September 25, 2012

Ms. Beverly Lawrence
U.S. Army Corps of Engineers, New England District
696 Virginia Road
Concord, MA 01742-2751

CONTRACT NO. W912WJ-11-D-0005
Delivery Order 0005

SUBMITTAL OF DELIVERABLE - *TECHNICAL MEMORANDUM, REVIEW OF 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 (Integral Consulting, Inc. October 2011) AND COMMENTS ON SUPPLEMENTAL BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT: OXBOW AREA FLOODPLAIN SOIL AND SEDIMENT, CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE, NORTH PROVIDENCE, RHODE ISLAND (Woonasquatucket River Watershed Council, October 2011)*

Dear Ms. Lawrence:

Please find enclosed one copy of the review of comments, submitted by Integral Consulting, Inc. on behalf of Emhart Industries and by the Woonasquatucket River Watershed Council, concerning the risk assessments conducted for the Oxbow Area of the Centredale Manor Project Restoration Superfund Site. I have also transmitted this letter and attachment to you and Anna Krasko via e-mail. If we can provide additional information, please contact me at (781) 213-5600.

Sincerely,
AMEC Environment & Infrastructure, Inc.

Michael J. Murphy
Project Manager

Encl.

cc: A. Krasko, USEPA

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TECHNICAL MEMORANDUM

REVIEW OF

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 (Integral Consulting, Inc. October 2011)

AND

COMMENTS ON SUPPLEMENTAL BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT: OXBOW AREA FLOODPLAIN SOIL AND SEDIMENT CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE NORTH PROVIDENCE, RHODE ISLAND (Woonasquatucket River Watershed Council, October 2011)

CONTRACT NO. W912WJ-11-D-0005
DELIVERY ORDER NO. 0005

Submitted to:

Department of the Army
U.S. Army Corps of Engineers
New England District

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September 25, 2012

Part 1 – Supplemental Baseline Human Health Risk Assessment

The review of comments concerning the Interim Final Supplemental Baseline Human Health Risk Assessment (HHRA) for the Oxbow Area for floodplain soil resulted in the conclusion that revision of the HHRA is not necessary in order to meet project objectives. The definition of exposure areas, identification of receptors, selection of data, and the exposure assessment are consistent with project objectives and are appropriate for characterizing current and potential future human health risks associated with surface soil in the Oxbow Area. Revisions to the Interim Final Supplemental Baseline HHRA are not deemed necessary.

Specific comments on the HHRA were provided in by the Potentially Responsible Party (Emhart Industries, Inc.), prepared by Integral Consulting, Inc. (Integral), and the Woonasquatucket River Watershed Council (WRWC). The comments provided by Integral, Inc. are presented and discussed followed by those comments from WRWC.

Comments submitted by Integral, Inc.

The Integral comments have focused on the following topics:

1) Definition of exposure areas
2) Data representativeness
3) Receptor identification
4) Exposure parameter quantification

Integral provided, as part of its comment package, an independent human health risk assessment for USEPA's consideration. That human health risk assessment reflects Integral's comments on the four topics identified above. Generally, Integral's comments would result in lower risk estimates and their independent risk assessment concluded that Oxbow Area does not pose an unacceptable human health risk requiring remedial action.

Definition of Exposure Areas

The comments concerning the definition of exposure areas included questioning exposure areas delineation, including a suggestion to combine The "General Area" and the "Human Health Concern Area" which would result in lower EPC value calculations, and a suggestion to include samples SS-G-01-SS4, SS-G-01-SS10, SS-G-01-SS2, and SS-G-01-SS1 in the General Area EPC calculations.

Responses to these comments are summarized below.

- The data included in the HHRA are representative of potential exposures for passive recreational receptors in floodplain surficial soil of Lyman Mill Pond. The data were grouped to correspond to two exposure areas in a manner that addresses current and potential future exposures to these soils.

- The grouping of data was sufficient for characterizing human health risks and for developing risk—based preliminary remediation goals (PRGs) and proposed cleanup levels for the passive recreational exposure scenarios. The identification of areas that require remediation has been conducted by comparing individual data points to the identified cleanup goals. The specific grouping of the data in the risk assessment has not influenced the numerical values of the PRGs or cleanup goals. Re-evaluation of human health risks using four exposure points is not necessary for the project objectives.
- It is not necessary or appropriate to combine the General Area and the Human Health Concern Area into a single exposure point. The visitor to the General Area does need to traverse the Human Health Concern Area, where generally lower dioxin levels were found. The physical environments of the two areas are not similar, and the potential for exposure differs between the two areas. There are also differences in contaminant distribution between the two areas based on historical impacts of flooding. Integral's risk assessment for the Oxbow acknowledged differences between the two areas and evaluates them as two separate areas.
- Data associated with sample G-01-SS2 was considered in the HHRA. The data for the other samples identified in the comment were considered to be outside the General Area (slope of the adjacent hill) rather than in the floodplain area (evidence of fill in the area). The exposure point typically includes the area where site-related impacts have been documented.

Data Representativeness

There were several comments concerning the representativeness of the data used in the HHRA. These comments include depth of sampling, use of discrete samples, a question about location of sample RES-11-419-02, and suggestion for a different sample grouping

Responses to these comments are summarized below.

- The data associated with soil samples collected from 0 - 0.5 ft bgs are considered representative of surficial soils. The soils in the 0 – 0.5 ft bgs interval are those soils that are most likely to be contacted by passive recreational receptors. All surface data (0 - 0.5 ft and 0 – 1ft) were considered valuable and representative and inclusion of all surface soil data outweighs some inconsistency introduced by data use from two intervals.
- There are often professional judgement and choices made during risk assessment activities. In some cases, there is a balancing of factors that are considered in conducting the exposure assessment activities. In some cases, when there is a high density of samples in a very small area, those samples in that small area might affect the overall characterization of exposure point concentrations in a non-representative manner (uneven spatial representation). In order to avoid such an uneven weighting of specific samples, data from samples in a small area have been averaged and the average used

in calculating the exposure point concentration. While this results in some uncertainty, it is consistent with the overall objectives of the exposure assessment. In this specific case, where the PRPs collected a relatively large number of soil samples in a small area to delineate and to confirm high dioxin levels initially found at that location, these localized delineation samples are treated differently in a risk assessment than other randomized sampling points.

- The location of sample RES-11-419-02 was confirmed by coordinates in the project database.
- As discussed above, the two exposure areas evaluated in the HHRA address two passive recreational exposure scenarios (a wetland soil exposure scenario and an upland soil exposure scenario). The risk assessment for those two exposure scenarios is the basis for development of preliminary remediation goals (PRGs) and proposed cleanup levels for the passive recreational exposure scenarios. The identification of areas that require remediation has been conducted by comparing individual data points in the study area to the identified cleanup goals. The specific grouping of the data in the risk assessment has not influenced the numerical values of the PRGs or cleanup goals. Re-evaluation of human health risks using five exposure points is not necessary for the project objectives.

Receptor Identification

The HHRA evaluated passive recreational receptors (child, older child, and adult) for the Oxbow General Area and separately for the Oxbow Human Health Concern Area. The comments recommend that the child should not be evaluated as a component of the passive recreational visitor receptor group.

The response to this receptor identification comment follows.

- Under current conditions, passive recreational receptors include visitors to the area for hiking/walking, dog-walking, bird watching, use of motorized vehicles, and possible social activities (such as campfires). Comments have been received that indicate that there is public recreational use of this area and there is some potential that the community may have an interest in increasing the use of the Oxbow Area as a recreational resource. It is reasonable to assume that families visiting the area (current and future) would include young children who would accompany older siblings and adults. Given the presence of walking trails within the Oxbow Area, it is reasonable to expect that young children would be able to visit the area without a great deal of difficulty.

Exposure Parameter Quantification

Comments were received concerning the numerical values selected for use in the HHRA for various exposure parameters, including exposure frequency, soil ingestion rate, fraction ingested, relative bioavailability, and exposed dermal surface area. Comments suggest that

numerical values that were utilized are unrealistic or implausible and result in overestimation of risk.

The responses to the comments concerning Exposure Parameter Quantification follow.

- Exposure Frequency
  - For the Human Health Concern Area, the assumed frequency of exposure of 78 days per year (2 days per week in May, September, October and 4 days per week in June, July, and August) is consistent with a Reasonable Maximum Exposure passive recreational scenario and is a professional judgment decision when there is no site-specific information. No EPA national default values for recreational use are available. The General Area is accessible via walking trails, and comments have been received that there is evidence of several types of activity. Other comments that have been received suggest that the community may have an increased interest in the use of the Oxbow Area as a passive recreational area in the future.
  - For the General Area, the assumed frequency of exposure of 26 days per year (1 day per week for 26 weeks per year) is consistent with a Reasonable Maximum Exposure passive recreational scenario and is a professional judgment decision when there is no site-specific information. No EPA national default values for recreational use are available. The frequency of exposure is substantially lower than that of the Human Health Concern Area, reflecting the different physical conditions, fewer walking trails, and the dense vegetation that is present in portions of this area, resulting to this area being not that attractive for recreational activities. Other comments that have been received suggest that the community may have an increased interest in the use of the Oxbow Area as a passive recreational area in the future.
- Soil Ingestion Rates
  - The soil ingestion rates utilized in the HHRA (100 mg/d for adults and adolescents and 200 mg/d for children) include ingestion rates typically applied in USEPA Region I risk assessments to Reasonable Maximum Exposure residential soil scenarios. There are no USEPA-guidance-based recommended passive recreational soil exposure soil ingestion rates and there are few, if any, scientific studies that have characterized soil ingestion rates for passive recreational activities. It is not uncommon, consistent with recommendations from USEPA and Rhode Island Department of Environmental Management, to apply residential soil ingestion rates to a passive recreational soil exposure scenario or to apply direct contact residential soil criteria to a recreational scenario as a means of addressing the uncertainty in the soil ingestion rates.
- Fraction Ingested
  - The Oxbow Area has been identified as a passive recreational area as the presence of walking trails and evidence of campfires and motorized vehicle use indicate. The

nature of the current and potential future use of the Oxbow Area suggests that the area is attractive to recreational receptors. Given that information, it is consistent with a Reasonable Maximum Exposure scenario to assume that visitors to the Oxbow Area may spend more time at the Oxbow Area than in their residential yards on those days that they visit the Oxbow Area. The fraction ingested value of 1 represents a conservative estimate for this Reasonable Maximum Exposure scenario when no site-specific information is available.

- Exposed Dermal Surface Area
  - The assumed exposed dermal surface area for children, adolescents, and adults for the Human Health Concern Area and the General Area are conservative estimates of potential skin surfaces that might be exposed to soils while passive recreational visitors are present in those areas.
- Relative Bioavailability
  - Relative Bioavailability refers to the relative bioavailability of dioxins/furans from ingested soil compared to the bioavailability of dioxins/furans assumed for the media that are the basis of toxicity values. The available information indicates that the relative bioavailability of dioxins/furans is likely less than 1. The comment suggests an RBA of 0.3 (30%) should be used in the HHRA. However, the May 2011 USEPA *Peer Review Report, Bioavailability of Dioxins and Dioxin-Like Compounds in Soil*, evaluated this issue and yielded the following conclusions:
    - Each of the reviewers agreed the RBA of dioxin in soils is less than 100%,
    - Two of the three reviewers agreed there were insufficient data to support a nationally-applicable value for RBA for use in risk assessments. The reviewer who did not agree recommended assigning a national RBA value less than 100% as a compromise due to the lack of data from a statistically balanced study on dioxins RBA in soil, but did not provide a scientifically defensible basis for doing so.
    - Two of the three reviewers agreed that the current literature does not support a preferred animal model for use as an animal bioassay.
    - The reviewers identified critical points of clarification that would be required to calculate a nationally applicable RBA.
    - The reviewers agreed that the animal models presented in the 2010 report (swine and rat) are appropriate and are commonly used in bioavailability studies, the two models do not produce equivalent results.
    - The reviewers agreed that additional studies are required to establish a standard animal protocol to be used to determine a site-specific RBA for dioxin.
  - The available information indicates that there is not sufficient information to identify, from the literature, an RBA for dioxin in soil to be applied to this Site. The available information also suggests there is not, at this time, a consensus protocol for determining a site-specific RBA for dioxin in soil. In this case when there is no

national default value for RBA, a conservative value of 100% is used. Therefore, no revision of the HHRA to address the RBA issue is required at this time.

Integral submitted, as Appendix A of the comment package, the human health risk assessment for the Oxbow Area and Lyman Mill Pond Floodplain Soils. That risk assessment evaluated five exposure areas and indicated that:

> "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})."

Based on the results of that risk assessment, Integral concluded,

> "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."

Responses/comments to the Appendix A Human Health Risk Assessment follow.

- Contrary to Integral's recommendation to combine the Human Health Concern Area and the General Area into a single exposure area, the risk assessment in Appendix A evaluates the Human Health Concern Area and the General Area as separate areas. The Human Health Concern Area exposure assessment included child, adolescent, and adult exposures, while only the adolescent and adult exposures were evaluated for four additional exposure areas (Oxbow General Area, Northeast Lyman Mill Pond Floodplain, Southeast Lyman Mill Pond Floodplain, and the area described as the Assapumpset Brook Floodplain).
- The Appendix A risk assessment is limited to the 2010 samples collection effort. By eliminating data associated with samples collected previously, the risk assessment does not include all of the available data, which is a shortcoming of the assessment.
- The Appendix A risk assessment utilizes an RBA for dioxin in soil of 30%. USEPA documents indicate that there is not sufficient information to identify, from the literature, dioxin RBA values for application to specific sites. The RBA utilized in the Appendix A risk assessment is highly uncertain, and may underestimate exposure and risk associated with soil exposure.
- The Appendix A risk assessment utilizes exposure frequencies, soil ingestion rates, and fraction ingested values that may underestimate Reasonable Maximum Exposures to soils for current and/or potential future use of the Oxbow Area by passive recreational receptors.
- The Appendix A risk assessment is not considered an acceptable alternative to the HHRA prepared for the Oxbow Area and the existing USEPA HHRA does not require revision.

Comments submitted by the Woonasquatucket River Watershed Council (WRWC)

The comments submitted by the Woonasquatucket River Watershed Council (WRWC) were concerned about whether the risk assessment underestimated risks to recreational visitors of the Oxbow Area. Comments were related to the selection process of samples used in the risk assessment, delineation of floodplain and other areas in the Oxbow, and access to and recreational activities in the Oxbow, including recreational activities that may result in dust inhalation. Other comments in the WRWC letter related to the dioxin cleanup level are addressed in Part 2 of this Technical Memorandum.

Responses to those comments are provided below.

- For the HHRA, analytical data associated with closely-spaced samples at four areas within the General Area were averaged, and the average concentration replaced the individual sample results prior to calculating exposure point concentrations for the general Area soil. The four areas include RES-SS-11-011 (samples -01, -02, and -03), RES-SS-11-012 (samples -01, -02, and -03), SS-G-01 (samples SS1, SS5, SS2, and SS3), and SS-G-29 (samples SS1, SS2, and SS3). This process was conducted to avoid unduly weighting the concentrations from these four areas which have a high density of samples per unit surface area.

The following text identifies soil samples that were not included in the HHRA and provides a rationale for their exclusion.

- Subsurface soil samples (top depth greater than or equal to 1 ft bgs) were not included in the HHRA that evaluated surface soil exposures and risks within the Oxbow Area.
- Three samples, located in the Oxbow Channel Remnant, were determined to be sediment samples rather than soil samples, and therefore were not utilized in the soil HHRA. Those samples included LPX-FP-4001, LPX-FP-4002, and LPX-FP-4003.
- Three samples were determined to have been collected from fill material (rather than floodplain surface soil) on the perimeter of the Oxbow Area and were deemed to not be representative of floodplain soil potentially impacted by sediments deposited during flood events. These samples (SS_G-10-SS1, SS_G-12-SS1, SS_G-13-SS1 (and its duplicate) were not utilized in the Oxbow Area soil HHRA.
- Data associated with Old Mill Raceway soil samples have not been evaluated in the Oxbow Area HHRA.
- Data associated with four soil samples (SS_G-30-SS1 and SS_G-33-SS1 (both on the southeastern shore of Lyman Mill Pond) and SS_G-31-SS1 and SS_G-32-SS1 (both collected on the southwestern shore of Lyman Mill Pond) were not used quantitatively in the Oxbow HHRA. These sample locations are not contiguous with the Oxbow Area proper and the dioxin TEQ concentrations in those samples were substantially lower (orders of magnitude) than those in the Oxbow Area proper (with concentrations of

2,3,7,8-TCDD and dioxin TEQ similar to background concentrations in 3 of those 4 samples).

- Data associated with soil sample SS_G-01-SS4 were not utilized in the Oxbow HHRA. That sample was the northern-most sample collected from the Oxbow study area – it was collected on a hillside and it appears to have been collected from a location that is not in the floodplain and not impacted by flooding.
- Soil samples collected from the Lee Romano Field and the Boys and Girls Club property (both east of the Lyman Mill Pond) were not evaluated in the Oxbow HHRA. The data associated with those soil samples were evaluated in the 2012 Technical Memorandum that addressed the dioxin reassessment.
- As a point of clarification, the floodplain has not been used to identify where people are likely to congregate. In selecting data to be used for evaluating the impacts of flooding-related Site sediment deposition, locations beyond the boundaries of the floodplain (and presumably beyond the reach of flooding-related Site sediment deposition) have been excluded (they are not representative of the Site impacts and associated risks). For the HHRA, the Human Health Area of Concern was identified as the area where people were most likely to visit (ease of access, proximity to walking trails, and evidence of human activity). The Human Health Area of Concern also happens to be, in general, the uplands portion of the Oxbow Area (and therefore it is less impacted by flooding-related deposition of Site-related sediments than the low-lying floodplain General Area – confirmed by the lower dioxin concentrations). The General Area overall has more difficult access (absence of well-worn walking trails, presence of wet soils that are difficult to walk in, and presence of dense vegetation in many places that prevents easy passage). Overall, the difficult access to the General Area suggest that it would be used less frequently, and for shorter periods of time than would the Human Health Area of concern, which is much more open, has well-worn walking trails, and the upland soils are generally much easier to enter and engage in passive recreational activities than would the low-lying General Area. Therefore, the frequency of exposure assumed for the General Area reflects the lower likelihood of access and potential soil exposure.
- The evaluation of exposures and risks associated with inhalation of contaminated soil-derived dust is typically evaluated for construction scenarios (no current or anticipated construction activities identified for the Oxbow) and for industrial or recreational activities (such as dirt-biking and ATV use) in areas of dry, exposed surface soils. For the Oxbow Area, the large majority of the surface area is in low-lying areas with wet or moist soils, standing water, and often surface cover consisting of live vegetation, leaf fall, and decomposing vegetation. Overall, conditions at the Oxbow, particularly in the General Area, are not favorable for generation of soil-derived dust for passive recreational receptors. The area of the oxbow with the driest soils would be the Human Health Concern Area, and soil samples from that area have shown orders of magnitude lower dioxin concentrations than in the adjacent low-lying, generally wet/moist soils of the General Area. There is very little information concerning ATV use at the Oxbow upon which an exposure scenario might be developed. Although anecdotal evidence (observed tracks) suggests ATV use, direct observation of ATV use has not been

reported and it is not known if this is a rare or frequent activity. In this case, a quantitative evaluation of this hypothetical exposure scenario would be very difficult to conduct without substantial uncertainty in the results. It appears frequency of this activity may be low and the duration of any event within the oxbow would likely be short (perhaps a matter of minutes per visit). This information suggests that a further evaluation of this exposure scenario would be unlikely to affect the conclusions of the HHRA.

Part 2, Supplemental Baseline Ecological Risk Assessment (Supplemental BERA)

The purpose of this Technical Memorandum is to document responses to comments provided by Emhart Industries, Inc. (prepared by Integral Consulting Inc. [Integral]) and the Woonasquatucket River Watershed Council (WRWC) on the Supplemental Baseline Ecological Risk Assessment for the Oxbow Area floodplain soil and sediment (Supplemental BERA), prepared for the Centredale Manor Restoration Project Superfund Site (Site), North Providence, Rhode Island.

After reviewing the comments on the Supplemental BERA, generally it was determined that suggested revisions would not be appropriate or necessary to achieve project objectives. The Supplemental BERA was conducted to determine whether the floodplain soils associated with Lyman Mill Pond as a whole should be included as an action area for remedial planning purposes based on ecological risk considerations. Specific remedial decisions will not be based on the overall level of risk within each of the floodplain habitat patches adjacent to Lyman Mill Pond. Rather areas to be remediated will be identified based on the comparison of contaminant concentrations at each sample location to the cleanup goals developed for the Site, including dioxin which is the primary risk driver

Generally themes from the comments received on the Supplemental BERA included:

1) Definition of exposure areas
2) Data representativeness
3) Exposure point concentration calculations
4) Requests for additional studies and/or information

Definition of Exposure Areas

Some of the comments pertain to how the exposure areas were identified and used in the risk assessment. Specifically, Integral commented that pooling data for floodplain soil from the Lyman Mill Pond study area into a single ecological exposure area minimizes the effectiveness of the risk assessment because risk results cannot be used to determine which portions of the floodplain areas may pose a significant risk to ecological receptors. Integral also commented that, due to how data were aggregated, risk results could not be used to determine what, if any, remediation may be needed to mitigate for potential risk. Integral commented that limiting the ecological exposure area of the Oxbow to the forested wetland area is arbitrary and ignores the fact that upland portions of the Oxbow also provide adequate habitat to the terrestrial receptors evaluated. The exposure area should include both the forested wetland and upland areas. Finally, Integral provided recommendations for four ecological exposure areas that should be evaluated independently.

Responses to these comments are summarized below.

- Although EPA agrees that increased granularity of the risk assessment would have improved the ability to distinguish differences in ecological risk between non-contiguous

habitat patches around Lyman Mill Pond, which includes the Oxbow, the increased level of effort is not necessary to achieve project objectives. The decision to remediate is based on comparison of floodplain soil concentrations with risk-based cleanup goals. If concentrations exceed cleanup goals, floodplain soils will be remediated regardless of whether exposure at that one point poses risk to ecological receptors because the remedy will be applied considering Lyman Mill Pond and its floodplain (i.e., the Lyman Mill Pond reach) as a whole.

- For the conceptual site model (CSM), the study area was specifically defined as the 100-year floodplain because this is the area that is likely to have been impacted by contaminants from the Source Area and, as such, is under consideration for remedial action; the study area should not include any upland soil data. An evaluation of analytical chemistry data for surficial floodplain soil samples collected from upland locations (classified based on a site visit and comparison with GIS mapping) determined that the relative composition and concentrations of dioxin/furan congeners for these samples were distinctly different from samples collected within the 100-year floodplain. Consistent with the CSM, this analysis supports the use of the 100-year floodplain boundary as an appropriate line of demarcation between areas that were potentially impacted by contaminants migrating from the Source Area and those that have not been impacted by contaminant migration from the Source Area (and thus would not require remedial consideration in this proposed action). As discussed in RAGS guidance, inclusion of environmental data for areas that have not been affected by a given site is not appropriate because of the potential dilutive effect on the exposure point concentrations (EPCs) and the potential to incorrectly conclude that the Site has not resulted in an unacceptable level of risk when in fact it has.
- The decision to analyze risks for the entire Lyman Mill floodplain, which is dominated by the Oxbow, is reasonable because most wildlife receptors have home ranges that are larger than the Lyman Mill floodplain area and are likely to receive an integrated exposure to floodplain soil borne contaminants across the entire available floodplain habitat. Even smaller receptors with home ranges smaller than the entire floodplain (e.g., short-tailed shrew) could experience impacts to the floodplain population, regardless of which part of the floodplain the exposure is occurring. Impacts to the floodplain small mammal populations ultimately impact higher trophic level receptors with small mammals as part of their food base.

  The individual habitat patches called out in the Integral comments are too small to support individuals of larger wildlife species or populations of smaller species. In addition to the issue of scale with respect to ecological receptor exposures, scale issues are also relevant to the point raised that the data distributions for the different "habitat patches" are not homogeneous (and thus ought to be evaluated as separate exposure areas). The small areal extent and sample sizes of the individual patches at the mouth of Assapumpset Brook (data from only two samples available) and along the southeast bank of Lyman Mill Pond provides a rebuttal to the argument regarding lack of homogeneity among the different patches. Statistical testing to evaluate the comparability of the available data sets (e.g., Bartlett's test for homogeneity of

variances) was not conducted because parametric test assumptions would likely be violated and statistical power would have been low. Furthermore, it is reasonable to consider data from the entire Lyman Mill Pond floodplain to be homogenous, as many sediment-bound contaminants transported into any part of the flood plain when the Woonasquatucket River and Lyman Mill Pond overtop its banks will generally have originated from the Site.

- The northeastern portion of the Lyman Mill Pond floodplain along the east bank of the Woonasquatucket River is contiguous with the Oxbow along the west bank of the river. Being transected by the Woonasquatucket River does not prevent mobile ecological receptors from being exposed to Site-related contaminants on both sides of the river; moreover, individual exposures are integrated within a given population. Although individual components of the soil community are much less mobile than wildlife, the question of whether their collective biomass could be reduced sufficiently to be a biologically relevant reduction in available forage to invertivorous wildlife is best evaluated from the perspective of the entire habitat rather than individual patches.

Data Representativeness Assessment

Some comments pertain to the representativeness of the data evaluated in the risk assessment. Specifically, Integral commented that data should not have been limited to a select group of surface soil samples, and that all recently collected surface soil data from Integral's 2010 investigation should have been used in the risk evaluations, including data collected from the forested wetland (i.e., General Area) and upland (i.e., Human Health Concern Area) areas. The WRWC commented that it was difficult to follow the decision-making process used to select samples for evaluation in the risk assessment.

Responses to these comments are summarized below.

- Integral commented that the following samples should be included in the ecological risk assessment. Samples are grouped by the four exposure areas that Integral indicated should have been evaluated independently in the risk assessment. A case-by-case response along with the rationale for exclusion, where appropriate, is provided in the following table.

Boring ID	Rationale for Exclusion
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 and SS_H-19	Not included; human health concern area elevated above the 100-year floodplain. Does not represent habitat that has been significantly impacted by off-Site transport of contaminants.

Boring ID	Rationale for Exclusion
Oxbow Area (continued)	
SS_H-20	This sample does not exist. There was no SS_H-20 in the table from the Field Sampling Plan, no indication that it was collected in any of the log books, and no data for this sample in the electronic data files. If the comment was intended to reference SS_H-22, then the rational is the same as other human health concern area samples (above).
SS-G-01-SS1, SS_G-01-SS2, SS_G-01-SS3, SS_G-01-SS5, SS_G-02, SS_G-04, SS_G-05, SS_G-06, SS_G-07, SS_G-08 and SS_G-09	Included
SS_G-01-CR1A and SS_G-05-CR1A	Not included; the top of this sample is at 1 foot (ft) below ground surface (bgs) and is a sub-surface soil sample. Only samples collected within the top 1 ft of soil bgs were considered to be within the ecological exposure zone.
SS_G-01-SS4	Not included; this was determined to be an upland sampling location (see the first response item under "Definition of Exposure Areas" and Figure 1) and was not included in the floodplain assessment.

Figure 1. Location of sample SS_G-01-SS4 (location name SS_G-01-04) – stake is located approximately 4-6 feet above the floodplain floor

Boring ID	Rationale for Exclusion
Oxbow Area (continued)	
SS_G-10, SS_G-12 and SS_G-13	Not included; this sample was collected from an area of fill that is located above the 100-year floodplain.
Northeastern Portion of Lyman Mill Pond East of Oxbow Area	
SS_G-23,SS_G-26, SS_G-29-SS1, SS_G-29-SS2, SS_G-29-SS3	Included
SS_G-26-CR1A	Not included; the top of this sample is at 1ft bgs and was classified as a sub-surface soil sample. Only samples collected within the top 1 ft of soil bgs were considered to be within the ecological exposure zone.
Assapumpset Brook Emergent Wetland and Floodplain	
SS_G-31 and SS_G-32	Included
Southeastern Lyman Mill Pond Floodplain Soil	
SS_G-30 and SS_G-33	Included

In addition to the samples mentioned above, samples collected in 2010 at SS_G-14, SS_G-15 and SS_G-18 were also included in the ecological risk assessment, although Integral did not identify these for inclusion.

Also, in addition to the data collected in 2010, the risk assessment included data for surficial floodplain soil samples collected in 1999, 2001, and 2004. These data were included in the Supplemental BERA data set to increase spatial coverage at the potential risk of increasing uncertainties related to temporal representativeness. For the primary contaminants of ecological concern (2,3,7,8-TCDD, 4,4'-DDD, antimony, and copper), there are no statistically significant differences between the 2010 data and older data indicating that the older data falls within the range of variability for the newer data.

- The decision-making process for the selection of samples to be included in the ecological risk assessment and how they were handled is described here. A step-wise approach was used for screening samples that would be used for the BERA.
- All samples collected from the Lyman Mill Pond reach of the study area for all sampling events were identified.
- Sediment samples used in the risk evaluations included samples collected in 2004 from the remnant channel that bisects the Oxbow and samples collected in 2010 from the

scrub-shrub and emergent marsh areas of the Oxbow. Sediment samples collected from other areas prior to the 2010 sampling event included those collected from the Woonasquatucket River and Lyman Mill Pond and were eliminated from the evaluation because sediment exposure risks in those areas had been characterized in the 2004 BERA for the Site.

- Sediment samples collected in 2010 were collected from the shrub-scrub habitat at the south end of the Oxbow, which had been previously under-characterized. These samples were retained for risk screening and assessment of risks to invertebrate populations, as well as for comparison with cleanup goals. These sediment samples were evaluated separately from floodplain soil samples because they represent different ecological exposures (i.e., aquatic vs. terrestrial receptor populations).
- Data from sample locations above the 100-year flood elevation were eliminated from the evaluation because they do not reflect exposures to contaminants from the Source Area, as confirmed by statistical analysis (see response above).
- Only samples collected within 0 – 1 ft bgs were included in the BERA, as these are the samples that represent ecological exposures (see responses below).
- Duplicate samples were eliminated from further evaluation because they were collected only for quality assurance to confirm field sample measurements. For sample locations where duplicate samples were collected, only the first sample collected from that location was included in the risk assessment.
- Floodplain soil samples across all sampling events were collected for three purposes: (1) to characterize contaminant concentrations across the floodplain, (2) to characterize areas identified where 2,3,7,8-TCDD concentrations appeared to be elevated (based on initial sampling round in Integral's 2010 study), and (3) to characterize floodplain contamination with increasing distance from Lyman Mill Pond. As a consequence, there was an uneven distribution of samples across the Oxbow, and to include every sample would result in uneven representation of exposures across the floodplain with over-representation of potentially more contaminated areas. Therefore, to avoid biasing results towards areas where disproportionately larger numbers of samples were collected, replicate and clustered samples collected within a given sampling event were averaged before developing EPCs. With the exception of the CMS samples (see below), replicate and clustered samples are typically identified as -01, -02, and -03. Data for the following samples were averaged:
    - CMS samples-217, -218, -219, -458, and -459 (although CMS-458 and -459 were sampled during a different sampling event than CMS-217, -218 and -219, these samples were averaged because of their close proximity and because they were only analyzed for 2,3,7,8-TCDD)
    - RES-12-556 samples RES-12-556-01 and RES-12-556-02
    - SS_G-01 samples SS_G-01, SS_G-01-01, SS_G-01-02, and SS_G-01-03 (SS_G-01-04 was eliminated from the evaluation because it was located in a fill area)

- SS_G-29 samples SS_G-29, SS_G-29-01 and SS_G-29-02
- RES-11-011 samples RES-11-011-01 and RES-11-011-02 ((RES-11-011-03 was not included in summary statistics because it is a field duplicate and was only use for QA)
- RES-10-005 samples RES-10-005-01, RES-10-005-02, and RES-10-005-03
- RES-10-042 samples RES-10-042-01, RES-10-042-02, and RES-10-042-03
- RES-10-044 samples RES-10-044-02 and RES-10-044-03 (RES-10-044-01 was not included in summary statistics because it is a field duplicate and was only use for QA)
- RES-10-604 samples RES-10-604-02 and RES-10-604-03 (RES-10-604-01 was not included in summary statistics because it is a field duplicate and was only use for QA)
- RES-11-012 samples RES-11-012-01, RES-11-012-02, and RES-11-012-03

Exposure Point Calculations

Some comments pertain to the approach used to calculate exposure point concentrations (EPCs), and the validity of using the calculated EPCs in the risk evaluations. Specifically, Integral commented that EPCs calculated using EPA's ProUCL software are not technically supportable because the EPC, which is based on the 95% UCL of the average concentration, does not account for the spatial representativeness of the chemical results. Integral provided recommendations regarding how the data (distributions and EPCs) should be evaluated to determine the appropriateness of the EPCs. Integral also commented that using the 95% UCL as the EPC for dioxin introduces bias and conservatism into the risk evaluations, and that EPA should rely on average or mean concentrations for EPCs, rather than the 95% UCL. Additionally, EPCs should have been calculated for each of the recommended exposure areas discussed above, rather than using a single EPC for each chemical to represent all floodplain soil. Finally, Integral commented that EPA should use all data from soil sampling locations with samples from both the 0-1 and 1-2 feet below ground surface (ft bgs) depth intervals because the food web exposure tables included in the Supplemental BERA indicate that surface soil is defined as 0-2 ft bgs.

Responses to these comments are summarized below.

- Integral commented that the use of the 95% upper confidence limit of the mean (UCL) is not appropriate to represent the central tendency of exposure. The data collected represent a subset of the total population of potential exposure points, the mean of which may or may not represent the true mean. The 95% UCL is calculated based on variability in the data in order to bracket the range of values that could potentially represent the mean concentration across an exposure area. Using the 95% UCL to estimate exposure concentrations is a conservative approach that ensures that there is 95% confidence that the mean exposure concentration is at or below the exposure point

concentration used to calculate risk without being overly conservative (i.e. using the maximum concentration). To use the mean concentration of the data collected increases the probability that risks will be underestimated and a Type II error (i.e., failure to detect risk when risk is present), especially since the data do not follow a normal distribution. This is considered unacceptable.

Integral's analysis of the 2,3,7,8-TCDD data indicate that the data are not normally distributed. However, Integral's analysis looks at percentiles assuming data are normally distributed and then compares the 95% UCL (calculated assuming a gamma distribution) with those percentiles and the arithmetic mean, which is also calculated based on a normal data distribution. This is not an appropriate comparison. Integral also comments that elevated concentrations at two sampling locations (SS_G-01-SS3 and SS_G-29-SS3) are driving the EPC up. Although they do influence the EPC, the calculated EPC is not as conservative as suggested because (1) it was calculated using the correct data distribution and (2) SS_G-01-SS3 is averaged with three other samples and SS_G-29-SS3 was averaged with two other samples so that EPCs were not biased toward an area where a disproportionately larger number of samples was collected (i.e., the concentration at SS_G-01-SS3 and SS_G-29-SS3 were diluted by concentrations at other nearby sample locations in order to take the average exposures in these two small areas into account. The reason for the higher sampling density in these areas was to more accurately and fully characterize concentrations at potential "hot spots", and as such, averaging across the area is appropriate.

Regarding the comment that risks should have been evaluated to each habitat fragment, this point becomes moot in light of the fact that remedial decisions are being made with respect to a risk-based cleanup goal rather than whether and where there is actionable ecological risk.

- For the purpose of this Supplemental BERA, surface soil was defined as 0 – 1 ft bgs. The dietary exposure tables in Appendix E incorrectly indicate that surface soil is 0 – 2 ft bgs. Table 1 correctly indicates the depth of the surface soil horizon for samples included in the BERA. Most ecological exposures will occur at or near the ground surface. The available data did not allow for the characterization of soil exposures on a finer scale; therefore, all samples collected between 0 and 1 ft bgs were used to quantify the floodplain soil EPCs.

  Although the short-tailed shrew has been reported in the literature to burrow to a depth of up to 20 inches (Saunders, 1988), burrows are usually found in the upper 4 inches (Hamilton, 1931; Jameson, 1943). In spite of the fact that deeper-burrowing receptors may potentially occur in the area, subsurface exposures were discounted in the Supplemental BERA because soils in the 100-year floodplain are frequently saturated due to the high water table. The high water table is expected to concentrate the majority of invertebrates in the top surficial soil layer, as earthworms and other soil organisms tend not to burrow as deeply in wetter soils. As ecologically relevant soil exposures below 1 foot bgs are considered unlikely, sampling data from deeper strata, such as 1-2 ft bgs or 0-2 ft bgs were not included in the assessment. Furthermore, deeper samples (>1 ft bgs) were only collected from a limited subset of floodplain soil sample locations,

and deeper floodplain soil contaminant concentrations are not as well-represented as concentrations in surface soil (0 – 1 ft bgs). Because floodplain soil contaminant concentrations typically decrease with vertical depth, inclusion of these other strata could have had the effect of "diluting" the EPCs and raising the likelihood that a Type I error could occur and ecological risks could be overlooked.

- Integral's streamlined ERA evaluated risks to vermivorous small mammals, represented by the short-tailed shrew, for each of the non-contiguous habitat patches within the Lyman Mill Pond floodplain using only the sample data from 2010. As such there were only two samples each for the habitat patches at the mouth of Assapumpset Brook and along the southeast bank of Lyman Mill Pond. Although Integral took a conservative approach and used the maxima from the two samples as the exposure concentrations, two samples cannot be considered representative of concentrations throughout these areas. For that reason, historical data collected from southeast Lyman Mill Pond was used in order to better characterize contaminants in this area and derive conclusions based on a more robust data set. Again, it is more reasonable to evaluate exposures across the floodplain, and evaluating the smaller habitat patches separately does not affect the remedial decision, which is based on a comparison of concentrations at each location with cleanup goals.
- As previously discussed above Integral's streamlined ERA included data collected outside of the 100-year floodplain, which is being considered for remedial action, and collected at depths greater than the ecological exposure zone (i.e., 1 – 2 ft bgs), diluting the average exposure concentration that was calculated for the Oxbow Area floodplain.
- In the uncertainty section of Integral's streamlined ERA, there is a statement that "the most conservative soil organic carbon content was used to calculate" the site-specific BSAFs used for estimating earthworm tissue concentrations, and it is commented that this likely overestimates risk. However, the mean organic carbon concentration and percent lipid were used to calculate the BSAFs, and the exposure parameters used for the wildlife exposures were average literature-based values. Although there are uncertainties inherent with the use of the selected values, there is no obvious conservative bias associated with either.
- In the uncertainty section in Integral's streamlined ERA, it is stated that, "[t]he major area of uncertainty in the risk characterization process is the combination of upper-bound exposure estimates with upper-bound toxicity estimate, resulting in an overestimation of risks." The streamlined ERA used the mean of a subset of data collected and not the upper-bound exposure estimates. Although the 2011 Supplemental BERA used reasonable maximum exposure concentrations to assure with 95% confidence that the mean Site concentration was at or below the calculated exposure concentration, leading to more conservative exposure estimates, risk was bounded by comparing estimated exposures with both the lowest-observable-adverse-effects level (LOAEL) and no-observable-adverse-effects level (NOAEL). The actual lowest effects concentration is assumed to lie somewhere between those two values, and risk determination is based on exceedences of both the NOAEL and LOAEL and determined to be less certain if exposures exceed the NOAEL but not the LOAEL.

- The use of hazard indices (HI), which are the sum of individual contaminant hazard quotient (HQs) was not meant to imply additive effects, except for classes of contaminants with a similar mode of action. Rather, HIs were used as a simpler way of comparing NOAEL- and LOAEL-based risks for individual receptor groups for which the contaminants of potential ecological concern (COPECs) are the same for the risk characterization. In general, a higher HQ (individual contaminant) or HI (class of contaminants with a similar mode of action) indicates higher risk but is not a direct measure of effects. Even though risks were discussed in terms of percent contribution of each class of contaminants to the total HI, this was not intended to imply that one class of contaminants might have greater impact than another, only that the risks from that class of contaminants may be higher. Regardless, as long as the assessment of risk from exposure to any single COPEC resulted in an HQ greater than 1, it was concluded that there is actionable ecological risk. The amount of remediation is determined by the comparison of data at each sampling location to cleanup goals.

Comments submitted by the Woonasquatucket River Watershed Council (WRWC)

The comments submitted by the Woonasquatucket River Watershed Council (WRWC) were associated with requests for additional studies and/or information. Specifically, the WRWC commented that the Oxbow topography and 100-yr flood elevation was not well defined and that a topographical survey should be performed to delineate one-foot contours of the Oxbow to better under the topography and current surface water channels, the location of the 100-yr floodplain and the location of soil and sediment sampling locations in the Oxbow. The WRWC also asked if preliminary remediation goals (PRGs) had been developed based on findings from the Supplemental BERA, and if EPA's report with this information was available for review. Finally, the WRWC requested clarification regarding the cleanup level proposed for dioxin (2,3,7,8-TCDD) in floodplain soil.

Responses to these comments are summarized below.

- EPA plans to conduct additional data collection activities to support the remedial design in order to confirm the spatial and vertical extent of the cleanup area and to better understand the microtopography and hydrodynamics (e.g., water flow and flood elevations) within the Oxbow.
- EPA's report that presents PRGs developed for the Oxbow area, based on findings from the Supplemental BERA, is included in the Administrative Record available for review at the Site information repositories at the North Providence Union Free Library (1810 Mineral Springs Avenue, North Providence, Rhode Island), the Mohr Memorial Library (1 Memorial Avenue, Johnston, Rhode Island) and the EPA New England Records Center (5 Post Office Square, Boston, Massachusetts) or online at www.epa.gov/region1/superfund/sites/centredale.
- EPA's 2011 Addendum to the Feasibility Study identified a cleanup goal of 35 ng/kg for dioxin (2,3,7,8-TCDD) in floodplain soil at the Oxbow, which is based on the ecological PRG for the most sensitive receptor or exposure pathway (short-tailed shrew/diet). The

cleanup goal was revised from that previously proposed in the 2010 FS to 17 ng/kg following findings from the Supplemental BERA.

References

Hamilton, W.J., Jr. 1931. Habits of the short-tailed shrew, *Blarina brevicauda* (Say). Ohio Journal of Science 31:97-106.

Jameson, E.W., Jr. 1943. Notes on the habits and siphonapterous parasites of the mammals of Welland County, Ontario. Journal of Mammalogy 24:194-197.

Saunders, D. A. 1988. Adirondack Mammals. State University of New York, College of Environmental Science and Forestry. 216 pp.