2	100	0.546	13.3	PG/G_DRY	0.0000133	No Bmark	YES
1,2,3,4,6,7,8-HpCDF	67562-39-4	DIOX	2/2	100	8.73	74.3	PG/G_DRY	0.0000743	No Bmark	YES
2,3,4,6,7,8-HxCDF	60851-34-5	DIOX	2/2	100	0.774	16.8	PG/G_DRY	0.0000168	No Bmark	YES
1,2,3,6,7,8-HxCDD	57653-85-7	DIOX	2/2	100	0.899	4.92	PG/G_DRY	4.92E-06	No Bmark	YES
1,2,3,6,7,8-HxCDF	57117-44-9	DIOX	2/2	100	0.516	11.7	PG/G_DRY	0.0000117	No Bmark	YES
1,2,3,7,8-PeCDF	57117-41-6	DIOX	2/2	100	0.285	5.85	PG/G_DRY	5.85E-06	No Bmark	YES
2,3,4,7,8-PeCDF	57117-31-4	DIOX	2/2	100	0.478	12.4	PG/G_DRY	0.0000124	No Bmark	YES
1,2,3,4,7,8,9-HpCDF	55673-89-7	DIOX	2/2	100	0.358	4.31	PG/G_DRY	4.31E-06	No Bmark	YES
2,3,7,8-TCDF	51207-31-9	DIOX	1/2	50	5.88	5.88	PG/G_DRY	5.88E-06	No Bmark	YES
OCDD	3268-87-9	DIOX	2/2	100	138	441	PG/G_DRY	0.000441	No Bmark	YES
1,2,3,7,8-PeCDD	40321-76-4	DIOX	1/2	50	2	2	PG/G_DRY	0.000002	No Bmark	YES
1,2,3,4,7,8-HxCDD	39227-28-6	DIOX	1/2	50	0.375	0.375	PG/G_DRY	3.75E-07	No Bmark	YES
OCDF	39001-02-0	DIOX	2/2	100	14.6	38.5	PG/G_DRY	0.0000385	No Bmark	YES
Total HpCDF	38998-75-3	DIOX	2/2	100	17.5	115	PG/G_DRY	0.000115	No Bmark	YES
Total HpCDD	37871-00-4	DIOX	2/2	100	40.5	139	PG/G_DRY	0.000139	No Bmark	YES
Total PeCDD	36088-22-9	DIOX	2/2	100	1.26	27.5	PG/G_DRY	0.0000275	No Bmark	YES
1,2,3,4,6,7,8-HpCDD	35822-46-9	DIOX	2/2	100	19.6	66.7	PG/G_DRY	0.0000667	No Bmark	YES
Total HxCDD	34465-46-8	DIOX	2/2	100	7.13	51.3	PG/G_DRY	0.0000513	No Bmark	YES
Total HxCDF	55684-94-1	DIOX	2/2	100	11.3	163	PG/G_DRY	0.000163	No Bmark	YES
TEQ mammal	TEM	DIOX	2/2	100	0.86	14.96	PG/G_DRY	1.496E-05	No Bmark	YES

Table B-2.4. COPC Screening - Assapumpset Brook Flood Plain Soil Exposure Area (0-1' soil)

Parameter	CASNO	Class	Freq of Det	Percent Det	Min Detected	Max Detected	Units	Max Detected (mg/kg)	Soil Screening Benchmark (mg/kg)	Retain as a COPEC?
4,4'-DDD	72-54-8	PESTP	2/2	100	4.1	14	UG/KG_DRY	0.014	0.0025	YES
4,4'-DDT	50-29-3	PESTP	2/2	100	14	53	UG/KG_DRY	0.053	0.0025	YES
alpha-Chlordane	5103-71-9	PESTP	2/2	100	2.8	6.4	UG/KG_DRY	0.0064	0.1	No
gamma-Chlordane	5566-34-7	PESTP	2/2	100	4.5	13	UG/KG_DRY	0.013	0.1	No
Endosulfan Sulfate	1031-07-8	PESTP	1/2	50	2.3	2.3	UG/KG_DRY	0.0023	0.1	No
Chlordane	57-74-9	PESTP	2/2	100	42	64	UG/KG_DRY	0.064	0.1	No
Endrin	72-20-8	PESTP	1/2	50	0.8	0.8	UG/KG_DRY	0.0008	0.001	No
4,4'-DDE	72-55-9	PESTP	2/2	100	8.5	8.8	UG/KG_DRY	0.0088	0.0025	YES
Aroclor 1260	11096-82-5	PESTP	2/2	100	92	280	UG/KG_DRY	0.28	0.028	YES
Endrin Aldehyde	7421-93-4	PESTP	1/2	50	1.6	1.6	UG/KG_DRY	0.0016	0.054	No
Aroclor 1254	11097-69-1	PESTP	2/2	100	51	250	UG/KG_DRY	0.25	0.092	YES
Butyl Benzyl Phthalate	85-68-7	OS	2/2	100	84	230	UG/KG_DRY	0.23	5.8	No
Dibenzofuran	132-64-9	OS	1/2	50	16	16	UG/KG_DRY	0.016	43	No
Carbazole	86-74-8	OS	2/2	100	28	53	UG/KG_DRY	0.053	61	No
Acenaphthene	83-32-9	OS	1/2	50	25	25	UG/KG_DRY	0.025	20	No
Benzo(g,h,i)perylene	191-24-2	OS	2/2	100	260	510	UG/KG_DRY	0.51	1.3	No
Phenanthrene	85-01-8	OS	2/2	100	170	570	UG/KG_DRY	0.57	0.1	YES
Dimethyl Phthalate	131-11-3	OS	2/2	100	48	70	UG/KG_DRY	0.07	5.8	No
Indeno(1,2,3-cd)pyrene	193-39-5	OS	2/2	100	240	530	UG/KG_DRY	0.53	0.0021	YES
Pyrene	129-00-0	OS	2/2	100	450	1200	UG/KG_DRY	1.2	0.1	YES
Benzo(a)pyrene	50-32-8	OS	2/2	100	290	670	UG/KG_DRY	0.67	0.021	YES
Fluorene	86-73-7	OS	1/2	50	45	45	UG/KG_DRY	0.045	30	No
Benzo(b)fluoranthene	205-99-2	OS	2/2	100	410	910	UG/KG_DRY	0.91	0.0015	YES
Fluoranthene	206-44-0	OS	2/2	100	470	1300	UG/KG_DRY	1.3	0.1	YES
Benzo(k)fluoranthene	207-08-9	OS	2/2	100	140	300	UG/KG_DRY	0.3	0.0015	YES
Acenaphthylene	208-96-8	OS	2/2	100	74	140	UG/KG_DRY	0.14	47	No
Chrysene	218-01-9	OS	2/2	100	320	740	UG/KG_DRY	0.74	0.0021	YES
Dibenz(a,h)anthracene	53-70-3	OS	2/2	100	54	120	UG/KG_DRY	0.12	0.0041	YES
Bis(2-ethylhexyl) Phthalate	117-81-7	OS	2/2	100	300	1200	UG/KG_DRY	1.2	6.8	No
Benz(a)anthracene	56-55-3	OS	2/2	100	220	590	UG/KG_DRY	0.59	0.0082	YES
Anthracene	120-12-7	OS	2/2	100	68	170	UG/KG_DRY	0.17	0.1	YES
Lead	7439-92-1	M	2/2	100	93	213	MG/KG_DRY	213	20	YES
Beryllium	7440-41-7	M	2/2	100	0.6	0.89	MG/KG_DRY	0.89	0.77	YES
Barium	7440-39-3	M	2/2	100	78.2	83	MG/KG_DRY	83	130	No
Arsenic	7440-38-2	M	2/2	100	5.3	13.7	MG/KG_DRY	13.7	0.22	YES
Antimony	7440-36-0	M	2/2	100	0.249	1.38	MG/KG_DRY	1.38	0.045	YES
Thallium	7440-28-0	M	1/2	50	0.8	0.8	MG/KG_DRY	0.8	0.24	YES
Silver	7440-22-4	M	1/2	50	2.2	2.2	MG/KG_DRY	2.2	38	No

Table B-2.4. COPC Screening - Assapumpset Brook Flood Plain Soil Exposure Area (0-1' soil)

Parameter	CASNO	Class	Freq of Det	Percent Det	Min Detected	Max Detected	Units	Max Detected (mg/kg)	Soil Screening Benchmark (mg/kg)	Retain as a COPEC?
Nickel	7440-02-0	M	2/2	100	20.7	28.3	MG/KG_DRY	28.3	53	No
Selenium	7782-49-2	M	2/2	100	0.6	4.5	MG/KG_DRY	4.5	0.34	YES
Manganese	7439-96-5	M	2/2	100	516	882	MG/KG_DRY	882	100	YES
Chromium	7440-47-3	M	2/2	100	17.3	18.2	MG/KG_DRY	18.2	0.4	YES
Cobalt	7440-48-4	M	2/2	100	3.64	9.11	MG/KG_DRY	9.11	0.13	YES
Copper	7440-50-8	M	2/2	100	35.3	119	MG/KG_DRY	119	0.71	YES
Vanadium	7440-62-2	M	2/2	100	12.9	22.8	MG/KG_DRY	22.8	0.72	YES
Cadmium	7440-43-9	M	2/2	100	0.44	0.83	MG/KG_DRY	0.83	1.7	No
Zinc	7440-66-6	M	2/2	100	127	190	MG/KG_DRY	190	76	YES
Molybdenum	7439-98-7	M	2/2	100	1.12	1.73	MG/KG_DRY	1.73	0.32	YES
1,2,3,7,8,9-HxCDD	19408-74-3	DIOX	2/2	100	5.78	17.2	PG/G_DRY	0.0000172	No Bmark	YES
2,3,7,8-TCDD	1746-01-6	DIOX	2/2	100	2.44	132	PG/G_DRY	0.000132	0.00000089	YES
OCDD	3268-87-9	DIOX	2/2	100	1050	4230	PG/G_DRY	0.00423	No Bmark	YES
Total PeCDF	30402-15-4	DIOX	2/2	100	96.1	443	PG/G_DRY	0.000443	No Bmark	YES
2,3,7,8-TCDF	51207-31-9	DIOX	2/2	100	3.51	12.7	PG/G_DRY	0.0000127	No Bmark	YES
1,2,3,7,8,9-HxCDF	72918-21-9	DIOX	1/2	50	8.6	8.6	PG/G_DRY	0.0000086	No Bmark	YES
1,2,3,4,7,8-HxCDF	70648-26-9	DIOX	1/2	50	41.3	41.3	PG/G_DRY	0.0000413	No Bmark	YES
1,2,3,4,6,7,8-HpCDF	67562-39-4	DIOX	2/2	100	60.1	241	PG/G_DRY	0.000241	No Bmark	YES
2,3,4,6,7,8-HxCDF	60851-34-5	DIOX	2/2	100	8.84	31.4	PG/G_DRY	0.0000314	No Bmark	YES
1,2,3,6,7,8-HxCDD	57653-85-7	DIOX	2/2	100	7.5	28.7	PG/G_DRY	0.0000287	No Bmark	YES
1,2,3,6,7,8-HxCDF	57117-44-9	DIOX	2/2	100	7.44	30.4	PG/G_DRY	0.0000304	No Bmark	YES
1,2,3,7,8-PeCDF	57117-41-6	DIOX	2/2	100	3.74	17.3	PG/G_DRY	0.0000173	No Bmark	YES
2,3,4,7,8-PeCDF	57117-31-4	DIOX	2/2	100	4.72	38.6	PG/G_DRY	0.0000386	No Bmark	YES
Total HxCDF	55684-94-1	DIOX	2/2	100	107	436	PG/G_DRY	0.000436	No Bmark	YES
1,2,3,4,7,8,9-HpCDF	55673-89-7	DIOX	2/2	100	4.32	17.3	PG/G_DRY	0.0000173	No Bmark	YES
Total HxCDD	34465-46-8	DIOX	2/2	100	59.9	282	PG/G_DRY	0.000282	No Bmark	YES
Total TCDD	41903-57-5	DIOX	2/2	100	76.9	145	PG/G_DRY	0.000145	No Bmark	YES
1,2,3,7,8-PeCDD	40321-76-4	DIOX	1/2	50	6.3	6.3	PG/G_DRY	0.0000063	No Bmark	YES
1,2,3,4,7,8-HxCDD	39227-28-6	DIOX	1/2	50	8.83	8.83	PG/G_DRY	0.00000883	No Bmark	YES
OCDF	39001-02-0	DIOX	2/2	100	98.3	576	PG/G_DRY	0.000576	No Bmark	YES
Total HpCDF	38998-75-3	DIOX	2/2	100	121	614	PG/G_DRY	0.000614	No Bmark	YES
Total HpCDD	37871-00-4	DIOX	2/2	100	272	1070	PG/G_DRY	0.00107	No Bmark	YES
Total PeCDD	36088-22-9	DIOX	2/2	100	21.6	139	PG/G_DRY	0.000139	No Bmark	YES
1,2,3,4,6,7,8-HpCDD	35822-46-9	DIOX	2/2	100	142	592	PG/G_DRY	0.000592	No Bmark	YES
Total TCDF	55722-27-5	DIOX	2/2	100	60.9	262	PG/G_DRY	0.000262	No Bmark	YES
TEQ mammal	TEM	Diox	2/2	100	48.6	139.2	PG/G_DRY	0.0001392	No Bmark	YES

Table B-2.5. Ecological Exposure Point Concentrations for the Oxbow , Northeast Lyman Mill Pond, Southeast Lyman Mill Pond, and Assapumpset Brook Floodplain Soils

			Oxbow Area		NE Lyman Mill Pond		Assapumpsett Brook		SE Lyman Mill Pond	
Parameter	CASNO	Class	Freq of Det	Arithmetic Mean (mg/kg)	Freq of Det	Arithmetic Mean (mg/kg)	Freq of Det	Max Detected (mg/kg)		Max Detected (mg/kg)
4,4'-DDD	72-54-8	PESTP	7/34	0.0004	4/6	0.00241	2/2	0.014	2/2	0.0038
4,4'-DDE	72-55-9	PESTP	28/34	0.0029	6/6	0.00446	2/2	0.0088	2/2	0.036
4,4'-DDT	50-29-3	PESTP	29/34	0.0103	4/6	0.01792	2/2	0.053	2/2	0.052
Aroclor 1254	11097-69-1	PESTP	13/34	0.0660	5/6	0.14356	2/2	0.25		
Aroclor 1260	11096-82-5	PESTP	5/34	0.0174			2/2	0.28	1/2	0.029
Aroclor 1268	11100-14-4	PESTP	3/34	0.0041	1/6	0.01067				
beta-BHC	319-85-7	PESTP	2/34	0.0004						
Chlordane	57-74-9	PESTP	11/34	0.0313	6/6	0.14623				
Dieldrin	60-57-1	PESTP	11/34	0.0017						
Endrin	72-20-8	PESTP	5/34	0.0006	3/6	0.00057				
gamma-BHC (Lindane)	58-89-9	PESTP	5/34	0.0017						
Anthracene	120-12-7	OS	30/34	0.79	6/6	0.40	2/2	0.17	2/2	0.15
Benz(a)anthracene	56-55-3	OS	34/34	2.26	6/6	1.49	2/2	0.59	2/2	0.3
Benzo(a)pyrene	50-32-8	OS	28/34	2.33	6/6	1.84	2/2	0.67	2/2	0.41
Benzo(b)fluoranthene	205-99-2	OS	34/34	2.41	6/6	2.40	2/2	0.91	2/2	0.58
Benzo(g,h,i)perylene	191-24-2	OS	34/34	1.17	6/6	1.26				
Benzo(k)fluoranthene	207-08-9	OS	34/34	0.88	6/6	0.76	2/2	0.3	2/2	0.17
Chrysene	218-01-9	OS	34/34	2.32	6/6	1.90	2/2	0.74	2/2	0.45
Dibenz(a,h)anthracene	53-70-3	OS	28/34	0.33	6/6	0.32	2/2	0.12	2/2	0.079
Fluoranthene	206-44-0	OS	34/34	4.34	6/6	3.05	2/2	1.3	2/2	0.64
Indeno(1,2,3-cd)pyrene	193-39-5	OS	34/34	1.37	6/6	1.33	2/2	0.53	2/2	0.37
Naphthalene	91-20-3	OS	16/34	0.13	2/6	0.03			1/2	0.025
Phenanthrene	85-01-8	OS	34/34	2.74	6/6	1.62	2/2	0.57	2/2	0.37
Pyrene	129-00-0	OS	34/34	3.99	6/6	3.00	2/2	1.2	2/2	0.65
Antimony	7440-36-0	M	25/34	0.33	4/6	0.49	2/2	1.38	2/2	3.18
Arsenic	7440-38-2	M	34/34	5.04	5/6	5.17	2/2	13.7	2/2	6.3
Barium	7440-39-3	M	34/34	40.2						
Beryllium	7440-41-7	M	34/34	0.64	6/6	0.79	2/2	0.89		
Cadmium	7440-43-9	M	28/34	0.29	6/6	0.58			2/2	2.43
Chromium	7440-47-3	M	34/34	17.8	6/6	35.7	2/2	18.2	2/2	12.8
Cobalt	7440-48-4	M	34/34	3.67	6/6	3.75	2/2	9.11	2/2	3.25
Copper	7440-50-8	M	34/34	27.4	6/6	33.3	2/2	119	2/2	91.9
Lead	7439-92-1	M	34/34	120	6/6	116	2/2	213	2/2	337
Manganese	7439-96-5	M	34/34	544	6/6	364	2/2	882	2/2	150
Molybdenum	7439-98-7	M	27/34	3.03	6/6	4.07	2/2	1.73	2/2	1.06
Nickel	7440-02-0	M	34/34	11.0						
Selenium	7782-49-2	M	33/34	0.69	4/6	0.45	2/2	4.5	1/2	0.4
Thallium	7440-28-0	M	2/34	0.25			1/2	0.8		
Vanadium	7440-62-2	M	34/34	23.9	6/6	22.0	2/2	22.8	2/2	13.5
Zinc	7440-66-6	M	34/34	67.3	6/6	88.5	2/2	190	2/2	188
TEQ mammal	TEM	Diox	34/34	0.0011	6/6	0.00337	2/2	0.0001392	2/2	0.00001469

Table B-2.6. Chemical-Specific Toxicological and Bioaccumulation Values for COPECs

Chemicals of Potential Concern	CAS Numbers	Mammal Toxicity Reference Dose[a] (mg/kg-d)		Literature-based BAFs[b]		Earthworm BSAFs[c]
		NOAEL	LOAEL	Terrestrial Plants	Terrestrial Inverts	
2,4-Dinitrophenol	51-28-5	20	30			#N/A
4,4'-DDD	72-54-8	0.8	4	0.0024	1.1	0.466
4,4'-DDE	72-55-9	0.8	4	0.00096	1.1	0.545
4,4'-DDT	50-29-3	0.8	4	0.0014	1.1	0.21
Anthracene	120-12-7	200	2000	0.021	1	#N/A
Antimony	7440-36-0	0.026	0.26	0.002		0.699
Aroclor 1254	11097-69-1	0.068	0.68	0.0014	1.1	0.354
Aroclor 1260	11096-82-5	0.068	0.68	0.00034	1.1	#N/A
Aroclor 1268	11100-14-4	0.068	0.68	0.00034	1.1	0.428
Arsenic	7440-38-2	0.13	1.3	0.01	0.025	0.112
Barium	7440-39-3	75	160	0.031	0.018	0.236
Benz(a)anthracene	56-55-3	1	10	0.0036	1.1	#N/A
Benzo(a)pyrene	50-32-8	1	10	0.0022	1.1	#N/A
Benzo(b)fluoranthene	205-99-2	1	10	0.0035	1.1	#N/A
Benzo(g,h,i)perylene	191-24-2	1	10	0.0011	1.1	#N/A
Benzo(k)fluoranthene	207-08-9	1	10	0.0023	1.1	#N/A
Beryllium	7440-41-7	0.66	6.6	0.002	0.009	0.144
beta-BHC	319-85-7	1.6	3.2	0.051	1	#N/A
Cadmium	7440-43-9	1	10	0.044	1	4.016
Chlordane	57-74-9	4.58	9.16	0.0026	1.1	0.39
Chromium	7440-47-3	1500	15000	0.0082	0.061	0.083
Chrysene	218-01-9	1	10	0.0034	1.1	#N/A
Cobalt	7440-48-4	0.076	0.76	0.0015	0.024	0.12
Copper	7440-50-8	0.42	4.2	0.097	0.2	0.098
Dibenz(a,h)anthracene	53-70-3	1	10	0.00097	1.1	#N/A
Dieldrin	60-57-1	0.028	0.28	0.0067	1.1	0.583
Endrin	72-20-8	0.65	0.065	0.0076	1.1	#N/A
Fluoranthene	206-44-0	130	250	0.0081	1.1	#N/A
gamma-BHC (Lindane)	58-89-9	1.6	3.2	0.059	1	1.331
Indeno(1,2,3-cd)pyrene	193-39-5	1	10	0.001	1.1	#N/A
Lead	7439-92-1	130	380	0.019	0.1	0.145
Manganese	7439-96-5	88	280	0.016	0.043	0.201
Molybdenum	7439-98-7	0.19	1.9	0.05	0.19	0.082
Naphthalene	91-20-3	30	300	0.096	1	#N/A
Nickel	7440-02-0	31	52	0.012	0.21	0.099
Phenanthrene	85-01-8	15	150	0.02	1	#N/A
Pyrene	129-00-0	75	130	0.012	1	#N/A
Selenium	7782-49-2	0.2	0.33	0.13	0.1	1.73
Thallium	7440-28-0	0.14	1.4	0.0008		0.176
Vanadium	7440-62-2	0.42	2.1	0.00097	0.0084	0.08
Zinc	7440-66-6	160	320	0.35	3.6	0.618
TEQ mammal	TEM	1.0E-06	1.0E-05			0.353

a. Toxicity values (NOAELs and LOAELs) are taken from Appendix D Tables in 2006 BERA and/or Table D-4 in the 2004 iBERA.
b. Literature-derived BAFs are summarized in Table J-1 in the BERA (MACTEC, 2004).
c. Site-Specific Mean Biota Soil Accumulation Factors (BSAFs) presented in Table J-8 of the BERA (MACTEC, 2004). Units are goc(drywt/glipid(wetwt).
#N/A - not available

Table B-3.1 Exposure Parameters for the Estimation of Soil Ingestion Exposures

Parameter Symbol	Parameter Definition	Units	Value	Rationale/Reference
EDI_{soil}	Estimated Daily Intake Via Soil Ingestion	mg/kg-d	calculated	
Csoil	Chemical Concentration in Soil	mg/kg	chemical-specific	
IRsoil	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

Table B-3.2 Exposure Parameters for the Estimation of Plant Ingestion Exposures

Parameter Symbol	Parameter Definition	Units	RME Value	RMA Rationale/Reference
EDI_{plant}	Estimated Daily Intake Via Plant Ingestion	mg/kg-d	calculated	
BAF	Bioaccumulation Factor	unitless	chemical-specific	
C_{plant}	Chemical Concentration in Plants	mg/kg	chemical-specific	
IR_{food}	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993
P_{plant}	Percent Plants in Diet	unitless	14%	Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993
BW	Body Weight	kg	0.017	Guilday, 1957

Table B-3.3 Exposure Parameters for the Estimation of Earthworm Ingestion Exposures

Parameter Symbol	Parameter Definition	Units	Value	Rationale/Reference
EDI_{invert}	Estimated Daily Intake Via Invertebrate Ingestion	mg/kg-d	calculated	
C_{soil}	Chemical Concentration in Soil	mg/kg	chemical-specific	
C_{invert}	Chemical Concentration in Invertebrates	mg/kg	chemical-specific	
BSAF	Biota Soil Accumulation Factor	unitless	chemical-specific	USEPA, 2004
L	Average lipid content of Lyman Mill earthworm samples	percent	2.66%	(Table 20; MACTEC, 2004)
TOC	Estimated Soil TOC	percent	8.88%	(Table J-8, MACTEC, 2004)
BAF	Bioaccumulation Factor	unitless	chemical-specific	USEPA, 2004
IRfood	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993;
P_{invert}	Percent Invertebrates in Diet	unitless	85%	USEPA, 1993; Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993;
BW	Body Weight	kg	0.017	Guilday, 1957

Table B-3.4. Calculation of Hazard Quotients: Short-tailed Shrew, Soil Ingestion, General and Human Use Areas of the Oxbow

Scenario Timeframe:
Exposure Medium: Surface Soil (0-2 feet)
Exposure Point: Oxbow Area
Receptor: Short-tailed Shrew

INTAKE EQUATION - Soil Ingestion
$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{soil}	Estimated Daily Intake Via Soil Ingestion	mg/kg-d	calculated	
Csoil	*Chemical Concentration in Soil*	*mg/kg*	*chemical-specific*	
IRsoil	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

Analyte	Csoil (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b] (mg/kg-day)		Hazard Quotient[c]	
			NOAEL	LOAEL	NOAEL	LOAEL
Antimony	0.33	1.25E-02	0.026	0.26	4.8E-01	4.8E-02
Arsenic	5.04	1.90E-01	0.13	1.3	1.5E+00	1.5E-01
Barium	40.15	1.51E+00	75	160	2.0E-02	9.4E-03
Beryllium	0.64	2.41E-02	0.66	6.6	3.7E-02	3.7E-03
Cadmium	0.29	1.10E-02	1	10	1.1E-02	1.1E-03
Chromium	17.84	6.72E-01	1500	15000	4.5E-04	4.5E-05
Cobalt	3.67	1.38E-01	0.076	0.76	1.8E+00	1.8E-01
Copper	27.36	1.03E+00	0.42	4.2	2.5E+00	2.5E-01
Lead	120.41	4.53E+00	130	380	3.5E-02	1.2E-02
Manganese	544.47	2.05E+01	88	280	2.3E-01	7.3E-02
Molybdenum	3.03	1.14E-01	0.19	1.9	6.0E-01	6.0E-02
Nickel	11.01	4.14E-01	31	52	1.3E-02	8.0E-03
Selenium	0.69	2.59E-02	0.2	0.33	1.3E-01	7.8E-02
Thallium	0.25	9.25E-03	0.14	1.4	6.6E-02	6.6E-03
Vanadium	23.85	8.98E-01	0.42	2.1	2.1E+00	4.3E-01
Zinc	67.26	2.53E+00	160	320	1.6E-02	7.9E-03
Anthracene	0.79	2.99E-02	200	2000	1.5E-04	1.5E-05
Benz(a)anthracene	2.26	8.52E-02	1	10	8.5E-02	8.5E-03
Benzo(a)pyrene	2.33	8.79E-02	1	10	8.8E-02	8.8E-03
Benzo(b)fluoranthene	2.41	9.06E-02	1	10	9.1E-02	9.1E-03
Benzo(g,h,i)perylene	1.17	4.39E-02	1	10	4.4E-02	4.4E-03
Benzo(k)fluoranthene	0.88	3.32E-02	1	10	3.3E-02	3.3E-03
Chrysene	2.32	8.74E-02	1	10	8.7E-02	8.7E-03
Dibenz(a,h)anthracene	0.33	1.25E-02	1	10	1.3E-02	1.3E-03
Fluoranthene	4.34	1.63E-01	130	250	1.3E-03	6.5E-04
Indeno(1,2,3-cd)pyrene	1.37	5.16E-02	1	10	5.2E-02	5.2E-03
Naphthalene	0.13	5.04E-03	30	300	1.7E-04	1.7E-05
Phenanthrene	2.74	1.03E-01	15	150	6.9E-03	6.9E-04
Pyrene	3.99	1.50E-01	75	130	2.0E-03	1.2E-03
4,4'-DDD	0.00039	1.47E-05	0.8	4	1.8E-05	3.7E-06
4,4'-DDE	0.0028954	1.09E-04	0.8	4	1.4E-04	2.7E-05
4,4'-DDT	0.01032	3.89E-04	0.8	4	4.9E-04	9.7E-05
Aroclor 1254	0.06601	2.49E-03	0.068	0.68	3.7E-02	3.7E-03
Aroclor 1260	0.017356	6.53E-04	0.068	0.68	9.6E-03	9.6E-04
Aroclor 1268	0.00407	1.53E-04	0.068	0.68	2.3E-03	2.3E-04
beta-BHC	0.00042	1.58E-05	1.6	3.2	9.9E-06	4.9E-06
Chlordane	0.03133	1.18E-03	4.58	9.16	2.6E-04	1.3E-04
Dieldrin	0.00165	6.21E-05	0.028	0.28	2.2E-03	2.2E-04
Endrin	0.00059	2.22E-05	0.65	0.065	3.4E-05	3.4E-04
gamma-BHC (Lindane)	0.00171	6.44E-05	1.6	3.2	4.0E-05	2.0E-05
TEQ mammal	0.001104562	4.16E-05	0.000001	0.00001	4.2E+01	4.2E+00
				HAZARD INDICES:	**6.2E+01**	**6.5E+00**

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.

Table B-3.5 Calculation of Hazard Quotients: Short-tailed Shrew, Terrestrial Plants, General and Human Use Areas of the Oxbow

Scenario Timeframe:	Current/Future
Exposure Medium:	Terrestrial Plants
Exposure Point:	Oxbow Area
Receptor:	Short-tailed Shrew

INTAKE EQUATION - Plant Ingestion

$EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF * 1/BW$

Where C_{plant} is calculated using the following equation:

$C_{plant} = C_{soil} * BAF_{plant}$

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{plant}	Estimated Daily Intake Via Plant Ingestion	mg/kg-d	calculated	
BAF	Bioaccumulation Factor	unitless	chemical-specific	Table __
C_{plant}	Chemical Concentration in Plants	mg/kg	chemical-specific	
IR_{food}	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993
P_{plant}	Percent Plants in Diet	unitless	14%	Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993
BW	Body Weight	kg	0.017	Guilday, 1957

Analyte	Csoil (mg/kg)	Cplant (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b]		Hazard Quotient[c]	
				NOAEL	LOAEL	NOAEL	LOAEL
Antimony	0.333279412	6.7E-04	7.14E-05	0.026	0.26	2.7E-03	2.7E-04
Arsenic	5.035294118	5.0E-02	5.39E-03	0.13	1.3	4.1E-02	4.1E-03
Barium	40.15294118	1.2E+00	1.33E-01	75	160	1.8E-03	8.3E-04
Beryllium	0.64	1.3E-03	1.37E-04	0.66	6.6	2.1E-04	2.1E-05
Cadmium	0.292352941	1.3E-02	1.38E-03	1	10	1.4E-03	1.4E-04
Chromium	17.84294118	1.5E-01	1.57E-02	1500	15000	1.0E-05	1.0E-06
Cobalt	3.667647059	5.5E-03	5.89E-04	0.076	0.76	7.7E-03	7.7E-04
Copper	27.36470588	2.7E+00	2.84E-01	0.42	4.2	6.8E-01	6.8E-02
Lead	120.4058824	2.3E+00	2.45E-01	130	380	1.9E-03	6.4E-04
Manganese	544.4735294	8.7E+00	9.33E-01	88	280	1.1E-02	3.3E-03
Molybdenum	3.033235294	1.5E-01	1.62E-02	0.19	1.9	8.5E-02	8.5E-03
Nickel	11.00676471	1.3E-01	1.41E-02	31	52	4.6E-04	2.7E-04
Selenium	0.686764706	8.9E-02	9.56E-03	0.2	0.33	4.8E-02	2.9E-02
Thallium	0.245588235	2.0E-04	2.10E-05	0.14	1.4	1.5E-04	1.5E-05
Vanadium	23.85	2.3E-02	2.48E-03	0.42	2.1	5.9E-03	1.2E-03
Zinc	67.25588235	2.4E+01	2.52E+00	160	320	1.6E-02	7.9E-03
Anthracene	0.79309	1.7E-02	1.78E-03	200	2000	8.9E-06	8.9E-07
Benz(a)anthracene	2.2629	8.1E-03	8.72E-04	1	10	8.7E-04	8.7E-05
Benzo(a)pyrene	2.33432	5.1E-03	5.50E-04	1	10	5.5E-04	5.5E-05
Benzo(b)fluoranthene	2.407229412	8.4E-03	9.02E-04	1	10	9.0E-04	9.0E-05
Benzo(g,h,i)perylene	1.165002941	1.3E-03	1.37E-04	1	10	1.4E-04	1.4E-05
Benzo(k)fluoranthene	0.882073529	2.0E-03	2.17E-04	1	10	2.2E-04	2.2E-05
Chrysene	2.322688235	7.9E-03	8.45E-04	1	10	8.5E-04	8.5E-05
Dibenz(a,h)anthracene	0.332127941	3.2E-04	3.45E-05	1	10	3.4E-05	3.4E-06
Fluoranthene	4.336764706	3.5E-02	3.76E-03	130	250	2.9E-05	1.5E-05
Indeno(1,2,3-cd)pyrene	1.37105	1.4E-03	1.47E-04	1	10	1.5E-04	1.5E-05
Naphthalene	0.133836765	1.3E-02	1.38E-03	30	300	4.6E-05	4.6E-06
Phenanthrene	2.741755882	5.5E-02	5.87E-03	15	150	3.9E-04	3.9E-05
Pyrene	3.985264706	4.8E-02	5.12E-03	75	130	6.8E-05	3.9E-05
4,4'-DDD	0.00039	9.4E-07	1.00E-07	0.8	4	1.3E-07	2.5E-08
4,4'-DDE	0.0028954	2.8E-06	2.98E-07	0.8	4	3.7E-07	7.4E-08
4,4'-DDT	0.01032	1.4E-05	1.55E-06	0.8	4	1.9E-06	3.9E-07
Aroclor 1254	0.06601	9.2E-05	9.89E-06	0.068	0.68	1.5E-04	1.5E-05
Aroclor 1260	0.017356	5.9E-06	6.32E-07	0.068	0.68	9.3E-06	9.3E-07
Aroclor 1268	0.00407	1.4E-06	1.48E-07	0.068	0.68	2.2E-06	2.2E-07
beta-BHC	0.00042	2.1E-05	2.29E-06	1.6	3.2	1.4E-06	7.2E-07
Chlordane	0.03133	8.1E-05	8.72E-06	4.58	9.16	1.9E-06	9.5E-07
Dieldrin	0.00165	1.1E-05	1.18E-06	0.028	0.28	4.2E-05	4.2E-06
Endrin	0.00059	4.5E-06	4.80E-07	0.65	0.065	7.4E-07	7.4E-06
gamma-BHC (Lindane)	0.00171	1.0E-04	1.08E-05	1.6	3.2	6.8E-06	3.4E-06
TEQ mammal	0.001104562	0	0.00E+00	0.000001	0.00001	0.0E+00	0.0E+00
					HAZARD INDICES:	**9.0E-01**	**1.3E-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.

Table B-3.6. Calculation of Hazard Quotients: Short-tailed Shrew, Terrestrial *Invertebrates*, General and Human Use Areas of the Oxbow

Scenario Timeframe: Current/Future
Exposure Medium: Soil Invertebrates
Exposure Point: Oxbow Area
Receptor: Short-tailed Shrew

INTAKE EQUATION - Invertebrate Ingestion

$$EDI_{invert} = C_{invert} \cdot IR_{food} \cdot P_{invert} * SFF * EF * 1/BW$$

Where C_{invert} is estimated using site-specific BSAFs:

$$C_{invert} = BSAF * C_{soil} * L * 1/TOC,$$

or, if a BSAF is not available:

$$C_{invert} = C_{soil} * BAF$$

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{invert}	Estimated Daily Intake Via Invertebrate Ingestion	mg/kg-d	calculated	
C_{soil}	Chemical Concentration in Soil	mg/kg	chemical-specific	
C_{invert}	Chemical Concentration in Invertebrates	mg/kg	chemical-specific	
BSAF	Biota Soil Accumulation Factor	unitless	chemical-specific	Table __
L	Average lipid content of Lyman Mill earthworm samples	percent	2.66%	(Table 20; MACTEC, 2004)
TOC	Estimated Soil TOC	percent	8.88%	(Table J-8, MACTEC, 2004)
BAF	Bioaccumulation Factor	unitless	chemical-specific	Table __
IRfood	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993;
P_{invert}	Percent Invertebrates in Diet	unitless	85%	USEPA, 1993Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993;
BW	Body Weight	kg	0.017	Guilday, 1957

Analyte	Csoil (mg/kg)	Site-Specific Earthworm *Tissue Concentration*[c] (mg/kg)	Cinvert (mg/kg)	Estimated *Daily Intake*[a] (mg/kg-d)	Reference Dose[b] *(mg/kg-day)* NOAEL	LOAEL	Hazard Quotient[c] NOAEL	LOAEL
Antimony	0.333279412	0.07	0.070	4.54E-02	0.026	0.26	1.7E+00	1.7E-01
Arsenic	5.035294118	0.17	0.169	1.10E-01	0.13	1.3	8.4E-01	8.4E-02
Barium	40.15294118	2.84	2.839	1.85E+00	75	160	2.5E-02	1.2E-02
Beryllium	0.64	0.03	0.028	1.79E-02	0.66	6.6	2.7E-02	2.7E-03
Cadmium	0.292352941	0.35	0.352	2.29E-01	1	10	2.3E-01	2.3E-02
Chromium	17.84294118	0.44	0.444	2.88E-01	1500	15000	1.9E-04	1.9E-05
Cobalt	3.667647059	0.13	0.132	8.57E-02	0.076	0.76	1.1E+00	1.1E-01
Copper	27.36470588	0.80	0.803	5.22E-01	0.42	4.2	1.2E+00	1.2E-01
Lead	120.4058824	5.23	5.230	3.40E+00	130	380	2.6E-02	8.9E-03
Manganese	544.4735294	32.78	32.782	2.13E+01	88	280	2.4E-01	7.6E-02
Molybdenum	3.033235294	0.07	0.075	4.84E-02	0.19	1.9	2.5E-01	2.5E-02
Nickel	11.00676471	0.33	0.326	2.12E-01	31	52	6.8E-03	4.1E-03
Selenium	0.686764706	0.36	0.356	2.31E-01	0.2	0.33	1.2E+00	7.0E-01
Thallium	0.245588235	0.01	0.013	8.42E-03	0.14	1.4	6.0E-02	6.0E-03
Vanadium	23.85	0.57	0.572	3.72E-01	0.42	2.1	8.8E-01	1.8E-01
Zinc	67.25588235	12.45	12.451	8.09E+00	160	320	5.1E-02	2.5E-02
Anthracene	0.79309	#N/A	0.793	5.16E-01	200	2000	2.6E-03	2.6E-04
Benz(a)anthracene	2.2629	#N/A	2.489	1.62E+00	1	10	1.6E+00	1.6E-01
Benzo(a)pyrene	2.33432	#N/A	2.568	1.67E+00	1	10	1.7E+00	1.7E-01
Benzo(b)fluoranthene	2.407229412	#N/A	2.648	1.72E+00	1	10	1.7E+00	1.7E-01
Benzo(g,h,i)perylene	1.165002941	#N/A	1.282	8.33E-01	1	10	8.3E-01	8.3E-02
Benzo(k)fluoranthene	0.882073529	#N/A	0.970	6.31E-01	1	10	6.3E-01	6.3E-02
Chrysene	2.322688235	#N/A	2.555	1.66E+00	1	10	1.7E+00	1.7E-01
Dibenz(a,h)anthracene	0.332127941	#N/A	0.365	2.37E-01	1	10	2.4E-01	2.4E-02
Fluoranthene	4.336764706	#N/A	4.770	3.10E+00	130	250	2.4E-02	1.2E-02
Indeno(1,2,3-cd)pyrene	1.37105	#N/A	1.508	9.80E-01	1	10	9.8E-01	9.8E-02
Naphthalene	0.133836765	#N/A	0.134	8.70E-02	30	300	2.9E-03	2.9E-04
Phenanthrene	2.741755882	#N/A	2.742	1.78E+00	15	150	1.2E-01	1.2E-02
Pyrene	3.985264706	#N/A	3.985	2.59E+00	75	130	3.5E-02	2.0E-02
4,4'-DDD	0.00039	0.0001	0.0001	3.54E-05	0.8	4	4.4E-05	8.8E-06
4,4'-DDE	0.0028954	0.0005	0.0005	3.07E-04	0.8	4	3.8E-04	7.7E-05
4,4'-DDT	0.01032	0.0006	0.0006	4.22E-04	0.8	4	5.3E-04	1.1E-04
Aroclor 1254	0.06601	0.0070	0.0070	4.55E-03	0.068	0.68	6.7E-02	6.7E-03
Aroclor 1260	0.017356	#N/A	0.0191	1.24E-02	0.068	0.68	1.8E-01	1.8E-02
Aroclor 1268	0.00407	0.0005	0.0005	3.39E-04	0.068	0.68	5.0E-03	5.0E-04
beta-BHC	0.00042	#N/A	0.0004	2.73E-04	1.6	3.2	1.7E-04	8.5E-05
Chlordane	0.03133	0.0037	0.0037	2.38E-03	4.58	9.16	5.2E-04	2.6E-04
Dieldrin	0.00165	0.0003	0.0003	1.87E-04	0.028	0.28	6.7E-03	6.7E-04
Endrin	0.00059	#N/A	0.0006	4.22E-04	0.65	0.065	6.5E-04	6.5E-03
gamma-BHC (Lindane)	0.00171	0.0007	0.0007	4.43E-04	1.6	3.2	2.8E-04	1.4E-04
TEQ mammal	0.001104562	0.00012	0.0001	7.59E-05	0.000001	0.00001	7.6E+01	7.6E+00
						HAZARD INDICES:	**9.4E+01**	**1.0E+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 B-3.7. Calculation of Hazard Quotients: Short-tailed Shrew, Soil Ingestion, Northeast Oxbow Area

Scenario Timeframe:	Current/Future	
Exposure Medium:	Surface Soil (0-2 feet)	INTAKE EQUATION - Soil Ingestion
Exposure Point:	NE Oxbow Area	$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
Receptor:	Short-tailed Shrew	

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{soil}	Estimated Daily Intake Via Soil Ingestion	mg/kg-d	calculated	
Csoil	Chemical Concentration in Soil	mg/kg	chemical-specific	
IRsoil	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

Analyte	Csoil (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b] (mg/kg-day)		Hazard Quotient[c]	
			NOAEL	LOAEL	NOAEL	LOAEL
Antimony	0.49225	1.85E-02	0.026	0.26	7.1E-01	7.1E-02
Arsenic	5.166666667	1.95E-01	0.13	1.3	1.5E+00	1.5E-01
Beryllium	0.791666667	2.98E-02	0.66	6.6	4.5E-02	4.5E-03
Cadmium	0.576666667	2.17E-02	1	10	2.2E-02	2.2E-03
Chromium	35.71666667	1.34E+00	1500	15000	9.0E-04	9.0E-05
Cobalt	3.746666667	1.41E-01	0.076	0.76	1.9E+00	1.9E-01
Copper	33.28333333	1.25E+00	0.42	4.2	3.0E+00	3.0E-01
Lead	116.15	4.37E+00	130	380	3.4E-02	1.2E-02
Manganese	364	1.37E+01	88	280	1.6E-01	4.9E-02
Molybdenum	4.068333333	1.53E-01	0.19	1.9	8.1E-01	8.1E-02
Selenium	0.45	1.69E-02	0.2	0.33	8.5E-02	5.1E-02
Vanadium	21.98333333	8.28E-01	0.42	2.1	2.0E+00	3.9E-01
Zinc	88.53333333	3.33E+00	160	320	2.1E-02	1.0E-02
Anthracene	0.39545	1.49E-02	200	2000	7.4E-05	7.4E-06
Benz(a)anthracene	1.493333333	5.62E-02	1	10	5.6E-02	5.6E-03
Benzo(a)pyrene	1.840666667	6.93E-02	1	10	6.9E-02	6.9E-03
Benzo(b)fluoranthene	2.399833333	9.03E-02	1	10	9.0E-02	9.0E-03
Benzo(g,h,i)perylene	1.260166667	4.74E-02	1	10	4.7E-02	4.7E-03
Benzo(k)fluoranthene	0.764516667	2.88E-02	1	10	2.9E-02	2.9E-03
Chrysene	1.8975	7.14E-02	1	10	7.1E-02	7.1E-03
Dibenz(a,h)anthracene	0.321266667	1.21E-02	1	10	1.2E-02	1.2E-03
Fluoranthene	3.052	1.15E-01	130	250	8.8E-04	4.6E-04
Indeno(1,2,3-cd)pyrene	1.3285	5.00E-02	1	10	5.0E-02	5.0E-03
Naphthalene	0.033191667	1.25E-03	30	300	4.2E-05	4.2E-06
Phenanthrene	1.624816667	6.12E-02	15	150	4.1E-03	4.1E-04
Pyrene	2.995333333	1.13E-01	75	130	1.5E-03	8.7E-04
4,4'-DDD	0.002413333	9.09E-05	0.8	4	1.1E-04	2.3E-05
4,4'-DDE	0.00446	1.68E-04	0.8	4	2.1E-04	4.2E-05
4,4'-DDT	0.017916667	6.75E-04	0.8	4	8.4E-04	1.7E-04
Aroclor 1254	0.143558333	5.40E-03	0.068	0.68	7.9E-02	7.9E-03
Aroclor 1268	0.010666667	4.02E-04	0.068	0.68	5.9E-03	5.9E-04
Chlordane	0.146233333	5.51E-03	4.58	9.16	1.2E-03	6.0E-04
Endrin	0.000566167	2.13E-05	0.65	0.065	3.3E-05	3.3E-04
TEQ mammal	0.00336888	1.27E-04	0.000001	0.00001	1.3E+02	1.3E+01
				HAZARD INDICES:	**137.5**	**14.0**

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.

Table B-3.8. Calculation of Hazard Quotients: Short-tailed Shrew, Terrestrial Plants, Northeast Oxbow Area

Scenario Timeframe:	Current/Future
Exposure Medium:	Terrestrial Plants
Exposure Point:	NE Oxbow Area
Receptor:	Short-tailed Shrew

INTAKE EQUATION - Plant Ingestion

$$EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF * 1/BW$$

Where C_{plant} is calculated using the following equation:

$$C_{plant} = C_{soil} * BAF_{plant}$$

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{plant}	Estimated Daily Intake Via Plant Ingestion	mg/kg-d	calculated	
BAF	Bioaccumulation Factor	unitless	chemical-specific	Table __
C_{plant}	Chemical Concentration in Plants	mg/kg	chemical-specific	
IR_{food}	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993
P_{plant}	Percent Plants in Diet	unitless	14%	Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993
BW	Body Weight	kg	0.017	Guilday, 1957

Analyte	Csoil (mg/kg)	Cplant (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b] (mg/kg-day)		Hazard Quotient[c]	
				NOAEL	LOAEL	NOAEL	LOAEL
Antimony	0.4922500	0.0009845	1.05E-04	0.026	0.26	4.1E-03	4.1E-04
Arsenic	5.1666667	0.0516667	5.53E-03	0.13	1.3	4.3E-02	4.3E-03
Beryllium	0.7916667	0.0015833	1.70E-04	0.66	6.6	2.6E-04	2.6E-05
Cadmium	0.5766667	0.0253733	2.72E-03	1	10	2.7E-03	2.7E-04
Chromium	35.7166667	0.2928767	3.14E-02	1500	15000	2.1E-05	2.1E-06
Cobalt	3.7466667	0.0056200	6.02E-04	0.076	0.76	7.9E-03	7.9E-04
Copper	33.2833333	3.2284833	3.46E-01	0.42	4.2	8.2E-01	8.2E-02
Lead	116.1500000	2.2068500	2.36E-01	130	380	1.8E-03	6.2E-04
Manganese	364.0000000	5.8240000	6.24E-01	88	280	7.1E-03	2.2E-03
Molybdenum	4.0683333	0.2034167	2.18E-02	0.19	1.9	1.1E-01	1.1E-02
Selenium	0.4500000	0.0585000	6.26E-03	0.2	0.33	3.1E-02	1.9E-02
Vanadium	21.9833333	0.0213238	2.28E-03	0.42	2.1	5.4E-03	1.1E-03
Zinc	88.5333333	30.9866667	3.32E+00	160	320	2.1E-02	1.0E-02
Anthracene	0.3954500	0.0083045	8.89E-04	200	2000	4.4E-06	4.4E-07
Benz(a)anthracene	1.4933333	0.0053760	5.76E-04	1	10	5.8E-04	5.8E-05
Benzo(a)pyrene	1.8406667	0.0040495	4.34E-04	1	10	4.3E-04	4.3E-05
Benzo(b)fluoranthene	2.3998333	0.0083994	8.99E-04	1	10	9.0E-04	9.0E-05
Benzo(g,h,i)perylene	1.2601667	0.0013862	1.48E-04	1	10	1.5E-04	1.5E-05
Benzo(k)fluoranthene	0.7645167	0.0017584	1.88E-04	1	10	1.9E-04	1.9E-05
Chrysene	1.8975000	0.0064515	6.91E-04	1	10	6.9E-04	6.9E-05
Dibenz(a,h)anthracene	0.3212667	0.0003116	3.34E-05	1	10	3.3E-05	3.3E-06
Fluoranthene	3.0520000	0.0247212	2.65E-03	130	250	2.0E-05	1.1E-05
Indeno(1,2,3-cd)pyrene	1.3285000	0.0013285	1.42E-04	1	10	1.4E-04	1.4E-05
Naphthalene	0.0331917	0.0031864	3.41E-04	30	300	1.1E-05	1.1E-06
Phenanthrene	1.6248167	0.0324963	3.48E-03	15	150	2.3E-04	2.3E-05
Pyrene	2.9953333	0.0359440	3.85E-03	75	130	5.1E-05	3.0E-05
4,4'-DDD	0.0024133	0.0000058	6.20E-07	0.8	4	7.8E-07	1.6E-07
4,4'-DDE	0.0044600	0.0000043	4.58E-07	0.8	4	5.7E-07	1.1E-07
4,4'-DDT	0.0179167	0.0000251	2.69E-06	0.8	4	3.4E-06	6.7E-07
Aroclor 1254	0.1435583	0.0002010	2.15E-05	0.068	0.68	3.2E-04	3.2E-05
Aroclor 1268	0.0106667	0.0000036	3.88E-07	0.068	0.68	5.7E-06	5.7E-07
Chlordane	0.1462333	0.0003802	4.07E-05	4.58	9.16	8.9E-06	4.4E-06
Endrin	0.0005662	0.0000043	4.61E-07	0.65	0.065	7.1E-07	7.1E-06
TEQ mammal	0.0033689	0.0000000	0.00E+00	0.000001	0.00001	0.0E+00	0.0E+00
					HAZARD INDICES:	**1.1E+00**	**1.3E-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.

Table B-3.9. Calculation of Hazard Quotients: Short-tailed Shrew, Invertebrate Ingestion, Northeast Oxbow Area

Scenario Timeframe: Current/Future
Exposure Medium: Soil Invertebrates
Exposure Point: Assapumpset Brook
Receptor: Short-tailed Shrew

INTAKE EQUATION - Invertebrate Ingestion

$$EDI_{invert} = C_{invert} \cdot IR_{food} \cdot P_{invert} * SFF * EF * 1/BW$$

Where C_{invert} is estimated using site-specific BSAFs:

$$C_{invert} = BSAF * C_{soil} * L * 1/TOC,$$

or, if a BSAF is not available:

$$C_{invert} = C_{soil} * BAF$$

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{invert}	Estimated Daily Intake Via Invertebrate Ingestion	mg/kg-d	calculated	
C_{soil}	Chemical Concentration in Soil	mg/kg	chemical-specific	
C_{invert}	Chemical Concentration in Invertebrates	mg/kg	chemical-specific	
BSAF	Biota Soil Accumulation Factor	unitless	chemical-specific	Table __
L	Average lipid content of Lyman Mill earthworm samples	percent	2.66%	(Table 20; MACTEC, 2004)
TOC	Estimated Soil TOC	percent	8.88%	(Table J-8, MACTEC, 2004)
BAF	Bioaccumulation Factor	unitless	chemical-specific	Table __
IRfood	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993;
P_{invert}	Percent Invertebrates in Diet	unitless	85%	USEPA, 1993Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993;
BW	Body Weight	kg	0.017	Guilday, 1957

Analyte	Csoil (mg/kg)	Site-Specific Earthworm Tissue Concentration[c] (mg/kg)	Cinvert (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b] (mg/kg-day)		Hazard Quotient[c]	
					NOAEL	LOAEL	NOAEL	LOAEL
Antimony	0.49225	0.10	0.103	6.70E-02	0.026	0.26	2.6E+00	2.6E-01
Arsenic	5.166666667	0.17	0.173	1.13E-01	0.13	1.3	8.7E-01	8.7E-02
Beryllium	0.791666667	0.03	0.034	2.22E-02	0.66	6.6	3.4E-02	3.4E-03
Cadmium	0.576666667	0.69	0.694	4.51E-01	1	10	4.5E-01	4.5E-02
Chromium	35.71666667	0.89	0.888	5.77E-01	1500	15000	3.8E-04	3.8E-05
Cobalt	3.746666667	0.13	0.135	8.75E-02	0.076	0.76	1.2E+00	1.2E-01
Copper	33.28333333	0.98	0.977	6.35E-01	0.42	4.2	1.5E+00	1.5E-01
Lead	116.15	5.04	5.045	3.28E+00	130	380	2.5E-02	8.6E-03
Manganese	364	21.92	21.916	1.42E+01	88	280	1.6E-01	5.1E-02
Molybdenum	4.068333333	0.10	0.100	6.50E-02	0.19	1.9	3.4E-01	3.4E-02
Selenium	0.45	0.23	0.233	1.52E-01	0.2	0.33	7.6E-01	4.6E-01
Vanadium	21.98333333	0.53	0.527	3.42E-01	0.42	2.1	8.2E-01	1.6E-01
Zinc	88.53333333	16.39	16.389	1.07E+01	160	320	6.7E-02	3.3E-02
Anthracene	0.39545	#N/A	0.395	2.57E-01	200	2000	1.3E-03	1.3E-04
Benz(a)anthracene	1.493333333	#N/A	1.643	1.07E+00	1	10	1.1E+00	1.1E-01
Benzo(a)pyrene	1.840666667	#N/A	2.025	1.32E+00	1	10	1.3E+00	1.3E-01
Benzo(b)fluoranthene	2.399833333	#N/A	2.640	1.72E+00	1	10	1.7E+00	1.7E-01
Benzo(g,h,i)perylene	1.260166667	#N/A	1.386	9.01E-01	1	10	9.0E-01	9.0E-02
Benzo(k)fluoranthene	0.764516667	#N/A	0.841	5.47E-01	1	10	5.5E-01	5.5E-02
Chrysene	1.8975	#N/A	2.087	1.36E+00	1	10	1.4E+00	1.4E-01
Dibenz(a,h)anthracene	0.321266667	#N/A	0.353	2.30E-01	1	10	2.3E-01	2.3E-02
Fluoranthene	3.052	#N/A	3.357	2.18E+00	130	250	1.7E-02	8.7E-03
Indeno(1,2,3-cd)pyrene	1.3285	#N/A	1.461	9.50E-01	1	10	9.5E-01	9.5E-02
Naphthalene	0.033191667	#N/A	0.033	2.16E-02	30	300	7.2E-04	7.2E-05
Phenanthrene	1.624816667	#N/A	1.625	1.06E+00	15	150	7.0E-02	7.0E-03
Pyrene	2.995333333	#N/A	2.995	1.95E+00	75	130	2.6E-02	1.5E-02
4,4'-DDD	0.002413333	0.00	0.000	2.19E-04	0.8	4	2.7E-04	5.5E-05
4,4'-DDE	0.00446	0.00	0.001	4.73E-04	0.8	4	5.9E-04	1.2E-04
4,4'-DDT	0.017916667	0.00	0.001	7.33E-04	0.8	4	9.2E-04	1.8E-04
Aroclor 1254	0.143558333	0.02	0.015	9.89E-03	0.068	0.68	1.5E-01	1.5E-02
Aroclor 1268	0.010666667	0.00	0.001	8.89E-04	0.068	0.68	1.3E-02	1.3E-03
Chlordane	0.146233333	0.02	0.017	1.11E-02	4.58	9.16	2.4E-03	1.2E-03
Endrin	0.000566167	#N/A	0.001	4.05E-04	0.65	0.065	6.2E-04	6.2E-03
TEQ mammal	0.00336888	0.00	0.000	2.32E-04	0.000001	0.00001	2.3E+02	2.3E+01
						HAZARD INDICES:	**2.6E+02**	**2.6E+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 B-3.10. Calculation of Hazard Quotients: Short-tailed Shrew, Soil Ingestion, Southeast Lyman Mill Pond Area

Inc HI

Scenario Timeframe:	Current/Future	
Exposure Medium:	Surface Soil (0-2 feet)	INTAKE EQUATION - Soil Ingestion
Exposure Point:	SE Lyman Mill Pond Area	$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
Receptor:	Short-tailed Shrew	

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{soil}	Estimated Daily Intake Via Soil Ingestion	mg/kg-d	calculated	
Csoil	Chemical Concentration in Soil	mg/kg	chemical-specific	
IRsoil	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

Analyte	Csoil (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b] (mg/kg-day)		Hazard Quotient[c]	
			NOAEL	LOAEL	NOAEL	LOAEL
Antimony	3.18	1.20E-01	0.026	0.26	4.6E+00	4.6E-01
Arsenic	6.3	2.37E-01	0.13	1.3	1.8E+00	1.8E-01
Cadmium	2.43	9.15E-02	1	10	9.1E-02	9.1E-03
Chromium	12.8	4.82E-01	1500	15000	3.2E-04	3.2E-05
Cobalt	3.25	1.22E-01	0.076	0.76	1.6E+00	1.6E-01
Copper	91.9	3.46E+00	0.42	4.2	8.2E+00	8.2E-01
Lead	337	1.27E+01	130	380	9.8E-02	3.3E-02
Manganese	150	5.65E+00	88	280	6.4E-02	2.0E-02
Molybdenum	1.06	3.99E-02	0.19	1.9	2.1E-01	2.1E-02
Selenium	0.4	1.51E-02	0.2	0.33	7.5E-02	4.6E-02
Vanadium	13.5	5.08E-01	0.42	2.1	1.2E+00	2.4E-01
Zinc	188	7.08E+00	160	320	4.4E-02	2.2E-02
Anthracene	0.15	5.65E-03	200	2000	2.8E-05	2.8E-06
Benz(a)anthracene	0.3	1.13E-02	1	10	1.1E-02	1.1E-03
Benzo(a)pyrene	0.41	1.54E-02	1	10	1.5E-02	1.5E-03
Benzo(b)fluoranthene	0.58	2.18E-02	1	10	2.2E-02	2.2E-03
Benzo(k)fluoranthene	0.17	6.40E-03	1	10	6.4E-03	6.4E-04
Chrysene	0.45	1.69E-02	1	10	1.7E-02	1.7E-03
Dibenz(a,h)anthracene	0.079	2.97E-03	1	10	3.0E-03	3.0E-04
Fluoranthene	0.64	2.41E-02	130	250	1.9E-04	9.6E-05
Indeno(1,2,3-cd)pyrene	0.37	1.39E-02	1	10	1.4E-02	1.4E-03
Naphthalene	0.025	9.41E-04	30	300	3.1E-05	3.1E-06
Phenanthrene	0.37	1.39E-02	15	150	9.3E-04	9.3E-05
Pyrene	0.65	2.45E-02	75	130	3.3E-04	1.9E-04
4,4'-DDD	0.0038	1.43E-04	0.8	4	1.8E-04	3.6E-05
4,4'-DDE	0.036	1.36E-03	0.8	4	1.7E-03	3.4E-04
4,4'-DDT	0.052	1.96E-03	0.8	4	2.4E-03	4.9E-04
Aroclor 1260	0.029	1.09E-03	0.068	0.68	1.6E-02	1.6E-03
TEQ mammal	0.00001469	5.53E-07	0.000001	0.00001	5.5E-01	5.5E-02
				HAZARD INDICES:	**1.9E+01**	**2.1E+00**

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.

Table B-3.11. Calculation of Hazard Quotients: Short-tailed Shrew, Terrestrial Plants, Southeast Lyman Mill Pond Area

Scenario Timeframe:	Current/Future
Exposure Medium:	Terrestrial Plants
Exposure Point:	SE Lyman Mill Pond Area
Receptor:	Short-tailed Shrew

INTAKE EQUATION - Plant Ingestion

$$EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF * 1/BW$$

Where C_{plant} is calculated using the following equation:

$$C_{plant} = C_{soil} * BAF_{plant}$$

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{plant}	Estimated Daily Intake Via Plant Ingestion	mg/kg-d	calculated	
BAF	Bioaccumulation Factor	unitless	chemical-specific	Table __
C_{plant}	Chemical Concentration in Plants	mg/kg	chemical-specific	
IR_{food}	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993
P_{plant}	Percent Plants in Diet	unitless	14%	Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993
BW	Body Weight	kg	0.017	Guilday, 1957

Analyte	Csoil (mg/kg)	Cplant (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b]		Hazard Quotient[c]	
				NOAEL	LOAEL	NOAEL	LOAEL
Antimony	3.18	0.00636	6.81E-04	0.026	0.26	2.6E-02	2.6E-03
Arsenic	6.3	0.063	6.74E-03	0.13	1.3	5.2E-02	5.2E-03
Cadmium	2.43	0.10692	1.14E-02	1	10	1.1E-02	1.1E-03
Chromium	12.8	0.10496	1.12E-02	1500	15000	7.5E-06	7.5E-07
Cobalt	3.25	0.004875	5.22E-04	0.076	0.76	6.9E-03	6.9E-04
Copper	91.9	8.9143	9.54E-01	0.42	4.2	2.3E+00	2.3E-01
Lead	337	6.403	6.85E-01	130	380	5.3E-03	1.8E-03
Manganese	150	2.4	2.57E-01	88	280	2.9E-03	9.2E-04
Molybdenum	1.06	0.053	5.67E-03	0.19	1.9	3.0E-02	3.0E-03
Selenium	0.4	0.052	5.57E-03	0.2	0.33	2.8E-02	1.7E-02
Vanadium	13.5	0.013095	1.40E-03	0.42	2.1	3.3E-03	6.7E-04
Zinc	188	65.8	7.04E+00	160	320	4.4E-02	2.2E-02
Anthracene	0.15	0.00315	3.37E-04	200	2000	1.7E-06	1.7E-07
Benz(a)anthracene	0.3	0.00108	1.16E-04	1	10	1.2E-04	1.2E-05
Benzo(a)pyrene	0.41	0.000902	9.66E-05	1	10	9.7E-05	9.7E-06
Benzo(b)fluoranthene	0.58	0.00203	2.17E-04	1	10	2.2E-04	2.2E-05
Benzo(k)fluoranthene	0.17	0.000391	4.19E-05	1	10	4.2E-05	4.2E-06
Chrysene	0.45	0.00153	1.64E-04	1	10	1.6E-04	1.6E-05
Dibenz(a,h)anthracene	0.079	0.00007663	8.20E-06	1	10	8.2E-06	8.2E-07
Fluoranthene	0.64	0.005184	5.55E-04	130	250	4.3E-06	2.2E-06
Indeno(1,2,3-cd)pyrene	0.37	0.00037	3.96E-05	1	10	4.0E-05	4.0E-06
Naphthalene	0.025	0.0024	2.57E-04	30	300	8.6E-06	8.6E-07
Phenanthrene	0.37	0.0074	7.92E-04	15	150	5.3E-05	5.3E-06
Pyrene	0.65	0.0078	8.35E-04	75	130	1.1E-05	6.4E-06
4,4'-DDD	0.0038	0.00000912	9.76E-07	0.8	4	1.2E-06	2.4E-07
4,4'-DDE	0.036	0.00003456	3.70E-06	0.8	4	4.6E-06	9.2E-07
4,4'-DDT	0.052	0.0000728	7.79E-06	0.8	4	9.7E-06	1.9E-06
Aroclor 1260	0.029	0.00000986	1.06E-06	0.068	0.68	1.6E-05	1.6E-06
TEQ mammal	0.00001469	0	0.00E+00	0.000001	0.00001	0.0E+00	0.0E+00
					HAZARD INDICES:	**2.5E+00**	**2.8E-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.

Table B-3.12. Calculation of Hazard Quotients: Short-tailed Shrew, Invertebrate Ingestion, Southeast Lyman Mill Pond Area

Scenario Timeframe: Current/Future
Exposure Medium: Soil Invertebrates
Exposure Point: Assapumpset Brook
Receptor: Short-tailed Shrew

INTAKE EQUATION - Invertebrate Ingestion

$$EDI_{invert} = C_{invert} \cdot Ir_{food} \cdot P_{invert} * SFF * EF * 1/BW$$

Where C_{invert} is estimated using site-specific BSAFs:

$$C_{invert} = BSAF * C_{soil} * L * 1/TOC,$$

or, if a BSAF is not available:

$$C_{invert} = C_{soil} * BAF$$

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{invert}	Estimated Daily Intake Via Invertebrate Ingestion	mg/kg-d	calculated	
C_{soil}	Chemical Concentration in Soil	mg/kg	chemical-specific	
C_{invert}	Chemical Concentration in Invertebrates	mg/kg	chemical-specific	
BSAF	Biota Soil Accumulation Factor	unitless	chemical-specific	Table __
L	Average lipid content of Lyman Mill earthworm samples	percent	2.66%	(Table 20; MACTEC, 2004)
TOC	Estimated Soil TOC	percent	8.88%	(Table J-8, MACTEC, 2004)
BAF	Bioaccumulation Factor	unitless	chemical-specific	Table __
IRfood	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993;
P_{invert}	Percent Invertebrates in Diet	unitless	85%	USEPA, 1993Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993;
BW	Body Weight	kg	0.017	Guilday, 1957

Analyte	Csoil (mg/kg)	Site-Specific Earthworm Tissue Concentration[c] (mg/kg)	Cinvert (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b] (mg/kg-day) NOAEL	Reference Dose[b] (mg/kg-day) LOAEL	Hazard Quotient[c] NOAEL	Hazard Quotient[c] LOAEL
Antimony	3.18	0.67	0.666	4.33E-01	0.026	0.26	1.7E+01	1.7E+00
Arsenic	6.3	0.21	0.211	1.37E-01	0.13	1.3	1.1E+00	1.1E-01
Cadmium	2.43	2.92	2.923	1.90E+00	1	10	1.9E+00	1.9E-01
Chromium	12.8	0.32	0.318	2.07E-01	1500	15000	1.4E-04	1.4E-05
Cobalt	3.25	0.12	0.117	7.59E-02	0.076	0.76	1.0E+00	1.0E-01
Copper	91.9	2.70	2.698	1.75E+00	0.42	4.2	4.2E+00	4.2E-01
Lead	337	14.64	14.637	9.51E+00	130	380	7.3E-02	2.5E-02
Manganese	150	9.03	9.031	5.87E+00	88	280	6.7E-02	2.1E-02
Molybdenum	1.06	0.03	0.026	1.69E-02	0.19	1.9	8.9E-02	8.9E-03
Selenium	0.4	0.21	0.207	1.35E-01	0.2	0.33	6.7E-01	4.1E-01
Vanadium	13.5	0.32	0.324	2.10E-01	0.42	2.1	5.0E-01	1.0E-01
Zinc	188	34.80	34.803	2.26E+01	160	320	1.4E-01	7.1E-02
Anthracene	0.15	#N/A	0.150	9.75E-02	200	2000	4.9E-04	4.9E-05
Benz(a)anthracene	0.3	#N/A	0.330	2.15E-01	1	10	2.1E-01	2.1E-02
Benzo(a)pyrene	0.41	#N/A	0.451	2.93E-01	1	10	2.9E-01	2.9E-02
Benzo(b)fluoranthene	0.58	#N/A	0.638	4.15E-01	1	10	4.1E-01	4.1E-02
Benzo(k)fluoranthene	0.17	#N/A	0.187	1.22E-01	1	10	1.2E-01	1.2E-02
Chrysene	0.45	#N/A	0.495	3.22E-01	1	10	3.2E-01	3.2E-02
Dibenz(a,h)anthracene	0.079	#N/A	0.087	5.65E-02	1	10	5.6E-02	5.6E-03
Fluoranthene	0.64	#N/A	0.704	4.58E-01	130	250	3.5E-03	1.8E-03
Indeno(1,2,3-cd)pyrene	0.37	#N/A	0.407	2.65E-01	1	10	2.6E-01	2.6E-02
Naphthalene	0.025	#N/A	0.025	1.63E-02	30	300	5.4E-04	5.4E-05
Phenanthrene	0.37	#N/A	0.370	2.41E-01	15	150	1.6E-02	1.6E-03
Pyrene	0.65	#N/A	0.650	4.23E-01	75	130	5.6E-03	3.3E-03
4,4'-DDD	0.0038	0.001	0.001	3.45E-04	0.8	4	4.3E-04	8.6E-05
4,4'-DDE	0.036	0.01	0.006	3.82E-03	0.8	4	4.8E-03	9.6E-04
4,4'-DDT	0.052	0.003	0.003	2.13E-03	0.8	4	2.7E-03	5.3E-04
Aroclor 1260	0.029	#N/A	0.032	2.07E-02	0.068	0.68	3.0E-01	3.0E-02
TEQ mammal	0.00001469	1.6E-06	1.6E-06	1.01E-06	0.000001	0.00001	1.0E+00	1.0E-01
						HAZARD INDICES:	**2.9E+01**	**3.4E+00**

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 B-3.13. Calculation of Hazard Quotients: Short-tailed Shrew, Soil Ingestion, Assapumpset Brook Area

Scenario Timeframe:	Current/Future	
Exposure Medium:	Surface Soil (0-2 feet)	INTAKE EQUATION - Soil Ingestion
Exposure Point:	Assapumpset Brook	$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
Receptor:	Short-tailed Shrew	

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{soil}	Estimated Daily Intake Via Soil Ingestion	mg/kg-d	calculated	
Csoil	Chemical Concentration in Soil	mg/kg	chemical-specific	
IRsoil	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

Analyte	Csoil (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b] (mg/kg-day)		Hazard Quotient[c]	
			NOAEL	LOAEL	NOAEL	LOAEL
Antimony	1.38	5.20E-02	0.026	0.26	2.0E+00	2.0E-01
Arsenic	13.7	5.16E-01	0.13	1.3	4.0E+00	4.0E-01
Beryllium	0.89	3.35E-02	0.66	6.6	5.1E-02	5.1E-03
Chromium	18.2	6.85E-01	1500	15000	4.6E-04	4.6E-05
Cobalt	9.11	3.43E-01	0.076	0.76	4.5E+00	4.5E-01
Copper	119	4.48E+00	0.42	4.2	1.1E+01	1.1E+00
Lead	213	8.02E+00	130	380	6.2E-02	2.1E-02
Manganese	882	3.32E+01	88	280	3.8E-01	1.2E-01
Molybdenum	1.73	6.51E-02	0.19	1.9	3.4E-01	3.4E-02
Selenium	4.5	1.69E-01	0.2	0.33	8.5E-01	5.1E-01
Thallium	0.8	3.01E-02	0.14	1.4	2.2E-01	2.2E-02
Vanadium	22.8	8.58E-01	0.42	2.1	2.0E+00	4.1E-01
Zinc	190	7.15E+00	160	320	4.5E-02	2.2E-02
Anthracene	0.17	6.40E-03	200	2000	3.2E-05	3.2E-06
Benz(a)anthracene	0.59	2.22E-02	1	10	2.2E-02	2.2E-03
Benzo(a)pyrene	0.67	2.52E-02	1	10	2.5E-02	2.5E-03
Benzo(b)fluoranthene	0.91	3.43E-02	1	10	3.4E-02	3.4E-03
Benzo(k)fluoranthene	0.3	1.13E-02	1	10	1.1E-02	1.1E-03
Chrysene	0.74	2.79E-02	1	10	2.8E-02	2.8E-03
Dibenz(a,h)anthracene	0.12	4.52E-03	1	10	4.5E-03	4.5E-04
Fluoranthene	1.3	4.89E-02	130	250	3.8E-04	2.0E-04
Indeno(1,2,3-cd)pyrene	0.53	2.00E-02	1	10	2.0E-02	2.0E-03
Phenanthrene	0.57	2.15E-02	15	150	1.4E-03	1.4E-04
Pyrene	1.2	4.52E-02	75	130	6.0E-04	3.5E-04
4,4'-DDD	0.014	5.27E-04	0.8	4	6.6E-04	1.3E-04
4,4'-DDE	0.0088	3.31E-04	0.8	4	4.1E-04	8.3E-05
4,4'-DDT	0.053	2.00E-03	0.8	4	2.5E-03	5.0E-04
Aroclor 1254	0.25	9.41E-03	0.068	0.68	1.4E-01	1.4E-02
Aroclor 1260	0.28	1.05E-02	0.068	0.68	1.6E-01	1.6E-02
TEQ mammal	0.0001392	5.24E-06	0.000001	0.00001	5.2E+00	5.2E-01
				HAZARD INDICES:	**30.8**	**3.8**

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.

Table B-3.14. Calculation of Hazard Quotients: Short-tailed Shrew, Terrestrial Plants, Assapumpset Brook Area

Scenario Timeframe:	Current/Future	INTAKE EQUATION - Plant Ingestion
Exposure Medium:	Terrestrial Plants	$EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF * 1/BW$
Exposure Point:	Assapumpset Brook	Where C_{plant} is calculated using the following equation:
Receptor:	Short-tailed Shrew	$C_{plant} = C_{soil} * BAF_{plant}$

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{plant}	Estimated Daily Intake Via Plant Ingestion	mg/kg-d	calculated	
BAF	Bioaccumulation Factor	unitless	chemical-specific	Table __
C_{plant}	Chemical Concentration in Plants	mg/kg	chemical-specific	
IR_{food}	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993
P_{plant}	Percent Plants in Diet	unitless	14%	Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993
BW	Body Weight	kg	0.017	Guilday, 1957

Analyte	Csoil (mg/kg)	Cplant (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b] NOAEL	Reference Dose[b] LOAEL	Hazard Quotient[c] NOAEL	Hazard Quotient[c] LOAEL
Antimony	1.38	0.00276	2.95E-04	0.026	0.26	1.1E-02	1.1E-03
Arsenic	13.7	0.137	1.47E-02	0.13	1.3	1.1E-01	1.1E-02
Beryllium	0.89	0.00178	1.91E-04	0.66	6.6	2.9E-04	2.9E-05
Chromium	18.2	0.14924	1.60E-02	1500	15000	1.1E-05	1.1E-06
Cobalt	9.11	0.013665	1.46E-03	0.076	0.76	1.9E-02	1.9E-03
Copper	119	11.543	1.24E+00	0.42	4.2	2.9E+00	2.9E-01
Lead	213	4.047	4.33E-01	130	380	3.3E-03	1.1E-03
Manganese	882	14.112	1.51E+00	88	280	1.7E-02	5.4E-03
Molybdenum	1.73	0.0865	9.26E-03	0.19	1.9	4.9E-02	4.9E-03
Selenium	4.5	0.585	6.26E-02	0.2	0.33	3.1E-01	1.9E-01
Thallium	0.8	0.00064	6.85E-05	0.14	1.4	4.9E-04	4.9E-05
Vanadium	22.8	0.022116	2.37E-03	0.42	2.1	5.6E-03	1.1E-03
Zinc	190	66.5	7.12E+00	160	320	4.4E-02	2.2E-02
Anthracene	0.17	0.00357	3.82E-04	200	2000	1.9E-06	1.9E-07
Benz(a)anthracene	0.59	0.002124	2.27E-04	1	10	2.3E-04	2.3E-05
Benzo(a)pyrene	0.67	0.001474	1.58E-04	1	10	1.6E-04	1.6E-05
Benzo(b)fluoranthene	0.91	0.003185	3.41E-04	1	10	3.4E-04	3.4E-05
Benzo(k)fluoranthene	0.3	0.00069	7.39E-05	1	10	7.4E-05	7.4E-06
Chrysene	0.74	0.002516	2.69E-04	1	10	2.7E-04	2.7E-05
Dibenz(a,h)anthracene	0.12	0.0001164	1.25E-05	1	10	1.2E-05	1.2E-06
Fluoranthene	1.3	0.01053	1.13E-03	130	250	8.7E-06	4.5E-06
Indeno(1,2,3-cd)pyrene	0.53	0.00053	5.67E-05	1	10	5.7E-05	5.7E-06
Phenanthrene	0.57	0.0114	1.22E-03	15	150	8.1E-05	8.1E-06
Pyrene	1.2	0.0144	1.54E-03	75	130	2.1E-05	1.2E-05
4,4'-DDD	0.014	0.0000336	3.60E-06	0.8	4	4.5E-06	9.0E-07
4,4'-DDE	0.0088	0.000008448	9.04E-07	0.8	4	1.1E-06	2.3E-07
4,4'-DDT	0.053	0.0000742	7.94E-06	0.8	4	9.9E-06	2.0E-06
Aroclor 1254	0.25	0.00035	3.75E-05	0.068	0.68	5.5E-04	5.5E-05
Aroclor 1260	0.28	0.0000952	1.02E-05	0.068	0.68	1.5E-04	1.5E-05
TEQ mammal	0.0001392	0	0.00E+00	0.000001	0.00001	0.0E+00	0.0E+00
					HAZARD INDICES	**3.5**	**0.5**

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.

Table B-3.15. Calculation of Hazard Quotients: Short-tailed Shrew, Invertebrate Ingestion, Assapumpset Brook Area

Scenario Timeframe: Current/Future
Exposure Medium: Soil Invertebrates
Exposure Point: Assapumpset Brook
Receptor: Short-tailed Shrew

INTAKE EQUATION - Invertebrate Ingestion

$$EDI_{invert} = C_{invert} \cdot Ir_{food} \cdot P_{invert} * SFF * EF * 1/BW$$

Where C_{invert} is estimated using site-specific BSAFs:

$$C_{invert} = BSAF * C_{soil} * L * 1/TOC,$$

or, if a BSAF is not available:

$$C_{invert} = C_{soil} * BAF$$

Parameter Symbol	Parameter Definition	Units	RME Vvalue	RME Rationale/ Reference
EDI_{invert}	Estimated Daily Intake Via Invertebrate Ingestion	mg/kg-d	calculated	
C_{soil}	Chemical Concentration in Soil	mg/kg	chemical-specific	
C_{invert}	Chemical Concentration in Invertebrates	mg/kg	chemical-specific	
BSAF	Biota Soil Accumulation Factor	unitless	chemical-specific	Table __
L	Average lipid content of Lyman Mill earthworm samples	percent	2.66%	(Table 20; MACTEC, 2004)
TOC	Estimated Soil TOC	percent	8.88%	(Table J-8, MACTEC, 2004)
BAF	Bioaccumulation Factor	unitless	chemical-specific	Table __
IRfood	Ingestion Rate of Food	kg/day	0.013	USEPA, 1993;
P_{invert}	Percent Invertebrates in Diet	unitless	85%	Whitaker and Feraro, 1963
SFF	Site Foraging Frequency	unitless	100%	Buckner, 1966
EF	Exposure Frequency	unitless	100%	USEPA, 1993;
BW	Body Weight	kg	0.017	Guilday, 1957

Analyte	Csoil (mg/kg)	Site-Specific Earthworm Tissue Concentration[c] (mg/kg)	Cinvert (mg/kg)	Estimated Daily Intake[a] (mg/kg-d)	Reference Dose[b] (mg/kg-day)		Hazard Quotient[c]	
					NOAEL	LOAEL	NOAEL	LOAEL
Antimony	1.38	0.29	0.289	1.88E-01	0.026	0.26	7.2E+00	7.2E-01
Arsenic	13.7	0.46	0.460	2.99E-01	0.13	1.3	2.3E+00	2.3E-01
Beryllium	0.89	0.04	0.038	2.50E-02	0.66	6.6	3.8E-02	3.8E-03
Chromium	18.2	0.45	0.452	2.94E-01	1500	15000	2.0E-04	2.0E-05
Cobalt	9.11	0.33	0.327	2.13E-01	0.076	0.76	2.8E+00	2.8E-01
Copper	119	3.49	3.493	2.27E+00	0.42	4.2	5.4E+00	5.4E-01
Lead	213	9.25	9.252	6.01E+00	130	380	4.6E-02	1.6E-02
Manganese	882	53.10	53.105	3.45E+01	88	280	3.9E-01	1.2E-01
Molybdenum	1.73	0.04	0.042	2.76E-02	0.19	1.9	1.5E-01	1.5E-02
Selenium	4.5	2.33	2.332	1.52E+00	0.2	0.33	7.6E+00	4.6E+00
Thallium	0.8	0.04	0.042	2.74E-02	0.14	1.4	2.0E-01	2.0E-02
Vanadium	22.8	0.55	0.546	3.55E-01	0.42	2.1	8.5E-01	1.7E-01
Zinc	190	35.17	35.173	2.29E+01	160	320	1.4E-01	7.1E-02
Anthracene	0.17	#N/A	0.170	1.11E-01	200	2000	5.5E-04	5.5E-05
Benz(a)anthracene	0.59	#N/A	0.649	4.22E-01	1	10	4.2E-01	4.2E-02
Benzo(a)pyrene	0.67	#N/A	0.737	4.79E-01	1	10	4.8E-01	4.8E-02
Benzo(b)fluoranthene	0.91	#N/A	1.001	6.51E-01	1	10	6.5E-01	6.5E-02
Benzo(k)fluoranthene	0.3	#N/A	0.330	2.15E-01	1	10	2.1E-01	2.1E-02
Chrysene	0.74	#N/A	0.814	5.29E-01	1	10	5.3E-01	5.3E-02
Dibenz(a,h)anthracene	0.12	#N/A	0.132	8.58E-02	1	10	8.6E-02	8.6E-03
Fluoranthene	1.3	#N/A	1.430	9.30E-01	130	250	7.2E-03	3.7E-03
Indeno(1,2,3-cd)pyrene	0.53	#N/A	0.583	3.79E-01	1	10	3.8E-01	3.8E-02
Phenanthrene	0.57	#N/A	0.570	3.71E-01	15	150	2.5E-02	2.5E-03
Pyrene	1.2	#N/A	1.200	7.80E-01	75	130	1.0E-02	6.0E-03
4,4'-DDD	0.014	0.00	0.002	1.27E-03	0.8	4	1.6E-03	3.2E-04
4,4'-DDE	0.0088	0.00	0.001	9.34E-04	0.8	4	1.2E-03	2.3E-04
4,4'-DDT	0.053	0.00	0.003	2.17E-03	0.8	4	2.7E-03	5.4E-04
Aroclor 1254	0.25	0.03	0.027	1.72E-02	0.068	0.68	2.5E-01	2.5E-02
Aroclor 1260	0.28	#N/A	0.308	2.00E-01	0.068	0.68	2.9E+00	2.9E-01
TEQ mammal	0.0001392	0.00	0.000	9.57E-06	0.000001	0.00001	9.6E+00	9.6E-01
						HAZARD INDICES:	**42.7**	**8.3**

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 B-5.1. Summary of Hazard Quotients Using NOAEL-Based RTVs: Short-tailed Shrew, Oxbow Area

Scenario Timeframe: Current/Future
Exposure Point: Oxbow Area
Receptor: Short-tailed Shrew

TOTAL RISK (HI): 146

Analyte	Exposure Medium[a]			Combined NOAEL HQs[b]	Percent Contribution[c]
	Soil	Terrestrial Plants	Terrestrial Inverts		
Metals					
Antimony	0.5	0.003	1.7	2.2	2%
Arsenic	1.5	0.04	0.8	2.3	2%
Barium	0.02	0.002	0.02	0.05	0%
Beryllium	0.04	0.0002	0.03	0.1	0%
Cadmium	0.01	0.001	0.2	0.2	0%
Chromium	0.0004	0.00001	0.0	0.0	0%
Cobalt	1.8	0.01	1.1	3.0	2%
Copper	2.5	0.7	1.2	4.4	3%
Lead	0.03	0.0019	0.03	0.1	0%
Manganese	0.2	0.0106	0.2	0.5	0%
Molybdenum	0.6	0.1	0.3	0.9	1%
Nickel	0.01	0.0005	0.01	0.02	0%
Selenium	0.1	0.0478	1.2	1.3	1%
Thallium	0.1	0.0002	0.1	0.1	0%
Vanadium	2.1	0.0059	0.9	3.0	2%
Zinc	0.02	0.02	0.1	0.1	0%
Semivolatile Organic Compounds					
Anthracene	0.0001	8.9E-06	2.6E-03	0.0027	0%
Benz(a)anthracene	0.09	0.0009	1.6	1.7	1%
Benzo(a)pyrene	0.0879	5.5E-04	1.669	1.76	1%
Benzo(b)fluoranthene	0.09	9.0E-04	1.7	1.8	1%
Benzo(g,h,i)perylene	0.04	0.0001	0.8	0.9	1%
Benzo(k)fluoranthene	0.03	0.0002	0.6	0.7	0%
Chrysene	0.09	0.0008	1.7	1.7	1%
Dibenz(a,h)anthracene	0.01	3.4E-05	0.2	0.3	0%
Fluoranthene	0.001	2.9E-05	0.02	0.03	0%
Indeno(1,2,3-cd)pyrene	0.05	0.0001	1.0	1.0	1%
Naphthalene	0.0002	0.0000	0.003	0.003	0%
Phenanthrene	0.007	0.0004	0.1	0.1	0%
Pyrene	0.002	0.0001	0.03	0.04	0%
Pesticides and PCBs					
4,4'-DDD	0.00002	1.3E-07	4.4E-05	0.0001	0%
4,4'-DDE	0.0001	3.7E-07	0.0004	0.0005	0%
4,4'-DDT	0.0005	1.9E-06	0.001	0.001	0%
Aroclor 1254	0.04	0.0001	0.1	0.10	0%
Aroclor 1260	0.01	9.3E-06	0.2	0.19	0%
Aroclor 1268	0.002	2.2E-06	0.005	0.01	0%
beta-BHC	0.00001	1.4E-06	0.0002	0.0002	0%
Chlordane	0.0003	1.9E-06	0.001	0.001	0%
Dieldrin	0.002	4.2E-05	0.007	0.01	0%
Endrin	0.00003	7.4E-07	0.001	0.001	0%
gamma-BHC (Lindane)	0.00004	6.8E-06	0.0003	0.0003	0%
PCDD/Fs					
TEQ mammal	42	0.0	76	118	80%
TOTAL MEDIUM-SPECIFIC RISK	**52**	**0.90**	**94**	**146**	
PERCENTAGE OF TOTAL RISK	35%	1%	64%	100%	

Footnotes:
a. Hazard Quotients presented by exposure medium
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

Table B-5.2. Summary of Hazard Quotients Using NOAEL-Based RTVs: Short-tailed Shrew, Northeast Lyman Mill Pond Area

Scenario Timeframe: Current/Future
Exposure Point: NE Oxbow Area
Receptor: Short-tailed Shrew

TOTAL RISK (HI): 387

Analyte	Exposure Medium[a]			Combined NOAEL HQs[b]	Percent Contribution[c]
	Soil	Terrestrial Plants	Terrestrial Inverts		
Metals					
Antimony	7.13E-01	4.05E-03	2.58E+00	3.29E+00	1%
Arsenic	1.50E+00	4.25E-02	8.67E-01	2.41E+00	1%
Beryllium	4.52E-02	2.57E-04	3.36E-02	7.90E-02	0%
Cadmium	2.17E-02	2.72E-03	4.51E-01	4.75E-01	0%
Chromium	8.96E-04	2.09E-05	3.85E-04	1.30E-03	0%
Cobalt	1.86E+00	7.92E-03	1.15E+00	3.02E+00	1%
Copper	2.98E+00	8.23E-01	1.51E+00	5.32E+00	1%
Lead	3.36E-02	1.82E-03	2.52E-02	6.07E-02	0%
Manganese	1.56E-01	7.09E-03	1.62E-01	3.25E-01	0%
Molybdenum	8.06E-01	1.15E-01	3.42E-01	1.26E+00	0%
Selenium	8.47E-02	3.13E-02	7.58E-01	8.74E-01	0%
Vanadium	1.97E+00	5.44E-03	8.15E-01	2.79E+00	1%
Zinc	2.08E-02	2.07E-02	6.66E-02	1.08E-01	0%
Semivolatile Organic Compounds				0.00E+00	
Anthracene	7.44E-05	4.45E-06	1.29E-03	1.36E-03	0%
Benz(a)anthracene	5.62E-02	5.76E-04	1.07E+00	1.12E+00	0%
Benzo(a)pyrene	6.93E-02	4.34E-04	1.32E+00	1.39E+00	0%
Benzo(b)fluoranthene	9.03E-02	8.99E-04	1.72E+00	1.81E+00	0%
Benzo(g,h,i)perylene	4.74E-02	1.48E-04	9.01E-01	9.49E-01	0%
Benzo(k)fluoranthene	2.88E-02	1.88E-04	5.47E-01	5.76E-01	0%
Chrysene	7.14E-02	6.91E-04	1.36E+00	1.43E+00	0%
Dibenz(a,h)anthracene	1.21E-02	3.34E-05	2.30E-01	2.42E-01	0%
Fluoranthene	8.84E-04	2.04E-05	1.68E-02	1.77E-02	0%
Indeno(1,2,3-cd)pyrene	5.00E-02	1.42E-04	9.50E-01	1.00E+00	0%
Naphthalene	4.17E-05	1.14E-05	7.19E-04	7.72E-04	0%
Phenanthrene	4.08E-03	2.32E-04	7.04E-02	7.47E-02	0%
Pyrene	1.50E-03	5.13E-05	2.60E-02	2.75E-02	0%
Pesticides and PCBs					
4,4'-DDD	1.14E-04	7.75E-07	2.74E-04	3.88E-04	0%
4,4'-DDE	2.10E-04	5.73E-07	5.92E-04	8.02E-04	0%
4,4'-DDT	8.43E-04	3.36E-06	9.16E-04	1.76E-03	0%
Aroclor 1254	7.95E-02	3.16E-04	1.46E-01	2.25E-01	0%
Aroclor 1268	5.91E-03	5.71E-06	1.31E-02	1.90E-02	0%
Chlordane	1.20E-03	8.89E-06	2.42E-03	3.64E-03	0%
Endrin	3.28E-05	7.09E-07	6.23E-04	6.56E-04	0%
PCDD/Fs					
TEQ mammal	1.27E+02	0.00E+00	2.32E+02	3.58E+02	93%
TOTAL MEDIUM-SPECIFIC RISK	**138**	**1**	**249**	**387**	
PERCENTAGE OF TOTAL RISK	36%	0%	64%	100%	

Footnotes:
a. Hazard Quotients presented by exposure medium
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

Table B-5.3. Summary of Hazard Quotients Using NOAEL-Based RTVs: Short-tailed Shrew, Southeast Lyman Mill Pond Area

Scenario Timeframe: Current/Future
Exposure Point: SE Lyman Mill Pond Area
Receptor: Short-tailed Shrew

TOTAL RISK (HI): 51

Analyte	Exposure Medium[a]			Combined NOAEL HQs[b]	Percent Contribution[c]
	Soil	Terrestrial Plants	Terrestrial Inverts		
Metals					
Antimony	4.60E+00	2.62E-02	1.66E+01	2.13E+01	42%
Arsenic	1.82E+00	5.19E-02	1.06E+00	2.93E+00	6%
Cadmium	9.15E-02	1.14E-02	1.90E+00	2.00E+00	4%
Chromium	3.21E-04	7.49E-06	1.38E-04	4.67E-04	0%
Cobalt	1.61E+00	6.87E-03	9.99E-01	2.62E+00	5%
Copper	8.24E+00	2.27E+00	4.18E+00	1.47E+01	29%
Lead	9.76E-02	5.27E-03	7.32E-02	1.76E-01	0%
Manganese	6.42E-02	2.92E-03	6.67E-02	1.34E-01	0%
Molybdenum	2.10E-01	2.99E-02	8.91E-02	3.29E-01	1%
Selenium	7.53E-02	2.78E-02	6.74E-01	7.77E-01	2%
Vanadium	1.21E+00	3.34E-03	5.01E-01	1.71E+00	3%
Zinc	4.42E-02	4.40E-02	1.41E-01	2.30E-01	0%
Semivolatile Organic Compounds				0.00E+00	
Anthracene	2.82E-05	1.69E-06	4.88E-04	5.17E-04	0%
Benz(a)anthracene	1.13E-02	1.16E-04	2.15E-01	2.26E-01	0%
Benzo(a)pyrene	1.54E-02	9.66E-05	2.93E-01	3.09E-01	1%
Benzo(b)fluoranthene	2.18E-02	2.17E-04	4.15E-01	4.37E-01	1%
Benzo(k)fluoranthene	6.40E-03	4.19E-05	1.22E-01	1.28E-01	0%
Chrysene	1.69E-02	1.64E-04	3.22E-01	3.39E-01	1%
Dibenz(a,h)anthracene	2.97E-03	8.20E-06	5.65E-02	5.95E-02	0%
Fluoranthene	1.85E-04	4.27E-06	3.52E-03	3.71E-03	0%
Indeno(1,2,3-cd)pyrene	1.39E-02	3.96E-05	2.65E-01	2.79E-01	1%
Naphthalene	3.14E-05	8.56E-06	5.42E-04	5.82E-04	0%
Phenanthrene	9.29E-04	5.28E-05	1.60E-02	1.70E-02	0%
Pyrene	3.26E-04	1.11E-05	5.63E-03	5.97E-03	0%
Pesticides and PCBs					
4,4'-DDD	1.79E-04	1.22E-06	4.31E-04	6.11E-04	0%
4,4'-DDE	1.69E-03	4.62E-06	4.78E-03	6.47E-03	0%
4,4'-DDT	2.45E-03	9.74E-06	2.66E-03	5.11E-03	0%
Aroclor 1260	1.61E-02	1.55E-05	3.05E-01	3.21E-01	1%
PCDD/Fs					
TEQ mammal	5.53E-01	0.00E+00	1.01E+00	1.56E+00	3%
TOTAL MEDIUM-SPECIFIC RISK	**19**	**2**	**29**	**51**	
PERCENTAGE OF TOTAL RISK	37%	5%	58%	100%	

Footnotes:
a. Hazard Quotients presented by exposure medium
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

Table B-5.4. Summary of Hazard Quotients Using NOAEL-Based RTVs: Short-tailed Shrew, Assapumpset Brook Area

Scenario Timeframe: Current/Future
Exposure Point: Assapumpset Brook
Receptor: Short-tailed Shrew

TOTAL RISK (HI): 77

Analyte	Exposure Medium[a]			Combined NOAEL HQs[b]	Percent Contribution[c]
	Soil	Terrestrial Plants	Terrestrial Inverts		
Metals					
Antimony	2.00E+00	1.14E-02	7.22E+00	9.23E+00	12%
Arsenic	3.97E+00	1.13E-01	2.30E+00	6.38E+00	8%
Beryllium	5.08E-02	2.89E-04	3.78E-02	8.89E-02	0%
Chromium	4.57E-04	1.07E-05	1.96E-04	6.64E-04	0%
Cobalt	4.51E+00	1.92E-02	2.80E+00	7.33E+00	10%
Copper	1.07E+01	2.94E+00	5.41E+00	1.90E+01	25%
Lead	6.17E-02	3.33E-03	4.63E-02	1.11E-01	0%
Manganese	3.77E-01	1.72E-02	3.92E-01	7.87E-01	1%
Molybdenum	3.43E-01	4.87E-02	1.45E-01	5.37E-01	1%
Selenium	8.47E-01	3.13E-01	7.58E+00	8.74E+00	11%
Thallium	2.15E-01	4.89E-04	1.96E-01	4.11E-01	1%
Vanadium	2.04E+00	5.64E-03	8.46E-01	2.89E+00	4%
Zinc	4.47E-02	4.45E-02	1.43E-01	2.32E-01	0%
Semivolatile Organic Compounds				0.00E+00	
Anthracene	3.20E-05	1.91E-06	5.53E-04	5.86E-04	0%
Benz(a)anthracene	2.22E-02	2.27E-04	4.22E-01	4.44E-01	1%
Benzo(a)pyrene	2.52E-02	1.58E-04	4.79E-01	5.04E-01	1%
Benzo(b)fluoranthene	3.43E-02	3.41E-04	6.51E-01	6.85E-01	1%
Benzo(k)fluoranthene	1.13E-02	7.39E-05	2.15E-01	2.26E-01	0%
Chrysene	2.79E-02	2.69E-04	5.29E-01	5.57E-01	1%
Dibenz(a,h)anthracene	4.52E-03	1.25E-05	8.58E-02	9.03E-02	0%
Fluoranthene	3.76E-04	8.67E-06	7.15E-03	7.54E-03	0%
Indeno(1,2,3-cd)pyrene	2.00E-02	5.67E-05	3.79E-01	3.99E-01	1%
Phenanthrene	1.43E-03	8.14E-05	2.47E-02	2.62E-02	0%
Pyrene	6.02E-04	2.06E-05	1.04E-02	1.10E-02	0%
Pesticides and PCBs				0.00E+00	
4,4'-DDD	6.59E-04	4.50E-06	1.59E-03	2.25E-03	0%
4,4'-DDE	4.14E-04	1.13E-06	1.17E-03	1.58E-03	0%
4,4'-DDT	2.49E-03	9.93E-06	2.71E-03	5.21E-03	0%
Aroclor 1254	1.38E-01	5.51E-04	2.53E-01	3.92E-01	1%
Aroclor 1260	1.55E-01	1.50E-04	2.94E+00	3.10E+00	4%
PCDD/Fs					
TEQ mammal	5.24E+00	0.00E+00	9.57E+00	1.48E+01	19%
TOTAL MEDIUM-SPECIFIC RISK	**31**	**4**	**43**	**77**	
PERCENTAGE OF TOTAL RISK	40%	5%	55%	100%	

Footnotes:
a. Hazard Quotients presented by exposure medium
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

Table B-5.5. Summary of Hazard Quotients Using LOAEL-Based RTVs: Short-tailed Shrew, Oxbow Area

Scenario Timeframe: Current/Future
Exposure Point: Oxbow Area
Receptor: Short-tailed Shrew

TOTAL RISK (HI): 16

Analyte	Exposure Medium[a]			Combined LOAEL HQs[b]	Percent Contribution[c]
	Soil	Terrestrial Plants	Terrestrial Inverts		
Metals					
Antimony	4.83E-02	2.74E-04	1.74E-01	2.23E-01	1%
Arsenic	1.46E-01	4.15E-03	8.45E-02	2.34E-01	1%
Barium	9.45E-03	8.33E-04	1.15E-02	2.18E-02	0%
Beryllium	3.65E-03	2.08E-05	2.72E-03	6.39E-03	0%
Cadmium	1.10E-03	1.38E-04	2.29E-02	2.41E-02	0%
Chromium	4.48E-05	1.04E-06	1.92E-05	6.51E-05	0%
Cobalt	1.82E-01	7.75E-04	1.13E-01	2.95E-01	2%
Copper	2.45E-01	6.77E-02	1.24E-01	4.37E-01	3%
Lead	1.19E-02	6.45E-04	8.95E-03	2.15E-02	0%
Manganese	7.32E-02	3.33E-03	7.61E-02	1.53E-01	1%
Molybdenum	6.01E-02	8.55E-03	2.55E-02	9.41E-02	1%
Nickel	7.97E-03	2.72E-04	4.08E-03	1.23E-02	0%
Selenium	7.83E-02	2.90E-02	7.01E-01	8.08E-01	5%
Thallium	6.60E-03	1.50E-05	6.01E-03	1.26E-02	0%
Vanadium	4.28E-01	1.18E-03	1.77E-01	6.06E-01	4%
Zinc	7.91E-03	7.88E-03	2.53E-02	4.11E-02	0%
Semivolatile Organic Compounds					
Anthracene	1.49E-05	8.92E-07	2.58E-04	2.74E-04	0%
Benz(a)anthracene	8.52E-03	8.72E-05	1.62E-01	1.70E-01	1%
Benzo(a)pyrene	8.79E-03	5.50E-05	1.67E-01	1.76E-01	1%
Benzo(b)fluoranthene	9.06E-03	9.02E-05	1.72E-01	1.81E-01	1%
Benzo(g,h,i)perylene	4.39E-03	1.37E-05	8.33E-02	8.77E-02	1%
Benzo(k)fluoranthene	3.32E-03	2.17E-05	6.31E-02	6.64E-02	0%
Chrysene	8.74E-03	8.45E-05	1.66E-01	1.75E-01	1%
Dibenz(a,h)anthracene	1.25E-03	3.45E-06	2.37E-02	2.50E-02	0%
Fluoranthene	6.53E-04	1.50E-05	1.24E-02	1.31E-02	0%
Indeno(1,2,3-cd)pyrene	5.16E-03	1.47E-05	9.80E-02	1.03E-01	1%
Naphthalene	1.68E-05	4.59E-06	2.90E-04	3.11E-04	0%
Phenanthrene	6.88E-04	3.91E-05	1.19E-02	1.26E-02	0%
Pyrene	1.15E-03	3.94E-05	1.99E-02	2.11E-02	0%
Pesticides and PCBs					
4,4'-DDD	3.67E-06	2.51E-08	8.85E-06	1.25E-05	0%
4,4'-DDE	2.73E-05	7.44E-08	7.68E-05	1.04E-04	0%
4,4'-DDT	9.71E-05	3.87E-07	1.05E-04	2.03E-04	0%
Aroclor 1254	3.65E-03	1.45E-05	6.69E-03	1.04E-02	0%
Aroclor 1260	9.61E-04	9.29E-07	1.82E-02	1.92E-02	0%
Aroclor 1268	2.25E-04	2.18E-07	4.99E-04	7.24E-04	0%
beta-BHC	4.94E-06	7.17E-07	8.53E-05	9.10E-05	0%
Chlordane	1.29E-04	9.52E-07	2.60E-04	3.89E-04	0%
Dieldrin	2.22E-04	4.23E-06	6.69E-04	8.95E-04	0%
Endrin	3.42E-04	7.39E-06	6.49E-03	6.84E-03	0%
gamma-BHC (Lindane)	2.01E-05	3.38E-06	1.38E-04	1.62E-04	0%
PCDD/Fs					
TEQ mammal	4.16E+00	0.00E+00	7.59E+00	11.75	74%
TOTAL MEDIUM-SPECIFIC RISK	**6**	**0.1**	**10**	**16**	
PERCENTAGE OF TOTAL RISK	35%	1%	64%	100%	

Footnotes:
a. Hazard Quotients presented by exposure medium
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

Table B-5.6. Summary of Hazard Quotients Using LOAEL-Based RTVs: Short-tailed Shrew, Northeast Lyman Mill Pond Area

Scenario Timeframe: Current/Future
Exposure Point: NE Oxbow Area
Receptor: Short-tailed Shrew

TOTAL RISK (HI): 40

Analyte	Exposure Medium[a]			Combined LOAEL HQs[b]	Percent Contribution[c]
	Soil	Terrestrial Plants	Terrestrial Inverts		
Metals					
Antimony	7.13E-02	4.05E-04	2.58E-01	3.29E-01	1%
Arsenic	1.50E-01	4.25E-03	8.67E-02	2.41E-01	1%
Beryllium	4.52E-03	2.57E-05	3.36E-03	7.90E-03	0%
Cadmium	2.17E-03	2.72E-04	4.51E-02	4.75E-02	0%
Chromium	8.96E-05	2.09E-06	3.85E-05	1.30E-04	0%
Cobalt	1.86E-01	7.92E-04	1.15E-01	3.02E-01	1%
Copper	2.98E-01	8.23E-02	1.51E-01	5.32E-01	1%
Lead	1.15E-02	6.22E-04	8.63E-03	2.08E-02	0%
Manganese	4.89E-02	2.23E-03	5.09E-02	1.02E-01	0%
Molybdenum	8.06E-02	1.15E-02	3.42E-02	1.26E-01	0%
Selenium	5.13E-02	1.90E-02	4.59E-01	5.30E-01	1%
Vanadium	3.94E-01	1.09E-03	1.63E-01	5.58E-01	1%
Zinc	1.04E-02	1.04E-02	3.33E-02	5.41E-02	0%
Semivolatile Organic Compounds					
Anthracene	7.44E-06	4.45E-07	1.29E-04	1.36E-04	0%
Benz(a)anthracene	5.62E-03	5.76E-05	1.07E-01	1.12E-01	0%
Benzo(a)pyrene	6.93E-03	4.34E-05	1.32E-01	1.39E-01	0%
Benzo(b)fluoranthene	9.03E-03	8.99E-05	1.72E-01	1.81E-01	0%
Benzo(g,h,i)perylene	4.74E-03	1.48E-05	9.01E-02	9.49E-02	0%
Benzo(k)fluoranthene	2.88E-03	1.88E-05	5.47E-02	5.76E-02	0%
Chrysene	7.14E-03	6.91E-05	1.36E-01	1.43E-01	0%
Dibenz(a,h)anthracene	1.21E-03	3.34E-06	2.30E-02	2.42E-02	0%
Fluoranthene	4.60E-04	1.06E-05	8.73E-03	9.20E-03	0%
Indeno(1,2,3-cd)pyrene	5.00E-03	1.42E-05	9.50E-02	1.00E-01	0%
Naphthalene	4.17E-06	1.14E-06	7.19E-05	7.72E-05	0%
Phenanthrene	4.08E-04	2.32E-05	7.04E-03	7.47E-03	0%
Pyrene	8.67E-04	2.96E-05	1.50E-02	1.59E-02	0%
Pesticides and PCBs					
4,4'-DDD	2.27E-05	1.55E-07	5.47E-05	7.76E-05	0%
4,4'-DDE	4.20E-05	1.15E-07	1.18E-04	1.60E-04	0%
4,4'-DDT	1.69E-04	6.71E-07	1.83E-04	3.52E-04	0%
Aroclor 1254	7.95E-03	3.16E-05	1.46E-02	2.25E-02	0%
Aroclor 1268	5.91E-04	5.71E-07	1.31E-03	1.90E-03	0%
Chlordane	6.01E-04	4.44E-06	1.21E-03	1.82E-03	0%
Endrin	3.28E-04	7.09E-06	6.23E-03	6.56E-03	0%
PCDD/Fs					
TEQ mammal	1.27E+01	0.00E+00	2.32E+01	3.58E+01	90%
TOTAL MEDIUM-SPECIFIC RISK	**14**	**0.1**	**25**	**40**	
PERCENTAGE OF TOTAL RISK	35%	0%	64%	100%	

Footnotes:
a. Hazard Quotients presented by exposure medium
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

Table B-5.7. Summary of Hazard Quotients Using LOAEL-Based RTVs: Short-tailed Shrew, Southeast Lyman Mill Pond Area

Scenario Timeframe:	Current/Future		
Exposure Point:	SE Lyman Mill Pond Area	**TOTAL RISK (HI):**	**6**
Receptor:	Short-tailed Shrew		

Analyte	Exposure Medium[a]			Combined LOAEL HQs[b]	Percent Contribution[c]
	Soil	Terrestrial Plants	Terrestrial Inverts		
Metals					
Antimony	4.60E-01	2.62E-03	1.66E+00	2.13E+00	38%
Arsenic	1.82E-01	5.19E-03	1.06E-01	2.93E-01	5%
Cadmium	9.15E-03	1.14E-03	1.90E-01	2.00E-01	4%
Chromium	3.21E-05	7.49E-07	1.38E-05	4.67E-05	0%
Cobalt	1.61E-01	6.87E-04	9.99E-02	2.62E-01	5%
Copper	8.24E-01	2.27E-01	4.18E-01	1.47E+00	26%
Lead	3.34E-02	1.80E-03	2.50E-02	6.02E-02	1%
Manganese	2.02E-02	9.18E-04	2.10E-02	4.21E-02	1%
Molybdenum	2.10E-02	2.99E-03	8.91E-03	3.29E-02	1%
Selenium	4.56E-02	1.69E-02	4.08E-01	4.71E-01	8%
Vanadium	2.42E-01	6.68E-04	1.00E-01	3.43E-01	6%
Zinc	2.21E-02	2.20E-02	7.07E-02	1.15E-01	2%
Semivolatile Organic Compounds					
Anthracene	2.82E-06	1.69E-07	4.88E-05	5.17E-05	0%
Benz(a)anthracene	1.13E-03	1.16E-05	2.15E-02	2.26E-02	0%
Benzo(a)pyrene	1.54E-03	9.66E-06	2.93E-02	3.09E-02	1%
Benzo(b)fluoranthene	2.18E-03	2.17E-05	4.15E-02	4.37E-02	1%
Benzo(k)fluoranthene	6.40E-04	4.19E-06	1.22E-02	1.28E-02	0%
Chrysene	1.69E-03	1.64E-05	3.22E-02	3.39E-02	1%
Dibenz(a,h)anthracene	2.97E-04	8.20E-07	5.65E-03	5.95E-03	0%
Fluoranthene	9.64E-05	2.22E-06	1.83E-03	1.93E-03	0%
Indeno(1,2,3-cd)pyrene	1.39E-03	3.96E-06	2.65E-02	2.79E-02	0%
Naphthalene	3.14E-06	8.56E-07	5.42E-05	5.82E-05	0%
Phenanthrene	9.29E-05	5.28E-06	1.60E-03	1.70E-03	0%
Pyrene	1.88E-04	6.42E-06	3.25E-03	3.44E-03	0%
Pesticides and PCBs					
4,4'-DDD	3.58E-05	2.44E-07	8.62E-05	1.22E-04	0%
4,4'-DDE	3.39E-04	9.25E-07	9.55E-04	1.29E-03	0%
4,4'-DDT	4.89E-04	1.95E-06	5.32E-04	1.02E-03	0%
Aroclor 1260	1.61E-03	1.55E-06	3.05E-02	3.21E-02	1%
PCDD/Fs					
TEQ mammal	5.53E-02	0.00E+00	1.01E-01	1.56E-01	3%
TOTAL MEDIUM-SPECIFIC RISK	**2**	**0.3**	**3**	**6**	
PERCENTAGE OF TOTAL RISK	36%	5%	59%	100%	

Footnotes:
a. Hazard Quotients presented by exposure medium
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

Table B-5.8. Summary of Hazard Quotients Using LOAEL-Based RTVs: Short-tailed Shrew, Assapumpset Brook Area

Scenario Timeframe: Current/Future
Exposure Point: Assapumpset Brook
Receptor: Short-tailed Shrew

TOTAL RISK (HI): 12.7

Analyte	Exposure Medium[a]			Combined LOAEL HQs[b]	Percent Contribution[c]
	Soil	Terrestrial Plants	Terrestrial Inverts		
Metals					
Antimony	2.00E-01	1.14E-03	7.22E-01	9.23E-01	7%
Arsenic	3.97E-01	1.13E-02	2.30E-01	6.38E-01	5%
Beryllium	5.08E-03	2.89E-05	3.78E-03	8.89E-03	0%
Chromium	4.57E-05	1.07E-06	1.96E-05	6.64E-05	0%
Cobalt	4.51E-01	1.92E-03	2.80E-01	7.33E-01	6%
Copper	1.07E+00	2.94E-01	5.41E-01	1.90E+00	15%
Lead	2.11E-02	1.14E-03	1.58E-02	3.81E-02	0%
Manganese	1.19E-01	5.40E-03	1.23E-01	2.47E-01	2%
Molybdenum	3.43E-02	4.87E-03	1.45E-02	5.37E-02	0%
Selenium	5.13E-01	1.90E-01	4.59E+00	5.30E+00	42%
Thallium	2.15E-02	4.89E-05	1.96E-02	4.11E-02	0%
Vanadium	4.09E-01	1.13E-03	1.69E-01	5.79E-01	5%
Zinc	2.24E-02	2.22E-02	7.14E-02	1.16E-01	1%
Semivolatile Organic Compounds					
Anthracene	3.20E-06	1.91E-07	5.53E-05	5.86E-05	0%
Benz(a)anthracene	2.22E-03	2.27E-05	4.22E-02	4.44E-02	0%
Benzo(a)pyrene	2.52E-03	1.58E-05	4.79E-02	5.04E-02	0%
Benzo(b)fluoranthene	3.43E-03	3.41E-05	6.51E-02	6.85E-02	1%
Benzo(k)fluoranthene	1.13E-03	7.39E-06	2.15E-02	2.26E-02	0%
Chrysene	2.79E-03	2.69E-05	5.29E-02	5.57E-02	0%
Dibenz(a,h)anthracene	4.52E-04	1.25E-06	8.58E-03	9.03E-03	0%
Fluoranthene	1.96E-04	4.51E-06	3.72E-03	3.92E-03	0%
Indeno(1,2,3-cd)pyrene	2.00E-03	5.67E-06	3.79E-02	3.99E-02	0%
Phenanthrene	1.43E-04	8.14E-06	2.47E-03	2.62E-03	0%
Pyrene	3.48E-04	1.19E-05	6.00E-03	6.36E-03	0%
Pesticides and PCBs					
4,4'-DDD	1.32E-04	8.99E-07	3.18E-04	4.50E-04	0%
4,4'-DDE	8.28E-05	2.26E-07	2.33E-04	3.17E-04	0%
4,4'-DDT	4.99E-04	1.99E-06	5.42E-04	1.04E-03	0%
Aroclor 1254	1.38E-02	5.51E-05	2.53E-02	3.92E-02	0%
Aroclor 1260	1.55E-02	1.50E-05	2.94E-01	3.10E-01	2%
PCDD/Fs					
TEQ mammal	5.24E-01	0.00E+00	9.57E-01	1.48E+00	12%
TOTAL MEDIUM-SPECIFIC RISK	**3.8**	**0.5**	**8.3**	**12.7**	
PERCENTAGE OF TOTAL RISK	30%	4%	66%	100%	

Footnotes:
a. Hazard Quotients presented by exposure medium
b. Combined risk across all media exposures.
c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.