REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN

UPPER HUDSON RIVER FLOODPLAIN

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LIST OF ACRONYMS AND ABBREVIATIONS

AE	assessment endpoint
Ah	aryl hydrocarbon
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BBL	Blasland, Bouck & Lee, Inc.
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CSF	cancer slope factor
CSM	Conceptual Site Model
CTE	central tendency exposure
DQO	data quality objective
DSR	Data Summary Report
EA	exposure area
EC20	20% effect concentration
EPC	exposure point concentration
ERA	Ecological Risk Assessment
FCR	Floodplain Characterization Report
FFI	Flood Frequency Interval
FFU	flood frequency unit
FS	Feasibility Study
FSP	Field Sampling Plan
GE	General Electric Company
GIS	Geographic Information System
GRA	General Response Action
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HHRA CSM	Human Health Risk Assessment Conceptual Site Model
HI	hazard index

HQ	hazard quotient
ID	identification number
IFCR	Initial Floodplain Characterization Report
IRIS	Integrated Risk Information System
LOAEL	lowest observed adverse effects level
ME	measurement endpoint
mg/kg	milligrams per kilogram
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effects level
NYSCC	New York State Canal Corporation
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	Operation and Maintenance
OSWER	Office of Solid Waste and Emergency Response
PAR	Pathway Analysis Report
PCB	polychlorinated biphenyl
PRA	probabilistic risk assessment
PRG	Preliminary Remediation Goal
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RfD	reference dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RM	River Mile
RME	reasonable maximum exposure
ROD	Record of Decision
RS	River Section
SLA	screening level assessment
SLERA	Screening Level Ecological Risk Assessment
STRA	Short-Term Response Action

TBC	to be considered
TIP	Thompson Island Pool
TRV	toxicity reference values
UCL	upper confidence limit
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
UHR	Upper Hudson River
USEPA	U.S. Environmental Protection Agency

1 INTRODUCTION

1.1 Purpose and Objectives

The purposes of the Remedial Investigation/Feasibility Study (RI/FS) are to gather additional information needed to understand the nature and extent of polychlorinated biphenyls (PCBs) in the Upper Hudson River (UHR) Floodplain,[1] conduct human health and ecological risk assessments for the UHR Floodplain, and develop and evaluate potential remedial alternatives for the UHR Floodplain. These goals form the basis for this RI/FS Work Plan. The primary objective of this Work Plan is to describe the elements of work to be conducted by the General Electric Company (GE) under the Settlement Agreement.[2] It presents the framework for additional UHR Floodplain evaluation activities, including additional investigations and the performance of human health and ecological risk assessments, and a Feasibility Study (FS) of potential remedial alternatives.

A substantial amount of work in the UHR Floodplain has already been conducted. This work has included prior investigations of the UHR Floodplain by the National Oceanic and Atmospheric Administration (NOAA), the U.S. Environmental Protection Agency (USEPA), New York State, and GE. Most recently, under an agreement with USEPA, GE has conducted soil sampling, topographic mapping, and field reconnaissance to assess physical characteristics and land use, vegetation mapping, hydrodynamic modeling of flood inundation, and development of a conceptual understanding of the distribution of PCB concentrations within the UHR Floodplain. Prior deliverables submitted to USEPA on this work have included Data Summary Reports on Floodplain soil sampling activities, a *Human Use and Vegetation Mapping Summary Report* (Mapping Report; ARCADIS 2009), and an *Initial Floodplain Characterization Report* (IFCR; Anchor QEA 2012). In addition, under a separate agreement with USEPA, GE has implemented Short-Term Response Actions (STRAs) consisting of the installation and maintenance of soil/stone covers and/or warning signs at a number of properties within the UHR Floodplain.

[1] "Floodplain" as defined in Paragraph 10.f of the Settlement Agreement has the same meaning as the term "Study Area," which is defined in Section 1.2 below.

[2] Nothing in this Work Plan, nor any activity or communication that may be carried out or held in connection with this Work Plan, constitutes or should be construed as any admission of law, fact, or liability by GE.

The RI/FS described in this Work Plan will build upon that prior work. Specifically, future work elements to be completed as part of this RI/FS Work Plan include:

- Additional investigation activities: Collection of additional data to refine the understanding of the spatial distribution of PCBs in the UHR Floodplain, to estimate exposure point concentrations (EPCs) to be used in the risk assessments, and to support the FS;
- Risk assessments: Performance of human health and ecological risk assessments (with any necessary associated data collection);
- Remedial Investigation (RI) reporting: Preparation of reports documenting the data collection efforts as well as the risk assessments; and
- Performance of an FS: Development and evaluation of potential remedial alternatives.

1.2 Study Area Definition

In 2002, USEPA issued a Record of Decision (ROD) for the removal and disposal of PCB-containing sediments in the Upper Hudson River between Fort Edward and the Federal Dam at Troy (referred to as the UHR) that meet certain PCB removal criteria, and GE is currently carrying out that remedy. USEPA divided the UHR into three sections for the sediment remediation activities outlined in the ROD. The approximate location of each river section (RS) is illustrated in Figure 1-1. The UHR has also been further divided into eight reaches defined by dams or locks (also shown in Figure 1-1). The northernmost reach is Reach 8, also known as the Thompson Island Pool (TIP), and is equivalent to RS 1. RS 2 contains Reaches 7 and 6, and RS 3 contains Reaches 5 through 1. In addition to requiring remediation of the river sediments, USEPA's ROD included a statement that "PCB contamination in the floodplains will be further evaluated . . . ."

The Study Area for this RI/FS is defined as the areas where flooding events could have transported PCBs within the following boundaries and areas:

- Northern boundary – the pool at the base of Bakers Falls (at approximate River Mile [RM] 197.0);
- Southern boundary – the Federal Dam at Troy (at approximate RM 153.9);

- Outer boundaries (Eastern and Western) – the 100-year Floodplain as mapped by the Federal Emergency Management Agency (FEMA) or the extent of the highest-flow event in 2011 as mapped by GE, whichever extends further from the river;
- Inner boundary– the elevation corresponding to the minimum daily average flow with a probability of occurring once every three years (1Q3 flow) over the last 10 years, which is a river flow of approximately 2,000 cubic feet per second (cfs) at the Ft. Edward gaging station. The near-shore sediments between the elevations corresponding to the 1Q3 flow and 5,000 cfs are considered a separate sub-area (referred to as near-shore sediments) of the Floodplain. This sub–area will be subject to an evaluation that is separate from the remainder of the Floodplain, as described in Section 2.4 of this RI/FS Work Plan;
- The area between the Bakers Falls pool and the former dam at Fort Edward will be assessed and USEPA and GE will discuss approaches to the assessment of these areas, and those areas will either be addressed using the approach discussed in this Work Plan or by an alternative approach proposed by GE. Any alternative approach proposed by GE would require USEPA review and approval; and
- Islands in the river that fall within the boundaries described above.

Areas excluded from the Floodplain because they are being addressed separately from this RI/FS are described below:

- Shorelines – Locations on the UHR shoreline that are dredged (or will be dredged) pursuant to the dredging Consent Decree in United States v. General Electric Co., Civ. No. 1:05-CV-1270 (N.D.N.Y.);
- Portions of Dredge Spoil Site Areas –These locations were identified in the *Hudson River Draft Environmental Impact Statement* (Malcolm Pirnie 1992). These dredge spoils are being investigated and/or remediated by the New York State Department of Environmental Conservation (NYSDEC) under the New York State Inactive Hazardous Waste Disposal Site Program at the following sites: 442033 – Newland Island (Lock 4); 546040 – Old Moreau Dredge Spoil Area; 546041 – Special Area 13; 546042 – Moreau Dredge Spoil Disposal Site; 558018 – Buoy 212; 558028 – Site 518; and any other NYSDEC-identified historic dredge spoil disposal sites. However,

where existing data or data collected pursuant to this RI/FS indicate that the PCBs have been deposited by flooding, these areas will be included in this RI/FS; and

- Remnant Sites – Capped areas of Remnant Deposit Sites 2 through 5 that were remediated pursuant to USEPA 1984 Record of Decision for the Hudson River PCBs Site.

1.3 Constituent of Concern

The RI/FS described in this Work Plan will focus solely on PCBs. The reason is that the impacts of concern to the Study Area have resulted from the transport and deposition of sediments from the river onto the Floodplain, and the constituent of concern for the river sediments consists of PCBs, as evidenced by the fact that USEPA's ROD for the river sediments required remediation solely for PCBs. USEPA recognized this when it indicated in the ROD that the future Floodplain evaluation would relate to "PCB contamination in the floodplains" (as noted in Section 1.2). For purposes of this RI/FS, PCBs will be defined as PCBs as measured by an Aroclor-based analytical method.[3]

1.4 Work Plan Organization

This RI/FS Work Plan is organized as follows:

- Section 1: Introduction.
- Section 2: Additional Remedial Investigation Activities – provides an overview of the current understanding of the distribution of PCBs in Floodplain soils (based on previous data collection and investigation activities),[4] outlines the approach to estimating PCB concentrations for use in the risk assessments, and identifies the RI tasks (including additional data collection) and deliverables to be completed for the RI (apart from those related to the risk assessments).

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[3] As discussed in Section 2.5.2, GE has agreed to collect up to 40 discrete samples for analysis of PCB congeners by a congener-specific analytical method, and USEPA will be provided with these data.

In addition, if, during sampling, contaminants other than PCBs are suspected based on observation, odor, etc., GE will notify USEPA, and the parties will discuss the need for sampling of the potentially impacted area. However, any such sampling will not expand the RI/FS to such other contaminants.

[4] For purposes of this RI/FS Work Plan, references to Floodplain soils also include sediments in standing water areas in the Floodplain (as defined in Section 2.1) unless otherwise indicated.

- Section 3: Baseline Human Health Risk Assessment (BHHRA) – describes the approach to assessing potential risks to human health from exposure to PCBs in Floodplain soils, including the several phases of that assessment, the inputs and procedures for each phase, the BHHRA data collection activities, and the deliverables to be submitted.
- Section 4: Ecological Risk Assessment (ERA) – describes the approach to assessing potential risks to ecological receptors from exposure to PCBs in the Floodplain, including an identification of the several phases of that assessment, the inputs and procedures for each phase, the ERA data collection activities, and the deliverables to be submitted.
- Section 5: Feasibility Study – describes the approach for development of remedial action objectives (RAOs) and preliminary remediation goals (PRGs), the development and evaluation of remedial alternatives for the UHR Floodplain, and the deliverables to be submitted as part of the FS.
- Section 6: Schedule – describes the schedule for the activities outlined in this RI/FS Work Plan.
- Section 7: References.

Tables and figures referenced in this Work Plan are either included in the text or attached. Additional information related to the performance of the human health and ecological risk assessments is provided in Appendices A, B, C, and D.

2 ADDITIONAL REMEDIAL INVESTIGATION ACTIVITIES

This section of the Work Plan describes the additional investigation activities to better define the nature and extent of PCBs in the UHR Floodplain (as well as obtaining other necessary information), so as to support, as necessary, the human health and ecological risk assessments and the feasibility study. The investigations completed through 2011 were described and summarized in the *Initial Floodplain Characterization Report* (IFCR; Anchor QEA 2012). The IFCR described the spatial distribution of PCBs in Hudson River Floodplain soils, a description which has been updated since the IFCR. This section of the RI/FS Work Plan presents the following:

- An overview of the PCB distribution in the Study Area (Section 2.1);
- A method for identifying data gaps and determining whether sufficient data have been collected to characterize the distribution of PCBs in Floodplain soils (Section 2.2);
- A general description of the approach that will be followed to develop exposure point concentrations (EPCs) for the human health and ecological risk assessments (Section 2.3);
- A description of the specific investigations and evaluations to be conducted in near-shore sediment areas below the shoreline (i.e., between elevations corresponding to river flows of 5,000 cfs and 1Q3 [approximately 2,000 cfs]) (Section 2.4); and
- A description of the general tasks and deliverables that will comprise the RI other than the human health and ecological risk assessments, which are discussed separately in Sections 3 and 4, respectively. These general deliverables will include a Floodplain Characterization Report (FCR), plans for additional RI data collection, a Revised FCR that will incorporate the additional data, a Final FCR (following receipt of all data from the risk assessments), work plans and reports on cultural resources survey work, and an RI Report to document all RI work (including the risk assessments). The schedule for submission of these deliverables is provided in Section 6.

The data collection efforts described in Sections 2.2 and 2.3 are focused on determining the PCB distribution in soils in the UHR Floodplain that will be used to determine EPCs for use in the human health and the ecological risk assessments.[5] Additional specific data collection needs to support those risk assessments are discussed in Section 3 for the Human Health Risk Assessment (HHRA) and Section 4 for the Ecological Risk Assessment (ERA). The data collection efforts described in Section 2.4 relate specifically to the near-shore sediment areas.

2.1 Overview of PCB Distribution

The current overall understanding of PCB distributions in UHR Floodplain soils will be refined as more data and information are collected and integrated. The refinements will be done in three distinct phases linked to major data collection programs for determining PCB concentrations in the UHR Floodplain. The first refinement will be to update the current understanding of PCB distributions based upon the data collected since 2011 and the issuance of the IFCR in 2012. This will be documented in the FCR (Section 2.5.1). The second refinement will be documented in the Revised FCR (Section 2.5.4) after the initial RI data collection (described in Sections 2.5.2 and 2.5.3) is completed. The final update will be provided in the Final FCR (Section 2.5.6) and the RI Report (Section 2.5.8) and will be informed by all soil data collected as described in Sections 2, 3, and 4 of this Work Plan. An overview of the existing understanding of the spatial distribution of PCBs in the Floodplain is provided below.

Based on the extensive data collected to date, patterns have emerged in the distribution of PCB within the Floodplain. Generally, PCB levels are highest close to the river and decrease further out into the Floodplain. This pattern is generally consistent over the length of the UHR Floodplain, with overall PCB levels decreasing with increasing distance downstream of Fort Edward. Significant factors influencing PCB levels in the UHR Floodplain soils are the frequency of flooding and the ground surface elevation. Higher elevations are less frequently flooded and typically have lower PCB levels. Using elevation, the Floodplain has been partitioned into regions inundated at different flood return intervals (e.g., the area inundated during a 2-year flood). These flood return intervals are termed flood frequency intervals (FFIs).

[5] As noted in Section 1.4 above, unless otherwise indicated, references to Floodplain soils in this section also include the sediments in standing water areas in the Floodplain.

As noted in Section 1.2, the UHR Floodplain has been divided longitudinally into the eight river reaches defined by the dams at their upstream and downstream ends (i.e., Reaches 8 through 1 from upstream to downstream). Based on factors that influence PCB distributions, the UHR Floodplain has been further divided into smaller geographic areas termed "local regions," as discussed below. The boundaries of these local regions may be adjusted based on additional data and will be documented in the appropriate FCR.

Another factor that influences Floodplain soil PCB concentrations is the manner by which a given area of the Floodplain becomes flooded. Floodplain areas where the elevation increases gradually from the river into the Floodplain are inundated most frequently along the shoreline and less frequently as the elevation increases moving inland. These areas are termed "direct-flow" areas. Low-lying areas separated from the river by higher elevation land closer to the river may receive flooding from the river in two ways: (1) from upstream or downstream through a break in the higher elevations closer to shore; or (2) from flood events where the water stage exceeds the higher elevation of the land closer to shore. These low-lying areas further from the shore are termed "backwater" areas. The existing data have shown that the different flood mechanisms affect the PCB distributions for a given FFI differently within backwater and direct-flow areas. This factor may be used to further partition the Floodplain. An example of how the Floodplain would be partitioned between backwater and direct-flow areas is provided on Figure 2-1.

Standing water areas are areas of the Floodplain that are inundated year-round, regardless of the flood stage. Standing water areas are often found in backwater areas, but can also be found in direct-flow areas. Examples of standing water areas within backwater and direct-flow areas are provided in Figure 2-2.

In addition to the flooding mechanisms discussed above, other Floodplain characteristics, such as the presence of wetlands, heavy vegetative cover, or steep banks, may also influence Floodplain soil PCB concentrations. An effort will be made to identify areas within the UHR Floodplain where such characteristics are present and could potentially affect soil PCB concentrations. The soil PCB distributions within these areas will be evaluated to determine whether further partitioning of the Floodplain based on such characteristics is warranted.

Areas of the UHR Floodplain that, due to certain historical events, do not exhibit the typical patterns in PCB levels (i.e., decreasing PCB levels with decreasing inundation frequency) are termed "unique areas." An example of a unique area is the Floodplain on the eastern bank across from Rogers Island, where elevated PCB concentrations have been measured. In 1976, sediment and debris released from the Fort Edward Dam removal blocked the channel in this area. Some of this material was likely deposited onto the Floodplain and provided a unique source of PCBs to this area. A review will be conducted to identify other areas where re-location of Floodplain soils is known to have occurred, based on historical records and the existing shoreline video survey, and to determine whether such areas should be treated as "unique areas." However, re-location of Floodplain soils is expected to have impacted a very small percentage of the Floodplain acreage, and this review will focus on areas of known re-location where there is high human use and PCB soil data are absent.

Because the Floodplain will be partitioned by flood frequency, local region, type of flooding (i.e., backwater and direct-flow areas), and potentially further sub-divided based on other Floodplain characteristics, the term flood frequency unit (FFU) will be used to describe the partitions representing the finest resolution of PCB concentrations in the Floodplain. In some local regions, the FFUs will correspond to FFIs. In other local regions, however, an FFU may combine multiple FFIs and/or comprise FFI subdivisions that are based on other factors (e.g., direct-flow versus backwater areas). Standing water areas will be evaluated on a case-by-case basis, and may be combined within a local region to comprise a single FFU depending on the size of the area, frequency and duration of inundation, and type of flooding. As the Floodplain is partitioned, additional soil or sediment data may need to be collected to refine the understanding of PCB concentrations within FFUs and unique areas.

The RI/FS will use the data partitioned by FFU to derive EPCs for use in the human health and ecological risk assessments. The method for determining when sufficient data have been collected to adequately characterize PCB concentrations in an FFU (and thus to be used in the development of EPCs) or whether additional data need to be collected to do so is presented in Section 2.2. (The characterization of PCB concentrations in unique areas, as described above, will be based on data specific to those areas.) Section 2.3 discusses the general approach to estimating PCB concentrations in exposure areas (EAs) for the HHRA and the ERA given the distribution of PCBs in the Floodplain.

2.2 Identifying Data Gaps

Data gaps exist where the distribution of PCB concentrations within an FFU associated with a local region is not well described by the existing data. The number of samples required to sufficiently characterize PCB concentrations in an FFU depends on the nature of the underlying concentration distribution. For example, fewer samples are required to characterize the distribution of PCB concentrations in an FFU where concentrations vary by a factor of two or three than in an FFU where concentrations vary by two or three orders of magnitude.

Data sufficiency in the local region FFUs will be evaluated using relative precision (i.e., [95th UCL – average]/average) and the number and range of existing measurements. Additional data will be collected as described below. A subset of these data will be collected from the 0- to 6-inch and 6- to 12-inch depth intervals, based on data needs and exposure considerations, consistent with previous sampling. Samples will also be collected from deeper intervals at a percentage of the locations as needed. The additional data will be collected in FFUs having less than a total of six samples or having a relative precision that exceeds 1, with two qualifications: First, the relative precision threshold will not be applied in FFUs whose maximum PCB concentration is less than 0.1 milligram per kilogram (mg/kg); improved relative precision is not needed in these FFUs because the EPCs used in the risk assessments are not sensitive to the precise value of such low concentrations. Second, to account for small FFUs, additional sampling will not occur in FFUs with a sample density greater than or equal to eight samples per acre and additional sampling will be capped when the sample set reaches this density.[6] Given that standing water areas will be evaluated separately, these data sufficiency requirements may not be applicable to such areas.

The initial evaluation of data sufficiency and the identification of data gaps will be presented in the FCR. Once the new data are obtained, a second data gap review will occur to determine whether further sampling should be done because the relative precision remains above 1 and the sampling density has not reached the maximum of eight samples per acre.

[6] The approach described in this paragraph for FFUs will not apply to the unique areas (described above) and near-shore sediment areas, whose characterization will be based on data specific to those areas. Additionally, preliminary data indicate that Reach 4 may also be a unique area, given the current understanding of the area.

The final data sufficiency evaluation for Phase 1 of the HHRA and Phase 1 of the ERA (described in Sections 3 and 4, respectively) will be presented in the Revised FCR. If other information indicates the need for additional samples, the parties will discuss the scope of such sampling on a case-by-case basis.

2.3 Developing Exposure Point Concentrations

A central purpose of the RI is to provide sufficient data/information to estimate EPCs in Floodplain soils for use in both the human health and the ecological risk assessments.[7] These assessments will be done in phases, starting with an initial screening phase using conservative EPCs and then moving to subsequent phases using more refined EPCs. This approach will allow the RI to focus efforts on areas of potential concern, while removing from further consideration those areas where unacceptable exposure or risks are highly unlikely.

The overall approach for calculating Floodplain soil EPCs for the EAs is as follows:

1. For each phase of the risk assessment and for each local region, PCB metrics will be specified for each FFU and will be provided in the FCR, Revised FCR, or Final FCR, as appropriate. These metrics will include the maximum PCB concentration, the upper 95th percentile confidence limit on the mean concentration (95^{th} UCL), the average PCB concentration, and any other appropriate metrics, including the upper 95^{th} percentile prediction limit (UPL) that is acceptable to USEPA. These metrics will be updated as additional data are collected. In areas where a soil cover has been placed as part of a Short-Term Response Action (STRA) (see Section 1.1), the PCB data collected prior to the placement of the soil cover will be used in developing the metrics for the FFUs.
2. In both the HHRA and the ERA, EAs will be defined, as described in Sections 3 and 4, respectively.

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7 For this purpose, as noted above, the term "Floodplain soils" include sediments in standing water areas in the Floodplain. To the extent that exposures to other media are evaluated, such as exposures to surface water or through the food chain in the ERA, the concentrations used to evaluate such exposures will be described in the relevant risk assessment deliverables.

3. The EAs will be mapped onto the local regions. Some EAs may map across multiple local regions. As discussed previously, local regions will be subdivided by FFU, and PCB metrics will be associated with each FFU. Thus, the process of mapping the EAs onto the local regions will result in each EA being partitioned into FFU sections, each with its associated PCB metrics.
4. For each Floodplain soil EA in each risk assessment, an EPC will be determined for the particular phase of the risk assessment, using the appropriate PCB metric for that phase (or, if warranted, a metric derived by an alternate method, subject to USEPA approval). The appropriate PCB metric will be derived on an area-weighted basis for each EA. These EPCs will be based on the local region data and FFUs provided in the FCR preceding that phase (i.e., FCR, Revised FCR, or Final FCR), except that (a) EPCs in unique areas (as described above) will be based on data specific to those areas, and (b) GE may propose to use an alternate averaging technique for the development of certain EPCs in the ERA. The process for developing Floodplain soil EPCs for each phase and the metrics to be used in that phase are discussed in Section 3 for the HHRA and Section 4 for the ERA.

2.4 Evaluation of Near-Shore Sediment Areas

At USEPA's request, GE will conduct an analysis of near-shore sediments as described in this section and Section 3.7.2. These near-shore sediment areas (as defined in Section 1.2) are temporarily exposed during lower river flows and therefore could present potential points of exposure for intermittent recreational users. Specifically, in lieu of performing the other RI tasks that relate to the remainder of the Study Area, GE will perform a separate evaluation involving the identification of areas with near-shore sediments that may be accessible for human contact. This section describes the approach that will be used to identify such areas.

The near-shore area will focus on areas that are likely to be accessible for human use, excluding areas that have been or will be dredged. Areas with near-shore sediments where there is a reasonable potential for human access and use will be identified based on their physical characteristics along with information about adjacent land use and accessibility.

During preparation of the FCR, GE will identify near-shore sediment areas and assess the accessibility of such areas and the likelihood that they will be used when the sediments are exposed. This identification and assessment will be based on existing information and will consider a number of different factors. These factors are expected to include the following:

- River bank height and slope – Elevation data, information collected during the 2012 shoreline survey, and a review of the shoreline video completed in 2012 will be used to evaluate bank height and slope in order to identify areas where there is reasonable potential for human access to the near-shore sediment areas. Areas that have bank heights greater than 3 feet combined with slopes greater than 50% and which have no signs of human use will be proposed for exclusion.
- Substrate – The substrate of the near-shore sediments will be considered in determining areas where there is a reasonable potential for recreational use and for exposure to PCB-containing sediment to occur. For example, areas of rip-rap and exposed bedrock will be proposed for exclusion.
- Vegetation – Near-shore sediment areas adjacent to wetlands or very heavily vegetated areas that have no signs of access are not likely to be used by humans and will be proposed for exclusion. Information collected during the habitat mapping, shoreline survey and shoreline video will be reviewed to identify areas with these land cover types.
- Width of near-shore sediment areas – The areal extent of the near-shore sediment area varies based on the slope of the area. For example, gentle-slope near-shore sediment areas will have a larger footprint within the near-shore region than will steep-slope areas. Near-shore sediment areas that are narrow and adjacent to very narrow shorelines are more difficult to access by individuals. The width of near-shore sediment areas will be considered, and very steep and narrow areas that have no signs of access may be proposed for exclusion.
- Land use – Based on our current understanding of the Study Area and the nearby adjacent lands, near-shore sediment areas that are not adjacent to residential areas or known recreational use areas are not likely to be accessed with any regularity. Therefore, the near-shore sediment areas to be evaluated are expected to focus on areas that are adjacent to residential or known recreational areas. Near-shore

sediment areas adjacent to year-round residences, seasonal residential properties, or known recreational areas, including parks, playgrounds, picnic sites, recreational areas accessed from the river, areas designated for outdoor sports, and marinas, are expected to be retained. Additionally, near-shore sediment areas adjacent to parcels on which the need for STRAs were evaluated, and those where signs of human use were identified during the shoreline survey, will be evaluated. Reasonably anticipated future use considerations may need to be taken into account on a case-by-case basis.

The results of this assessment, including the identification of near-shore sediment areas determined to be potentially accessible for human use based on review of the above factors, will be included in the FCR. That report will also identify any data gaps that need to be filled to complete the identification of potentially accessible near-shore sediment areas. In addition, the FCR will evaluate the availability and adequacy of existing data from the identified near-shore sediment areas, including both PCB data and sediment type information; and it will identify the areas where additional PCB and/or sediment type data are needed to complete that evaluation. A proposal for sampling of those areas to obtain the necessary data will be included in the Field Sampling Plan/Quality Assurance Project Plan (FSP/QAPP) described below. Samples will be collected from 0 to 12 inches below the sediment surface.

Following the collection of the additional data, the identification of near-shore sediment areas with a reasonable potential for human use will be refined as necessary, and those areas will be identified in the Revised FCR for subsequent evaluation in a specific human health assessment, described in Section 3.7.2.

The identification of near-shore sediment areas in the Revised FCR will be subject to further evaluation following USEPA review of the Pathway Analysis Report (PAR), which is part of the HHRA, as described in Section 3.4 below. Specifically, at that time, based on USEPA review of the land uses presented in the PAR, GE will evaluate whether there are any additional near-shore sediment areas (not previously identified), that are likely to be subject to human use when the sediments are exposed considering the same factors described above. Further, GE will evaluate the availability of PCB data from any such areas. The results of these evaluations will be presented in a submittal entitled Additional Evaluation of Near-Shore Sediment Areas. That submittal will also propose any additional PCB or other data collection necessary in such areas.

If any additional near-shore sediment areas with a reasonable potential for recreational use are identified, they will be added to the ones previously identified in the Revised FCR and designated for inclusion in the specific human health risk assessment described in Section 3.7.2. The overall results from the evaluations of near-shore sediment areas will be summarized in the RI Report.

2.5 Remedial Investigation Tasks and Deliverables

This section describes the general tasks and deliverables that comprise the RI, apart from the human health and ecological risk assessments, which are discussed in Sections 3 and 4. This sequence of tasks and deliverables is designed to establish a process by which the data available for developing EPCs in the human health and ecological risk assessments are evaluated and the need for additional data is assessed. Additional non-risk assessment deliverables required as part of the RI are also described.

2.5.1 Floodplain Characterization Report

The initial step in the performance of the RI will be submission of the FCR. The FCR will incorporate data collected since the IFCR was submitted in 2012 and will document the revisions to the PCB distribution description in Section 2.1. The FCR will also document the data analyses that will be used in the screening-level HHRA and ERA (described in Sections 3 and 4, respectively). In addition, the evaluations of the near-shore sediment areas will be described. Specifically, the following elements will be included:

- A physical description of the Floodplain will be provided.
- All available UHR Floodplain soil data will be described and referenced.
- A project database and Geographic Information System (GIS) database will be described and provided as an attachment to the FCR. Property owner confidentiality will be maintained in data presented in the FCR and in all subsequent publicly available reports.

- A data quality and usability assessment will be provided. Data which are not usable will be qualified appropriately in the project database.
- The current understanding of the distribution of PCBs in the Floodplain will be described in detail.
- The approach to developing local regions and FFUs will be described, including unique areas, direct flow areas, and backwater areas.
- A summary of existing habitat and land-cover information will be provided.
- PCB metrics will be provided for each FFU based on the PCB distribution and the existing data.
- Analysis of available Floodplain soil data will be presented within the context of the FFUs, as appropriate, including the results of the data sufficiency evaluation discussed in Section 2.2.
- Using the approach described in Section 2.2, data gaps will be identified that need to be filled to allow further refinement of the understanding of PCB distribution in the Floodplain and to reduce uncertainty in the FFU PCB concentration metrics that will be used to support Floodplain soil EPC calculations for the risk assessments.
- A detailed description of the statistically based approach for determining the proposed metrics, along with a discussion of preliminary results, will be included.
- As described in Section 2.4, the near-shore sediment areas determined to be potentially accessible for human use will be identified, as will any data gaps that need to be filled to complete the evaluation of such near-shore sediment areas.

2.5.2 Field Sampling Plan/Quality Assurance Project Plan and Health and Safety Plan

Following USEPA approval of the FCR, GE will submit an RI Field Sampling Plan and Quality Assurance Project Plan (RI FSP/QAPP), which will specify the procedures for collecting the data necessary to fill the data gaps identified in the FCR. The RI FSP/QAPP will be developed consistent with USEPA guidance (e.g., Uniform Federal Policy for Quality Assurance Project Plans [UFP-QAPP] per Office of Solid Waste and Emergency Response [OSWER] Directive 9272.0-17) and will include the following elements:

- Description of data quality objectives (DQOs);
- Details of sampling and analytical procedures, using, where appropriate, previously approved procedures, including USEPA Method SW846 8082 for Total PCBs and the Lloyd Khan Method for total organic carbon (see QEA and ARCADIS 2008); and
- An implementation schedule for field work, data management, and reporting, accounting for time required to seek access to third-party properties.

In addition, the RI FSP/QAPP will propose the collection of up to 40 samples for analysis of PCB congeners, and will specify the analytical procedure to be used for such analysis. GE will work with USEPA to select the locations as well as the sampling and analytical procedures for these samples.

Concurrently with submittal of the RI FSP/QAPP, a Health and Safety Plan (HASP) will be submitted to support the additional field sampling efforts. Where appropriate, this HASP will reference the HASP developed for previous Hudson River Floodplain sampling programs. The HASP will include the following elements:

- Identification of potential physical, chemical, and biological hazards present during field work associated with the UHR Floodplain soils RI sampling;
- Description of protective measures necessary to control these hazards;
- Documentation of emergency procedures and other response measures; and
- Training and medical qualification criteria for site personnel.

2.5.3 Additional Data Collection

Once the initial round of RI sampling is complete, the results will be reviewed to determine if sufficient data are available to proceed with the Revised FCR. If review of the data indicates that the DQOs (as documented in the RI FSP/QAPP) have not been satisfied, or if the data are not sufficient, as defined in Section 2.2, to characterize PCB concentrations in certain FFUs, then a proposal for additional data collection will be submitted. That proposal will contain a review of the data collected, an assessment of their usability for development of the Revised FCR, an identification of remaining data gaps, and a proposal for conducting the additional investigations necessary to fill those data gaps.

Following USEPA approval of this additional data collection proposal, an addendum to the RI FSP/QAPP will be submitted, as necessary, to describe the additional data collection efforts approved by USEPA.

Following the collection of the additional data, this process will be repeated as necessary until it is determined that sufficient data are available to proceed to the Revised FCR.

Once it is determined that sufficient data are available to complete the Revised FCR, an RI Data Summary Report (DSR) will be submitted that documents the sampling efforts performed, the data collection, and the usability and completeness of the collected data. This RI DSR will include an updated database and GIS files containing all UHR Floodplain data, and it will also include data validation reports on the RI data collected.

2.5.4 Revised Floodplain Characterization Report

Using the updated database provided in the RI DSR, the Revised FCR will be submitted to document any updates to the understanding of PCB distribution in the Floodplain and provide the data evaluations required to develop the Phase 1 Floodplain soil EPCs for the human health and ecological risk assessments. Additionally, the results of the investigations of the near-shore sediment areas will be presented. More specifically, the Revised FCR will include the following:

- Summary of the data presented in the RI DSR;
- If necessary, refinements to the understanding of PCB distribution and any changes to the FFUs and unique areas, along with the basis for such changes and supporting spatial statistics;
- Updated PCB metrics for each local region FFU based on the revised understanding of PCB distribution and the additional data;
- Presentation of the final data sufficiency evaluation for Phase 1 of the HHRA and Phase 1 of the ERA (described in Sections 3 and 4, respectively); and

- Identification of the near-shore sediment areas that have a reasonable potential for human use.

2.5.5 Additional Evaluation of Near-Shore Sediment Areas

As discussed in Section 2.4, following USEPA review of the PAR (part of the HHRA), GE will submit an additional evaluation of the near-shore sediment areas. That submittal will include an evaluation, based on review of the land uses presented in the PAR, as to whether there are any additional near-shore sediment areas (not previously identified) that are likely to be subject to human use when the sediments are exposed. This submittal will also present an assessment of the availability of PCB data from any such areas and a proposal for any additional data collection in those areas.

2.5.6 Final Floodplain Characterization Report

Following receipt of any additional Floodplain data that may be collected to support completion of the HHRA and the ERA (as discussed in Sections 3 and 4, respectively), those additional data will be incorporated into the site database and GIS files, and a Final FCR will be submitted. The Final FCR will document all data collected (referencing previous FCRs as necessary), including the data collected for the HHRA and the ERA; and it will update the description of PCB distribution in the Floodplain and the FFU and unique area data assessments and associated PCB metrics for the local regions. It will also provide the results from any additional investigations and evaluations of near-shore sediment areas. An updated project database and GIS files will be provided in the Final FCR.

The Final FCR will be used to complete the final HHRA and ERA, as described in Sections 3 and 4, respectively.

2.5.7 Cultural Resources Assessment

In compliance with the substantive requirements of the National Historic Preservation Act of 1966, the potential presence of cultural, archaeological, and historical resources within the UHR Floodplain will be assessed during the RI process. The steps in this process are described below.

2.5.7.1 Stage IA Cultural Resources Assessment Work Plan

A work plan for an initial cultural resources assessment will be submitted early in the RI process. This work plan will propose a Stage IA cultural resources assessment designed to identify any previously recorded historical, archaeological, architectural, or culturally significant resources within the project area and to evaluate the potential for the Study Area to contain previously unidentified resources. The Stage IA Cultural Resources Assessment Work Plan will include plans for review and incorporation of the existing data collected as part of the cultural and archaeological resources assessment program for the Upper Hudson River dredging project, where applicable, and will propose review of additional background data as needed from archival sources (e.g., the files of the New York State Office of Parks, Recreation, and Historic Preservation).

2.5.7.2 Stage IA Cultural Resource Survey

Following USEPA approval of the Stage IA Cultural Resources Assessment Work Plan, the Stage IA cultural resources assessment will be conducted, and the results will be presented in a Stage IA Cultural Resources Survey Report. If the results of Stage IA assessment indicate that cultural, archaeological, or historic resources may be located in Floodplain areas potentially subject to remedial action, this report will propose Stage IB field survey work as necessary to further investigate those potential resources. The Stage IB survey will include systematic field investigations appropriate to the characteristics of the landforms being investigated.

2.5.7.3 Stage IB Cultural Resources Survey

In the event that a Stage IB field survey of potential cultural resources is proposed, the survey activities will be conducted following USEPA approval of that proposal, and the results will be presented in a Stage IB Cultural Resources Survey Report. This report will be included as part of the RI Report unless the Stage IB survey is completed well ahead of the RI Report, in which case this report will be submitted separately.

2.5.8 Remedial Investigation Report

Upon completion of the RI activities documented above, as well as the final HHRA and ERA, an RI Report will be prepared to document all RI work. The RI Report will include the following elements:

- Site background information for the UHR Floodplain, such as site description, site history, and a summary of previous investigations and response actions;
- Description of the RI activities undertaken for the UHR Floodplain, including the activities described in the IFCR as well as investigation efforts conducted under this RI/FS Work Plan;
- Description of the physical characteristics of the UHR Floodplain such as geology, hydrology, climate, and habitat characterization;
- Discussion of the nature and extent of PCBs in the UHR Floodplain; and
- A summary of the findings of the RI, the HHRA, and the ERA, including the separate evaluation of the near-shore sediment areas.

In addition, the RI Report will include, as appendices, the Final Baseline Human Health Risk Assessment Report, the Final Baseline Ecological Risk Assessment Report, and the Stage IB Cultural Resources Survey Report (if submitted).

3 BASELINE HUMAN HEALTH RISK ASSESSMENT

The BHHRA will assess potential risks to human health resulting from current and reasonably anticipated future exposures to PCBs in UHR Floodplain soils. For purposes of this assessment, GE will identify current and reasonably anticipated future use areas in the UHR Floodplain and develop a conceptual site model (CSM) for potential human exposures (referred to as the Human Health Risk Assessment Conceptual Site Model, or HHRA CSM) to PCBs in Floodplain soils. The BHHRA will be conducted using a phased approach. The first step will be to conduct an initial conservative Screening-Level Assessment (SLA) to identify the areas of the UHR Floodplain that warrant further analysis. Exposure areas (EAs) for each tax parcel remaining after the SLA will then be evaluated in Phase 1 of the BHHRA, which will constitute a more refined screening assessment, using exposure point concentrations (EPCs) derived from available data. The development of EAs will take into consideration varied characteristics and uses (if any) within individual tax parcels. The individual EAs that are shown in Phase 1 to have potentially unacceptable screening-level baseline risks or are otherwise identified as warranting further evaluation will be further evaluated in Phase 2 of the BHHRA, which will be a more EA-specific characterization of potential human health risks associated with PCB exposure. For that purpose, supplemental data will be collected, as necessary, to develop EA-specific EPCs for the Phase 2 assessment, which will combine those EPCs with other EA-specific exposure assumptions. The estimated potential risks from Phase 2 for each of the human EAs will be compared with USEPA's cancer risk range of 10^{-6} to 10^{-4} as specified in the National Contingency Plan (NCP) and a non-cancer hazard index (HI) of 1.

The BHHRA will be conducted in accordance with accepted risk assessment approaches and will include the hazard identification, dose-response, exposure assessment, and risk characterization steps outlined by the National Academy of Sciences (1983) and summarized below:

- The objective of hazard identification is to determine whether there are substances present in site-specific exposure media at concentrations that have the potential to cause adverse health effects in humans. Key components of the hazard identification are the selection of media of concern and selection of constituents of potential concern.

- Dose-response assessment is the process of characterizing the relationship between the dose of an agent administered or received and the incidence of a potentially adverse health effect in an exposed population. The end result of the dose-response assessment is the determination of human uptake levels (toxicity criteria) that provide a certain measure of protection to exposed persons for carcinogenic (cancer) and non-carcinogenic (non-cancer) endpoints.
- Exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of human exposure to substances present in the environment. It includes the identification of potential exposure areas and potentially exposed populations, development of exposure scenarios, analysis of exposure pathways, and estimation of EPCs in order to estimate potential dose rates under current and reasonably anticipated future uses.
- Risk characterization is the quantification of potential risks and hazards and is completed by comparing estimated exposure levels with defined toxicity criteria and then comparing the resulting estimated risks and hazards with benchmarks that have been established for the protection of public health.

The BHHRA will focus solely on potential exposures to PCBs in Floodplain soils (as well as any adjacent areas within the Study Area that are part of the identified EAs). For purposes of the BHHRA, the term "Floodplain soils" will include sediments in the standing water areas (as defined in Section 2.1) to the extent that individuals may be exposed to those sediments.

In developing the BHHRA, relevant guidance documents will be considered in conjunction with the procedures and criteria provided in this Work Plan, including the following:

- *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (USEPA 1989a);
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)* (USEPA 1991b);
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives)* (USEPA 1991c);

- *Final Guidelines for Exposure Assessment* (USEPA 1992a);
- *Data Usability for Risk Assessment, Parts A and B* (USEPA 1992b);
- *Supplement Guidance to RAGS: Calculating the Concentration Term* (USEPA 1992c);
- *Guidance for Risk Characterization* (USEPA 1995a);
- *Land Use in the CERCLA Remedy Selection Process* (USEPA 1995b);
- *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures* (USEPA 1996a);
- *Guiding Principles for Monte Carlo Analysis* (USEPA 1997a);
- *Policy on Use of Probabilistic Risk Assessment* (USEPA 1997b);
- *Risk Assessment Guidance for Superfund: Volume III, Part A, Process for Conducting Probabilistic Risk Assessment* (USEPA 2001a);
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments), Final* (USEPA 2001b);
- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA 2002a);
- *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (USEPA 2002b);
- *Human Health Toxicity Values in Superfund Risk Assessments* (USEPA 2003a);
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final* (USEPA 2004);
- *Guidelines for Carcinogen Risk Assessment; Final* (USEPA 2005a);
- *Exposure Factors Handbook* (USEPA 2011);
- *ProUCL Version 5.0.00 Technical Guide* (USEPA 2013a);
- *ProUCL Version 5.0.00 User Guide* (USEPA 2013b); and

- *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors* (USEPA 2014c).

The BHHRA will be conducted according to the methodology outlined in USEPA's (2001b) Risk Assessment Guidance for Superfund, Volume I, Part D (RAGS Part D). RAGS Part D complements the other USEPA guidance documents by presenting an approach to standardize the planning, reporting, and review of risk assessments.[8] This approach includes a process for preparation, submission, and approval of interim deliverables prior to the completion and submission of the Final BHHRA Report. It provides for the involvement of USEPA risk assessors during the planning, conduct, and completion of the BHHRA.

This section discusses the basis and approach for the BHHRA and describes the major reports that will be submitted to USEPA for review and approval. Specifically,

- Section 3.1 presents the preliminary HHRA CSM.
- Section 3.2 provides an overview of the multi-step approach to be used in the BHHRA and the reports to be submitted to USEPA.
- Sections 3.3 through 3.7 describe the key major steps and deliverables in the BHHRA process – i.e., the SLA, the Pathway Analysis Report (PAR), Phase 1 of the BHHRA, the proposal for collection of additional data to support Phase 2, the performance of Phase 2 of the BHHRA, and the Final BHHRA Report.

3.1 Preliminary Conceptual Site Model for the Baseline Human Health Risk Assessment

The Floodplain includes a variety of land types, including bottom-land forests, wetlands, undeveloped open land, recreational areas, residential properties, agricultural fields, commercial/industrial properties, and utility corridors. Several types of human usage occur along the UHR Floodplain. These include residential, recreational, agricultural, and commercial/industrial uses. Specific uses are variable, with some areas of the Floodplain used more regularly and other portions used only on an occasional or seasonal basis. In addition,

[8] RAGS Part D Table 8, which pertains to radiation risks, is not relevant and so will not be included.

the potential for exposure within these use areas varies, depending upon the extent of the Floodplain, the contribution of the Floodplain areas to the total use areas, and their physical characteristics (e.g., topography, accessibility, land cover, etc.).

A preliminary HHRA CSM has been developed in an effort to describe the media of potential concern for the BHHRA, the potential routes of human exposure to those media, and the potentially exposed human populations. This preliminary HHRA CSM, which is illustrated on Figure 3-1, will be used to help identify both complete and incomplete exposure pathways and to assist in developing the focus for the BHHRA. This will also help to guide data collection.

As shown in Figure 3-1, potential exposure to PCBs via groundwater is an incomplete exposure pathway, and therefore groundwater will not be considered a medium of potential concern for the BHHRA. The classification of groundwater as an incomplete exposure pathway is supported by survey work completed along the UHR. PCBs were not detected in any of the 33 private drinking water wells sampled as part of 2009 and 2011 surveys specifically aimed at evaluating potential exposures to PCBs via drinking water from private wells in the Floodplain (NYSDOH 2013). Based on the survey results, the New York State Department of Health (NYSDOH) and the Agency for Toxic Substances and Disease Registry (ATSDR) concluded that PCBs from the Hudson River site are not expected to harm people's health via private drinking water wells. If additional information, including Floodplain soil data, indicates potential impacts to existing wells from PCBs deposited by flooding at properties where groundwater is being used, the potential for exposure to PCBs in groundwater in these areas will be assessed on a case-by-case basis.

Based on what is known about the areas of the Floodplain that have already been sampled, and the results presented in the 2009 *Human Use and Vegetation Mapping Summary Report* (Mapping Report; ARCADIS 2009), a preliminary draft of RAGS Part D Planning Table 1, entitled "Selection of Exposure Pathways – Upper Hudson River Floodplain," is provided as Table 3-1. Although inhalation is defined as a complete exposure pathway under the preliminary HHRA CSM, its contribution to cumulative exposure under most scenarios is minor when compared with the dermal and ingestion pathways, as demonstrated by the standard exposure assumptions used by USEPA for determining residential and industrial soil screening levels (USEPA 2014a). Exposure to PCBs via inhalation of vapors from UHR Floodplain soil is considered minor because the PCBs found there have low vapor pressure (ATSDR 2000) and do not tend to volatilize into ambient air. While inhalation of particulates derived from the resuspension of surface soil may also occur, this pathway generally contributes less than 1% of total estimated exposure when direct soil contact pathways (ingestion and dermal contact) are considered (USEPA 2014a). For scenarios under which greater amounts of dust are generated, there may be a higher potential for exposure to particulates derived from the resuspension of surface soils. Thus, a quantitative evaluation of the inhalation of particulates will be conducted for construction and agricultural workers. Otherwise, exposures via the inhalation pathway will not be quantified in the BHHRA. However, for the receptors for which inhalation exposures are not evaluated quantitatively, the relative contribution of potential exposures due to the inhalation of dust and vapors will be discussed qualitatively in the BHHRA.

3.2 Overview of Baseline Human Health Risk Assessment Process

The BHHRA will be conducted using a phased approach consisting of the following steps:

- A SLA will be performed to identify the areas of the UHR Floodplain that warrant further analysis. The SLA will provide a conservative estimate of potential risks in that it will use maximum PCB concentrations for each parcel and compare the results to a conservative pre-established PCB screening level specified by USEPA.
- A PAR will be developed to present the HHRA CSM (refined as appropriate) and information regarding the EAs and the exposure scenarios and parameters to be evaluated in Phases 1 and 2 of the BHHRA, as well as the EPCs to be used in Phase 1.
- Phase 1 of the BHHRA will constitute a more refined but still screening-level risk assessment and will be performed to further focus the BHHRA on those areas that may have unacceptable levels of exposure and risk. This phase will include two estimates of potential risks/hazards – one using USEPA's default exposure assumptions and the other using modified/adjusted exposure assumptions. Before the Phase 1 assessment is conducted, data gap sampling will be conducted as part of general RI activities, as discussed in Sections 2.5.2 and 2.5.3, to ensure that the data are adequate and representative of the FFUs. Phase 1 will also consider the most conservative of current and reasonably anticipated future uses, conservative upper-bound estimates of

EPCs, and conservative comparison benchmarks. EPCs will be derived as specified in Section 3.4. At the end of Phase 1, a supplemental evaluation will be conducted to assess whether any EAs that show no unacceptable risks in the Phase 1 analysis should nevertheless be carried into Phase 2 due to factors indicating significant uncertainties about their exclusion at this stage.

- After Phase 1 of the BHHRA is completed, additional sampling will be proposed and conducted, as necessary, to further characterize EAs for which Phase 1 indicates the potential for unacceptable risks or which are identified in the Phase 1 supplemental evaluation as warranting additional, EA-specific assessment. The additional data collected will be used to develop EA-specific EPCs for use in the Phase 2 assessment.
- Phase 2 of the BHHRA will use reasonable upper-bound and central tendency estimates of exposures at the retained EAs under current and reasonably anticipated future conditions. This phase will include two estimates of potential risks/hazards – one using USEPA's default exposure assumptions and the other using site-specific exposure assumptions. EPCs will be derived as specified in Section 3.7. The results will be compared with USEPA's cancer risk range and a non-cancer hazard index (HI) of 1.
- A Final BHHRA Report will be prepared to provide final baseline exposure and risk estimates for current and reasonably anticipated future uses of the UHR Floodplain.

GE has indicated to USEPA that non-default parameters to be used in Phase 1 and Phase 2 of the BHHRA will be provided simultaneously with the default parameters and will include the rationale for use of those parameters for USEPA's consideration.

The above steps and their associated deliverables are discussed in the following sections.

3.3 Screening-Level Assessment

The first step in completing the BHHRA will be to conduct the SLA to identify those properties that have some potential to pose an unacceptable level of risk and, therefore, should be carried forward into Phase 1 of the BHHRA. The results of the SLA will be submitted to USEPA for approval before proceeding with the development of the PAR and Phase 1 of the BHHRA.

The process that will be used to complete the SLA includes the following steps:

- Each individual tax parcel, in its entirety, will be considered to be a discrete EA and will be given a unique and anonymous alpha-numeric identification code.
- As requested by USEPA, the maximum concentration for the tax parcel will be identified as the highest of the maximum concentrations measured in the FFUs that are present on that particular tax parcel (discussed in Section 2.2).
- The depth increment to be used for the screening will be the 0- to 12-inch depth interval. Where multiple samples have been collected within this depth interval at a single sampling location (e.g., 0- to 6-inch and 6- to 12-inch samples), the maximum PCB concentration measured in any discrete sample within that depth interval will be used in the screening comparison.[9]
- As also requested by USEPA, the selected maximum concentration for the tax parcel will be compared with USEPA's default residential screening PCB concentration of 0.24 mg/kg (USEPA 2014a), regardless of current or potential future use of the parcel. This screening level assumes, among other things, residential exposure of adults and children to soils for 350 days per year and is based on a lifetime excess cancer risk level of 1×10^{-6}.
- For each tax parcel, if the maximum concentration on the parcel exceeds the default screening level, that tax parcel will be retained for further consideration in Phase 1 of the BHHRA, unless GE provides to USEPA for review and approval a parcel-specific rationale (e.g., based on size of and accessibility of the FFU that contains the maximum concentration, and the concentrations in other areas of the parcel) for not carrying the parcel forward into Phase 1.
- Each tax parcel for which the maximum concentration does not exceed the screening level of 0.24 mg/kg will be subject to a supplemental qualitative assessment to

[9] In areas where a soil cover has been placed as a Short-Term Response Action (STRA), the data from the 0- to 12-inch depth interval prior to placement of the soil cover will be used in determining the maximum concentration.

determine whether there is any reason, based on the physical characteristics of the parcel, that the parcel should be retained for further evaluation in Phase 1. In the absence of any such reason, tax parcels for which the maximum concentration does not exceed the screening level do not warrant further consideration in the BHHRA and will not be carried forward to Phase 1 of the BHHRA.

The results of the screening analysis for each tax parcel will be provided in the SLA Report. This report will identify those tax parcels that will be carried forward into Phase 1 of the BHHRA. The screening analysis will be documented in a table similar to RAGS D Table 2.3 (USEPA 2001b), but the table will be modified, as shown in Figure 3-2, to reflect the numbers of parcels evaluated and the fact that PCBs will be the only chemical of potential concern evaluated. The SLA Report will be submitted to USEPA for approval before proceeding with the PAR.

3.4 Pathway Analysis Report

The PAR will be completed and submitted to USEPA following USEPA's approval of the SLA Report or the Revised FCR (whichever is later) and prior to initiation of Phase 1 of the BHHRA.

The PAR will present a refined HHRA CSM, summarize the results of the SLA, select EAs for each parcel remaining after the SLA, designate current and reasonably anticipated future uses for each parcel and for each EA remaining after the SLA, and select the exposure scenario to be evaluated for each such EA in Phase 1. The PAR will detail the specific exposure scenarios to be evaluated in Phases 1 and 2 of the BHHRA, the age groups to be considered under each, the exposure pathways that will be evaluated quantitatively and qualitatively (if any), and the specific exposure parameters and toxicity values to be used.

The identification of current and reasonably anticipated future uses for each parcel and for each EA designated for evaluation in Phase 1 of the BHHRA will be accomplished using information about current ownership, land use classification, zoning, topography, planning documents, and information from other agencies or groups on general trends in residential development, agricultural practices, and recreational activities in the counties along the

UHR. The designated current and reasonably anticipated future use for each EA will be provided in the PAR. In cases where there is more than one reasonably anticipated future use for an individual EA, all such reasonably anticipated future uses will be identified and the one that is based on the most protective assumptions will be selected for assessment.

A preliminary evaluation of current human uses of individual tax parcels in the UHR Floodplain was conducted in 2008 and 2009 and was reported in the 2009 Mapping Report (ARCADIS 2009). The land uses reported for individual tax parcels in that report were based on the information about property ownership and usage that was available at that time.

Conditions in some portions of the Floodplain have changed since that report was submitted. Tax identification numbers (Tax IDs), ownership, and use categories have changed for some parcels; some properties have been subdivided, others have been combined, and for some the zoning classifications may have changed. In addition, the 2009 report included some parcels which do not contain any Floodplain area but were previously included in the list of parcels because they are adjacent to the river and/or soil samples had been collected on them. Thus, it will be necessary to update the information presented in the 2009 Mapping Report to reflect current conditions on those tax parcels that have acreage that falls within the Floodplain. To do this, the following steps will be taken:

- Tax parcels that have acreage within the Floodplain will be verified.
- Changes to Tax IDs, ownership, and land use classifications will be used to identify parcels that may have had changes in usage since the 2009 report was completed and on which current uses may need to be confirmed or updated.
- More recent land use data from the counties (post-2006 for Rensselaer County and post-2004 for the other counties), if available, will be used to compare the current land uses assigned to each tax parcel with the land uses designated in the original report, to determine if land uses have changed. Field verification will be conducted as needed to confirm actual current uses of the properties.
- Reasonably anticipated future uses of the tax parcels will be identified based on current uses, zoning requirements, local/regional planning information, known land use/development restrictions, lease/permit conditions, physical characteristics of the parcels, proximity to current use areas, and information obtained from the

U.S. Department of Agriculture, recreational groups and other groups that may be able to provide insight into future changes in Floodplain land uses that may occur.

- Table 2-2 of the 2009 report will be updated to reflect this information and a current and reasonably anticipated future usage will be identified for each parcel.

Following the identification of current and reasonably anticipated future use for each parcel to be included in the Phase 1 BHHRA, the appropriate EA(s) for each parcel will be identified.[10] The entire area of each parcel, including any area outside of the Floodplain, will be considered when defining EAs. The approach that will be used to identify the appropriate EA(s) on individual parcels depends upon the size of the parcel, its physical characteristics, and the location of current and potential future use areas relative to the Floodplain boundary. In general, as discussed in Appendix A, the entire parcel will be selected as the EA. However, if there are physical characteristics or use patterns at a parcel (particularly a large parcel) that would indicate that a portion or portions would involve distinct or more frequent uses from other portions, the parcel may be subdivided into smaller EAs. However, risk management decisions will be made on individual properties. Characteristics considered in determining whether a tax parcel should be divided into more than one EA are described in Appendix A. If a parcel is subdivided, all of the subdivided areas will be evaluated.

In addition, there may be some areas in which it may be most appropriate to combine multiple properties into a single EA, rather than evaluating them separately. Such combined parcels might include, for example, neighborhoods or contiguous parcels that have similar physical characteristics, flooding frequency, and usage patterns, or circumstances in which a single receptor is anticipated to engage in a single activity (e.g., hiking or farming) using multiple, adjacent parcels. However, decisions will be made on individual properties.

The EPCs for each of the EAs to be evaluated in Phase 1 will be presented in the PAR as those will be based on data provided in the approved Revised FCR. A statistical approach will be used to calculate the EPC for each EA. More specifically, the FFU-based 95th UCLs for all FFUs present on an EA will be spatially weighted and averaged to generate an FFU

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[10] As described in Section 3.5, EAs that show the potential for unacceptable risks under Phase 1 of the BHHRA will be reviewed and may be revised prior to conducting Phase 2 of the BHHRA.

95th UCL EPC for that EA. Also, a 95th percentile upper prediction limit of the mean (FFU 95th UPL) will be calculated in each EA. To compute the FFU 95th UPL for each EA, simulated PCB concentration distributions in a subset of the local regions will be generated, and the upper 95th percentile of the EA means generated from those distributions will be treated as a FFU 95th UPL. Those values will be used to provide a basis to calculate equivalent FFU 95th UPLs in local regions without simulated PCB concentration distributions. The FFU 95th UCL and FFU 95th UPL will be evaluated to determine their effectiveness in predicting the EPC and the ability to identify false negatives (i.e., calculated EPCs that are less conservative than the true mean at an EA) using synthetic data. The decision to use either the FFU 95th UCL or FFU 95th UPL statistic will be based on discussions with USEPA on which method is more conservative in calculating the EPC. If either statistic is not capable of conservatively predicting the parcel mean with a 95% confidence, the statistic will not be used. If both statistics do not conservatively predict the parcel mean, the statistical method(s) will be modified following discussions with USEPA. GE may propose modifications to the methods used for development and/or evaluation of the Phase 1 EPCs called for in this paragraph for USEPA consideration.

In deriving these EPCs, the length-weighted average concentration for the 0- to 12-inch soil depth increment in each sampling location will be used.[11] Additional data may be collected, based on data needs and exposure considerations, with a subset of those samples collected from the 0- to 6-inch and 6- to 12-inch depth intervals consistent with previous sampling. Samples will also be collected from deeper intervals at a percentage of the locations as needed. EPCs will be based on the FFUs represented, including areas outside the Floodplain that are included in the EA.

It will not be possible to present the Phase 2 EPCs in the PAR because the additional data that will be collected following the completion of Phase 1 (and submission of the PAR) will be used to develop the Phase 2 EA-specific EPCs. The PAR will, however, outline the

[11] Some historical sampling of Floodplain soil only provided data for the 0- to 6-inch depth increment. In these cases, it will be assumed that the concentration measured in the 0- to 6-inch depth increment is representative of the 0- to 12-inch depth increment in that location for Phase 1. The need to collect additional samples at these locations as part of the RI/FS will be evaluated. In addition, as noted in Section 2.3, in areas where a soil cover has been placed as a STRA, the data from the pre-cover 0- to 12-inch depth increment will be used.

specific approach that will be used to develop the EPCs for Phase 2 of the BHHRA after the additional data are collected. The final EPCs developed for each EA evaluated in Phase 2 will be provided in the Final BHHRA Report, as discussed below.

The specific exposure assumptions to be used in evaluating each receptor and age group will be clearly outlined and justified in tables developed using RAGS Part D formatting. Exposure equations to be used will also be provided. The reasonable maximum exposure (RME) assumptions and equations that will be used to evaluate these scenarios are presented in Appendices B and C of this Work Plan for Phases 1 and 2, respectively. Appendix C does not include the parameters and assumptions that will be incorporated into the central tendency exposure (CTE) analysis in Phase 2, but those parameters and assumptions will be presented and discussed in the PAR.

For agricultural properties in the Floodplain, the factors that are associated with consumption of agricultural food products (plants, etc.) and land uses will be characterized. This characterization will include dairy farms with homes, crops that are consumed or are used to feed animals, sod farming, home-grown produce, and livestock. Based on this characterization, the need for potential sampling and/or modeling will be determined by USEPA.

The PAR will also present the carcinogenic and non-carcinogenic toxicity values to be used in estimating risks and hazards. PCB toxicity values that will be used in the BHHRA include a cancer slope factor (CSF; expressed in units of $(\text{mg/kg-day})^{-1}$) and a non-cancer reference dose (RfD; expressed in units of mg/kg-day). The CSF provides an upper-bound estimate of risk per mg/kg-day of chemical intake that, when combined with the estimated exposure, results in an estimate of the incremental excess lifetime cancer risk. The RfD is a dose level that is expected to result in no adverse effect for all non-cancer toxic endpoints.

USEPA (2003a) has developed a tiered hierarchy for the selection of toxicity values including, in order of preference: (1) values presented in USEPA's Integrated Risk Information System (IRIS) database; (2) provisional values developed by USEPA's National Center for Environmental Assessment (NCEA); and (3) values taken from additional USEPA and non-USEPA sources, with priority given to those sources of information that are peer-reviewed, current, publicly available, and derived in a transparent manner. In its IRIS database (USEPA 2014b), USEPA has published a Tier 1 upper-bound CSF of 2 $(mg/kg\text{-}day)^{-1}$ and a central estimate CSF of 1 $(mg/kg\text{-}day)^{-1}$ for highly chlorinated PCB mixtures. In addition, USEPA has published a Tier 1 chronic RfD of $2x10^{-5}$ mg/kg-day for PCB Aroclor 1254. In the HHRA of the UHR Floodplain, GE will use the CSFs of 2 and 1 $(mg/kg\text{-}day)^{-1}$ to evaluate the potential carcinogenic risks of PCBs in the RME and CTE analyses, respectively, and it will use the IRIS chronic RfD of $2x10^{-5}$ mg/kg-day to evaluate potential non-cancer hazards.[12] If the available toxicological information for PCBs indicates that the use of alternative toxicity values is scientifically justified, those toxicity values and the rationale for their selection will be presented in the PAR for USEPA's consideration in accordance with USEPA (1993, 2003a) guidance.

In addition, the PAR will describe the supplemental evaluation that will be conducted at the end of Phase 1 to assess whether the EAs for which the Phase 1 analysis showed no unacceptable risk should nevertheless be retained for evaluation in Phase 2 due to significant uncertainties about their exclusion in Phase 1. This supplemental evaluation will consider such factors as physical characteristics of an EA (if any) indicating that PCB concentrations could differ from the patterns represented by the FFU approach, the outcome of the Phase 1 analysis for neighboring EAs, the presence of elevated discrete PCB concentrations that could warrant further examination of the EA, and the potential existence of subareas of the EAs that may have higher PCB concentrations and a more intensive or different use from the remainder of the EA. This supplemental evaluation is discussed in Section 3.5 below. As described there, it will utilize a combination of qualitative and/or quantitative methods in a weight-of-evidence approach to determine if any of these EAs warrants retention for further evaluation in Phase 2. Additional details regarding this supplemental evaluation, including a description of how the multiple lines of evidence will be considered, will be provided in the PAR.

Finally, the PAR will present an approach for communication of risk results to property owners and the public. It will discuss the approach that will be used to present risk and

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[12] GE's use of these toxicity values, which are based on bioassays of laboratory animals, should not be considered to indicate GE's acceptance of those values as reflecting the potential cancer or non-cancer effects of PCBs on humans.

hazard estimates for individual EAs and the steps to be taken to protect the confidentiality of property owners.

Given the numerous possible uses of the UHR Floodplain and the likely variations in exposure potential in certain areas, it is possible that a deterministic approach, which incorporates point estimates for each exposure parameter, may not provide adequately refined estimates of the variability of risks and hazards posed by potential exposures to Floodplain soils. As a result, if the deterministic analysis indicates that there is potential for unacceptable risks, a probabilistic risk assessment (PRA) may be conducted to further refine risk estimates and to provide a more complete perspective on the likelihood of risks associated with the potential range of exposures in these areas.

To prepare for the potential conduct of a probabilistic analysis, a work plan for conducting the PRA will be included as an attachment to the PAR. This work plan will present and discuss: (1) the decision process regarding how a determination will be made to conduct a PRA; (2) the input distributions to be used for each assumption and parameter, including the sources of that information, the statistical distribution of the data to be used, and any correlations among variables; (3) the framework for the model to be used, including the software employed, the number of runs to be completed, and the random number generator used; and (4) the percentile values to be compared with risk and hazard benchmarks.

3.5 Phase 1 of Baseline Human Health Risk Assessment

Following USEPA approval of the PAR, Phase 1 of the BHHRA will be conducted. Phase 1 is intended to be a conservative, refined screening-level risk assessment that will further focus the BHHRA on those areas of the Floodplain that have the potential for unacceptable levels of risk and where additional EA-specific sampling for Phase 2 will be considered. The results of Phase 1 will be submitted to USEPA for approval before commencing with field collection efforts to support Phase 2 of the BHHRA.

3.5.1 Phase 1 Evaluation

Completion of Phase 1 of the BHHRA will include the following steps:

- Each EA for the Phase 1 BHHRA will be assigned to one of four general use categories based on the identified current or reasonably anticipated future use of the EA that is expected to result in the highest potential for exposure to soil. The categories to which EAs may be assigned will include residential, agricultural, commercial/industrial, or recreational usage. When current and reasonably anticipated future uses of the EA differ, the use that is based on the most conservative exposure assumptions will be selected. Those parcels on which more than one EA has been identified may have more than one usage category assigned if the uses of those EAs differ. School properties that contain portions within the Floodplain will be assigned to the residential category for Phase 1 if the Floodplain portion consists of maintained areas of the school yard or associated playing fields. If the Floodplain portion consists of an area that is unlikely to be used regularly by students, it will be evaluated as a recreational EA for Phase 1. If the Floodplain portions of the school property are mowed or otherwise maintained, these parcels will also be evaluated using the commercial category to represent potential risks to outdoor maintenance workers.
- All EAs will also be evaluated using a construction worker scenario. It is possible that re-construction or replacement of existing buildings may occur in the future, road construction may occur, and/or utility lines may need to be repaired or replaced. Because the location of future construction/utility activities cannot be determined with certainty, all EAs will also undergo Phase 1 screening using this scenario with an assumed exposure depth of 10 feet.
- Two estimates of potential risks and hazards will be calculated for each EA according to its designated usage, using the Phase 1 EPCs described above. USEPA previously requested that the default exposure parameters presented in the 1991 OSWER guidance entitled *Standard Default Exposure Factors* (USEPA 1991a) be used to calculate potential risks for the Phase 1 screening analysis. However, that guidance has been superseded by more recent guidance entitled *Update of Standard Default Exposure Factors*, issued in February 2014 (USEPA 2014c), which sets forth updated but still default exposure parameter values for use in human health risk assessments. In addition, USEPA has provided additional information about many of these

parameters in its revised *Exposure Factors Handbook* (USEPA 2011). Based on review of this information, two Phase 1 estimates will be developed as follows:

- To address USEPA's request, one set of estimates, which will be identified as the Default Refined Screening Analysis, will use USEPA's updated default exposure factors listed in its *Update of Standard Default Exposure Factors* (USEPA 2014c), where available, and will assume year-round exposure without taking into account the regional climatic conditions that affect potential exposures to Floodplain soils. Factors that are not provided in the February 2014 *Update of Standard Default Exposure Factors* will default to the specific factors from the 1991 Guidance when available. For the construction worker scenario (for which those guidance documents do not provide all parameters), the additional default exposure factors provided in the 2002 *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* will be used.
- Another set of Phase 1 risk calculations, which will be identified as the Adjusted Refined Screening Analysis, will use several of the updated default exposure factors listed by USEPA (2014c), but will also use certain modified exposure factors to take account of the climatic conditions in upstate New York that affect potential soil exposures during the colder months of the year, as well as certain other modified factors based on the more refined conceptualization of receptors presented in USEPA's 2011 *Exposure Factors Handbook*.

The specific parameters to be used in these two Phase 1 risk estimates are provided in Appendix B. USEPA has not currently adopted the use of the non-default parameters presented in Appendix B. GE can provide the rationale for the use of those parameters for USEPA consideration. Both sets of risk estimates will utilize the upper-end EPCs described in Section 3.4.

- Agricultural EAs will be treated differently. A variety of agricultural practices may occur in the Floodplain, ranging from large tracts of open land where a variety of commercial crops may be grown, to individual parcels that include a residence, homegrown produce, and/or raising of livestock for personal use. These EAs will be considered individually and will then be grouped into one of two categories:

- The first category will be those agricultural EAs on which there is no home present and the crops being grown are not intended for human consumption (e.g., forage, pasture, feed corn). Because the primary exposure in these EAs will be direct contact with soil during the workday, all EAs that fall into this category will be evaluated in Phase 1 using parameters defined for an agricultural worker scenario. The parameters for this category for both the Default Refined Screen and the Adjusted Refined Screen are outlined in Appendix B.
- The second category will be those agricultural EAs on which there is a home and/or crops and/or livestock are being raised for personal consumption. Because exposure at these EAs may include both direct contact and ingestion pathways, all of these EAs will be automatically carried forward into Phase 2 for an EA-specific evaluation.

- The estimated cancer risks and non-cancer hazards associated with each EA will be quantified. Cancer risk estimates will be calculated by multiplying estimated dose rates by a CSF. Hazard quotients (HQs) for non-carcinogenic impacts will be calculated by dividing estimated dose rates by the RfD. These values will be summed across all relevant pathways for each receptor group to determine combined cancer risks and non-cancer HIs for each exposure scenario and EA.
- The potential risks and hazards estimated for each EA will be compared with conservative benchmarks established by USEPA: a cancer risk level of 10^{-6} (i.e., the more conservative end of USEPA's risk range) and a non-cancer HI of 1. These comparisons will be made both for the results of the Default Refined Screening Analysis and for the results of the Adjusted Refined Screening Analysis. The results of both the Default Refined Screening Analysis and the Adjusted Refined Screening Analysis will be presented in the Phase 1 BHHRA report for USEPA's consideration. GE will make a recommendation regarding properties to be carried forward to Phase 2 based on these analyses.

3.5.2 Verification of the Phase 1 Screening Decisions

A subset of the EAs screened out using the EPCs calculated in the PAR will be sampled to validate the screening process, provided that, if only a small number of EAs are screened out, USEPA may agree that validation is not needed for those EAs. The sample locations will be stratified across the FFUs present on the EA and randomly chosen within each FFU. The number of sample locations selected from each FFU will be proportional to its relative area within the EA. The data collected in this sampling step will be used to validate the screening decisions made using FFU-based EPCs and, as necessary, to make adjustments to the approach and the statistics used to set FFU-based EPCs.

3.5.3 Supplemental Evaluation

At the conclusion of the above Phase 1 analyses, the EAs that would be screened out through those analyses will be subject to a supplemental evaluation to assess whether any of those EAs or subareas of those EAs should nevertheless be retained for evaluation in Phase 2 of the BHHRA. This supplemental evaluation will be performed to determine whether particular EAs or subareas should not be screened out at this stage due to the presence of variability in PCB concentrations that may not have been captured in the FFU-based EPC derivation. This evaluation will consider uncertainties in EAs on which physical characteristics indicate that PCB concentrations could differ from the patterns represented by the FFU approach, the outcome of the Phase 1 analysis for neighboring EAs, the presence of elevated discrete PCB concentrations that could warrant further examination of the EA, and the potential existence of subareas of the EAs that may have higher PCB concentrations and a more intensive or different use from the remainder of the EA. A combination of methods, qualitative or quantitative, will be used to evaluate these EAs in a weight-of-evidence approach. These methods will include some or all of the following for each of these EAs:

- The physical characteristics of the EA will be reviewed to determine whether there are any physical features within the EA that would indicate (based on data for other EAs with such features or other reasons) that the FFU approach used in the Phase 1 analysis may have underestimated the EPC.
- The magnitude of the difference between the potential risks and hazards estimated for the EA in the Phase 1 analysis and the conservative benchmarks used for comparison (i.e., a cancer risk level of 10^{-6} and a non-cancer HI of 1) will be considered. For example, an EA for which the estimated risks and hazards are substantially below the benchmarks would be less likely to need further evaluation than would an EA for which the risks and hazards are closer to the benchmarks.

- The EA will be reviewed to determine whether it contains a subarea or areas that may be subject to more intensive or different types of use from the rest of the EA and that were not previously identified as a separate EA in the Phase 1 analysis. If such a subarea is identified and there is reason to believe (e.g., based on the position of the subarea in the Floodplain and/or relative to the river) that the EPC in that subarea may differ from the EPC used to evaluate the EA, that subarea will undergo a separate evaluation. This evaluation will include defining the areal extent of the subarea of interest and calculating a spatially weighted EPC (using the same approach used for the initial Phase 1 analysis) based on the PCB concentrations in the FFUs in that particular area. That EPC will then be combined with appropriate exposure parameters for that subarea to determine whether the estimated risks and hazards exceed the benchmarks established for Phase 1. This evaluation will be consistent with USEPA's RAGS Part A guidance, which states: "In some cases, contamination may be unevenly distributed across a site, resulting in hot spots (areas of high concentration relative to other areas of the site). If a hot spot is located near an area which, because of site or population characteristics, is visited or used more frequently, exposure to the hot spot should be assessed separately" (USEPA 1989a, p. 6-28).
- Data and risk results for neighboring EAs will be evaluated to determine whether they indicate that the EA that showed no unacceptable risk or hazard at the end of Phase 1 may need to be reconsidered. For example, if the Phase 1 risks or hazards for the EA of interest are below the Phase 1 benchmarks but the risks or hazards calculated for adjacent EAs exceed those benchmarks, then consideration will be given to whether there are physical and/or usage factors that justify the differing outcomes and thereby support the elimination of that EA from further evaluation. If those factors are not apparent, then it may be appropriate to carry that EA forward into Phase 2 despite the Phase 1 results.

A description of how these multiple lines of evidence will be considered in a weight-of-evidence approach will be presented in the PAR. For each of the EAs that showed no unacceptable risk or hazard in the Phase 1 analysis, this weight-of-evidence approach will be applied to determine whether there is adequate justification for excluding the EA from further consideration based on the results of the Phase 1 analysis. Any EA for which the uncertainty is considered too great to support its exclusion, or for which the above analyses indicate that further evaluation is warranted, will be carried forward into Phase 2 of the BHHRA.

Once the EAs to be carried forward into Phase 2 have been identified, a sampling plan will be developed to collect enough supplemental data to allow EA-specific EPCs to be determined. This plan is described in Section 3.6.

A report on Phase 1 of the BHHRA will be submitted to USEPA for approval. This report will identify the current and reasonably anticipated future usage of each EA evaluated in the Phase 1 analysis, the usage(s) selected for the refined screening, the exposure parameters used for both the Default and Adjusted Refined Screening Analyses, the results of the Phase 1 screening level risk calculations, and the results of the supplemental evaluation described above. In addition, the report will indicate which Phase 1 EAs will be evaluated in Phase 2 of the BHHRA, revise EAs if appropriate for the Phase 2 evaluation, and identify the EAs for which additional data will need to be collected to derive EA-specific EPCs for Phase 2 of the BHHRA.

3.6 Data Collection Plan for Phase 2

To support the collection of the supplemental data needed to develop EA-specific EPCs for Phase 2 of the BHHRA (as identified in the Phase 1 BHHRA Report), a data collection plan will be submitted following USEPA's approval of the Phase 1 BHHRA Report, including the identification of EAs requiring further characterization for Phase 2 of the BHHRA. This data collection plan for Phase 2 of the BHHRA will be composed of a Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP). The FSP will describe the type, number, and location of proposed samples. The planned sampling will be designed to ensure that there are adequate numbers of samples, considering the size and configuration of the FFUs in each EA, to allow reliable and representative estimates of EA-specific EPCs for Phase 2 of the BHHRA. This sampling may involve the collection of EA-specific data at the EAs in question and/or other proposed method(s) to obtain sufficient data to determine representative EA-specific EPCs for Phase 2. As sampling is planned, consideration should be given to data needs for other purposes, including data to develop remedial alternatives, PCB delineation, technology evaluations, and evaluations of RAOs/PRGs. Data collected are anticipated to have multiple uses where possible.

It is possible that more than one round of sampling may be required to satisfy the data requirements for Phase 2 of the BHHRA. If it is determined that additional sampling is required following review of the data from a given round of collected samples, an addendum to the data collection plan will be submitted to describe that proposed additional sampling. Upon completion of all sampling, a Data Summary Report (DSR) will be submitted to USEPA on this sampling effort, and the data will subsequently be incorporated into the Final FCR (see Section 2.5.6).

3.7 Phase 2 of Baseline Human Health Risk Assessment and Final Report

After the Phase 1 BHHRA Report has been completed and approved, and the supplemental soil data collection for the remaining EAs has been completed, Phase 2 of the BHHRA will be conducted. The goal of Phase 2 of the BHHRA is to refine the risk estimates derived in Phase 1 by using data collected to derive final EA-specific EPCs and refined exposure scenarios, pathways, and assumptions to reflect EA-specific conditions. Phase 2 of the BHHRA will be documented in the Final BHHRA Report.

In order to provide a more comprehensive characterization of potential risks in Phase 2 of the BHHRA, risks and hazards for both current and reasonably anticipated future uses of each EA will be estimated for both RME and CTE scenarios. RME estimates are intended to provide an upper-bound estimate of potential risk and will be based on a combination of upper-bound and central tendency assumptions and parameters, as recommended by USEPA (1992a). CTE estimates are meant to be representative of typical exposures that may occur and will be based on typical or average exposure parameters and assumptions.

Two separate analyses will be conducted for Phase 2. The first will evaluate a wide range of exposure scenarios, combining EPCs based on the EA-specific data with exposure parameters that reflect site-specific usage patterns and climatic conditions (Phase 2 Site-Specific Analysis). The second will combine the same EPCs with USEPA's default assumptions where available (Phase 2 Default Analysis). Where no default exposure assumptions are available, alternatives will be proposed to USEPA for review and approval. For the Phase 2 Default Analysis, the site-specific exposure scenarios evaluated in the Phase 2 Site-Specific Analysis, which are presented in Section 3.7.1, will be assigned to one of the default scenarios as indicated.

The final EPCs for the RME analysis will be the 95th UCLs on the spatially weighted mean concentrations of the data specified for determining EA-specific EPCs, as presented in the Final FCR, with two exceptions: (1) If review of the characteristics and existing PCB concentrations in a given EA indicates that collection of additional data needed to calculate a 95^{th} UCL is unnecessary or unwarranted, a 95^{th} UCL will not be calculated and the maximum concentration will be used as the EPC; or (2) if the 95^{th} UCL exceeds the maximum concentration, the maximum concentration will be used as the EPC. The final CTE EPCs will be calculated as the spatially weighted mean concentrations of the data for the EA as presented in the Final FCR. EPCs will be based on all data for defining PCB concentrations across an EA, including data for areas outside the Floodplain that are included in the EA. These final EPCs will then be combined with the exposure parameters for the scenario to be evaluated for each EA to derive refined and final estimates of risks and hazards in each EA.

3.7.1 Exposure Scenarios and Parameters

Both default and site-specific exposure scenarios will be evaluated in Phase 2 of the BHHRA, including multiple scenarios under each of the general usage categories evaluated in Phase 1. The exposure scenarios that will be evaluated in Phase 2 and descriptions of the associated EAs are described in detail in Appendix C. Those exposure scenarios will consider both current use and the reasonably anticipated future use. Except as otherwise specified, all scenarios will assume exposure to a depth of 1 foot below ground surface. An example of such an exception includes a removal action cover area, where the initial depth will be the original ground surface (i.e., assume conditions prior to cover). The exposure scenarios to be evaluated in the Phase 2 Site-Specific Analysis are summarized below, along with the default categories to which each of those scenarios will be assigned for the Phase 2 Default Analysis.

- Residential Use: For residential properties in the UHR Floodplain, three potential exposure scenarios have been developed for Phase 2, depending on the location of the Floodplain relative to the house and maintained portions of the yard, as well as the physical characteristics of the Floodplain within the property. Residential 1 will be applied to properties that include a house located within or close to the Floodplain, so that there is a potential for residents to contact Floodplain soils while outdoors and also to track outdoor Floodplain soils into the house. On a case-by-case basis, Residential 2 will be applied to properties where a portion of the EA is in the Floodplain, but the home is located a sufficient distance away from the outer Floodplain boundary (or there is some physical barrier) such that residents who may contact outdoor Floodplain soils are unlikely to track such soils into the house. A third scenario will be applied to residential properties with homes and maintained yards outside of the Floodplain and on which there are physical constraints, such as steep topography or wet areas, which make it unlikely that the Floodplain area would be regularly used. Potential exposures at this type of property will be evaluated using a recreational scenario (most appropriate of Recreational 1, 2, or 3, as discussed below).

For the Phase 2 Default Analysis, EAs in both the Residential 1 and Residential 2 scenarios will be assigned to the default residential scenario. Residential properties at which it is unlikely that the Floodplain area will be regularly used will be assigned to the default recreational scenario.

- Agricultural Use: There are a number of agricultural properties that include at least a portion in the UHR Floodplain. Some contain residential homes while others are used solely for cropland or the raising of livestock. Because specific farm practices on agricultural properties vary, resulting in different exposure potential, the exposure scenario for the agricultural properties to be evaluated in the Phase 2 Site-Specific Analysis will be developed on an EA-specific basis, taking into consideration the specific practices occurring there, including the presence of an agricultural worker. For each specific agricultural scenario for a given EA, if default exposure assumptions are available, these will also be applied as part of the Phase 2 Default Analysis.
- Seasonal Residential Use: There are a number of properties in the UHR Floodplain at which there are camps or seasonal residences that are used during the warmer months of the year. Some of these are publicly owned parcels that are leased/permitted for seasonal use and others are privately owned. These properties will be evaluated in the Phase 2 Site-Specific Analysis using a seasonal residential use scenario, which will

be the same as the appropriate residential use scenario except with a lower exposure frequency.[13] For the Phase 2 Default Analysis, these EAs will be assigned to the default recreational scenario for current and reasonably anticipated future use if construction of a permanent home is not expected, and will be assigned to the default residential scenario if construction of a permanent home is reasonably anticipated for the future.

- School Use: There are five designated school properties on which a portion of the property falls within the UHR Floodplain. The exposure scenarios for these properties will be developed on an EA-specific basis, considering the characteristics and size of the Floodplain portion of the property and its proximity to the schoolyard. This will also include a school outdoor worker scenario. These parcels will be evaluated using site-specific parameters for the Phase 2 Site-Specific Analysis. For the Phase 2 Default Analysis, school properties will be assigned to the default residential scenario.
- Recreational Use: Three recreational use scenarios have been developed for application in the Phase 2 Site-Specific Analysis: (1) Recreational 1 (high use), which will be applied to areas that have been developed for or have obvious signs of regular public use (e.g., parks, boat launches) or where regular public use is likely (e.g., beach areas, docks adjacent to roads); (2) Recreational 2 (medium use), which will be applied to areas that could be used for recreational purposes but do not have signs of regular usage; and (3) Recreational 3 (low use), which will be applied to undeveloped areas that are remote and difficult to access, have steep banks, or contain wet areas.[14] All recreational areas will be evaluated under the default recreational scenario for the Phase 2 Default Analysis.
- Commercial Outdoor Work: For the Phase 2 Site-Specific Analysis, two scenarios have been developed to apply to commercial properties at which outdoor worker exposures are expected to occur in the UHR Floodplain: (1) Outdoor Worker 1,

[13] Future use of such parcels will be evaluated under a regular residential scenario if such future residential use is reasonably anticipated.

[14] The Recreational 3 scenario is intended to be inclusive of individuals who may be trespassing on private land, as the age groups exposed and the types of exposure that would likely occur are most similar to those experienced by a low frequency recreational user.

which will apply to properties where individuals work outdoors daily in the same location; and (2) Outdoor Worker 2, which will apply to properties where workers would be present only occasionally to perform groundskeeping or other periodic maintenance activities.[15] EAs to which either of these scenarios applies will be included in the default commercial worker scenario for the Phase 2 Default Analysis.

- Utility Work: A utility worker scenario will be applied to identified utility corridors that include either underground utilities (e.g., sewer lines) or above-ground utilities (e.g., power lines) for the Phase 2 Site-Specific Analysis. A single exposure scenario will be used to evaluate these utility workers, but the soil depths to be evaluated will depend on whether the utility work would require the workers to be exposed to both surface and subsurface soil (i.e., upper four feet for areas with underground utilities) or surface soil only (i.e., the top foot for areas with only above-ground utilities). For the Phase 2 Default Analysis, EAs on which utility work is expected to occur will be assigned to the default construction worker scenario.

In addition to these scenarios, three additional Phase 2 exposure scenarios have been developed that could apply almost anywhere on the UHR Floodplain and do not depend on the assigned use categories described above. These are: (1) a construction worker scenario (ten-foot exposure depth); (2) a residential garden scenario, which will evaluate potential exposures from consumption of home-grown produce; and (3) a utility work scenario for private properties outside of identified utility corridors (four-foot exposure depth). For the Phase 2 Site-Specific Analysis, these scenarios will be applied as future use scenarios at any EAs where such activities are reasonably anticipated. For the Phase 2 Default Analysis, all EAs will be evaluated using default parameters for construction workers, to represent potential risks for both construction workers and utility workers, and the gardening scenario will be evaluated using the default residential garden exposure parameters.

For application of all of these exposure scenarios, the EA will be defined as the area of the property(ies) involved that is likely to be used for the stated purpose of the scenario. In each case, the EA may include either the entire property or a subarea of it (including any subarea

[15] Commercial properties where the Floodplain is remote from areas used by workers will be evaluated using the appropriate recreational scenario.

with a significantly higher PCB concentration and more intensive use than the rest of the property), and it may include not only the Floodplain portion of the property but also any portion outside the Floodplain that is part of the same use area. There may also be more than one EA on a single property, or the designated EA may include more than one property, depending on use.

The RME exposure parameters that will be used to evaluate the scenarios identified above are presented in Appendix C to this Work Plan (except for the agricultural and school scenarios, for which the exposure parameters will be EA-specific and will be proposed in the PAR). While CTE exposure parameters are not provided in Appendix C, they will be provided in the PAR for approval by USEPA.

3.7.2 Evaluation of Near-Shore Sediments

As discussed in Section 2.4, GE will identify near-shore sediment areas with a reasonable potential for human use. A separate risk assessment will be undertaken during Phase 2 to provide better understanding of the potential risks and hazards associated with these areas.

The identified near-shore sediment areas are only exposed when river flow is low (typically discrete periods during the summer and fall), and the exposure during these periods is typically intermittent and short-term because of variations in daily flow. Thus, a low frequency recreational scenario is the most appropriate scenario to be used to evaluate exposures in these areas. This scenario will evaluate potential exposures to the following three age groups: young children, adolescents, and adults. The exposure durations for each age group in the RME analysis will be 6, 12 and 12 years, respectively, for a total duration of 30 years.

Sediment samples will be collected from the 0- to 1-foot depth interval in each area (with a subset of samples collected from the 0- to 6-inch and 6- to 12-inch depth intervals based on data needs and exposure considerations) and used to derive area-specific EPCs. These EPCs will be based on the 95th UCL of the spatially-weighted average PCB concentration for each area.

RME exposure parameters have been selected from the parameters used by USEPA in completing its analysis of direct contact with sediments by recreational users in its risk assessment for the Upper Hudson River (River HHRA; USEPA 2000a). These include an exposure frequency of 13 days/year for adults and young children, which was based on the assumption that contact might occur 1 day/week during the summer months, and a higher exposure frequency of 39 days/year for adolescents.[16] Age-specific body weights, exposed skin surface areas (including hands, forearms, face, lower legs and feet), and soil-skin adherence factors provided by USEPA will also be used. The specific exposure factors used for this analysis are presented in Table C-23 of Appendix C.

Potential cancer risks and non-cancer hazards will be calculated for each identified section of near-shore sediment using the same CSF and RfD that will be used to evaluate potential risks and hazards for the other risk calculations in the BHHRA, as described in Section 3.4 of this work plan. Those calculated risks will then be compared with USEPA's cancer risk range of 10^{-4} to 10^{-6} and a non-cancer HI of 1. The results of this analysis will be used to identify any near-shore areas that may need to be considered in the FS.

3.7.3 Risk Characterization

As described by USEPA (1995a), the results of a risk assessment are usually communicated to the risk manager through "risk descriptors" that convey information and answer questions about risk. The presentation of multiple risk and hazard estimates provides insight into the range of potential exposures and risks to individuals. Use of multiple descriptors instead of a single descriptor will enable the presentation of a picture of risk that corresponds to the range of different exposure conditions encountered.

Consistent with USEPA's *Risk Assessment Guidance for Superfund* (USEPA 1989a), RME and CTE exposures will be estimated for the scenarios described above under both current and reasonably anticipated future conditions. These estimates will provide multiple descriptors of potential exposure and risk.

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[16] An evaluation of 15-minute flow data from the Fort Edward gaging station (2003 to 2013) will be conducted to determine the frequency with which sediments are exposed during flows of 1Q3 to 5,000 cfs. This information may indicate that the exposure frequencies for this scenario need to be modified. If this is the case, revised exposure frequencies will be provided to USEPA for review.

For each EA, final estimates of potential cancer risks and non-cancer hazards will be quantified by multiplying estimated dose rates by the CSF to derive cancer risk estimates, and dividing estimated non-cancer dose rates by the RfD to derive HQs. These HQs will be summed across all relevant pathways for each receptor group to determine cumulative cancer risks and non-cancer HIs for each exposure scenario and EA. Resulting risks and hazards will be compared with USEPA's cancer risk range of 10^{-6} to 10^{-4} and a non-cancer HI of 1.

If the deterministic calculation for an EA indicates that risks are below levels of concern for the RME exposure, there will be no need to conduct a more refined probabilistic analysis for that EA. If, however, the estimated deterministic RME risks associated with Floodplain soils exceed USEPA's risk and/or hazard benchmarks for an EA, a PRA may be conducted to more fully characterize the range of risks that may occur on that EA and to identify where, in the range of risks calculated, the deterministic RME and CTE estimates fall. This analysis will use distributions of appropriate input parameters, and the resulting risk distributions will provide a more complete range of risks to be considered in risk management decisions than will deterministic estimates of RME and CTE risks. As discussed in Section 3.4, a work plan for conducting a PRA, if appropriate, will be included in the PAR.

As part of the BHHRA, an analysis of uncertainty will be conducted. The approaches used to estimate exposure and toxicity in risk assessments are intentionally conservative so that they are most likely to overestimate rather than underestimate potential risks. Thus, it is expected that potential risks and hazards will be overestimated, rather than underestimated. The primary objective of the uncertainty analysis will be to determine the extent to which the risk results may be overestimated or underestimated, and to identify the specific uncertainties associated with these estimates. A second objective of the uncertainty analysis will be to place the numerical risk estimates within the overall context of what is known and what is not known about the site usage, and within the context of decisions that the risk manager may need to make about possible remediation.

The uncertainty analysis will be designed such that various sources of uncertainty associated with data evaluation, hazard identification, dose-response assessment, and exposure assessment are described. It will be conducted by evaluating all sources of uncertainty listed above, as well as their impacts on the overall conclusions of the BHHRA. As part of this analysis, the following will be evaluated: (1) the reliability and relevance of the overall analysis with respect to the state of scientific understanding; (2) the policies and professional judgments used to bridge data gaps; and (3) the impacts of uncertainties on the risk characterization.

3.7.4 Final Baseline Human Health Risk Assessment Report

The results of Phase 2 of the BHHRA will be presented in the Final BHHRA Report. This report will include an overview and summary of the entire BHHRA process, including the SLA, Phase 1, and Phase 2. It will discuss the results of the data collection after the completion of Phase 1 and will provide a summary of all EAs evaluated in Phase 2, the exposure scenarios and EPCs assigned to them, and the estimated risks and hazards associated with each. Appendices to the Final BHHRA Report will include the SLA Report, the Phase 1 BHHRA Report, RAGS Part D tables,[17] and the shape files that summarize the various results for each EA.

Results for each EA evaluated will be included in a single table in the Final BHHRA Report, using the format shown in Table 3-2. All EAs in the Study Area will be included in that table along with the maximum concentration used for the SLA. For all of those EAs that exceeded the conservative default residential screening level so that they were carried forward into Phase 1, the general exposure scenario assigned to each, the Phase 1 EPC, and the Phase 1 risk results will be presented. All parcels that exceeded one or both of the risk benchmarks for Phase 1, so that they were carried forward into Phase 2, will be identified, along with the refined and default exposure scenarios assigned to them for Phase 2, the EA-specific EPC used to evaluate them, and the cancer risks and non-cancer hazards calculated under both the Phase 2 Site-Specific Analysis and the Phase 2 Default Analysis for the current-use scenario evaluated as well as future-use scenarios for reasonably anticipated future uses (including the construction, residential garden, and utility work scenarios where appropriate). All of this information will be provided in electronic format to USEPA so that it can be incorporated into its GIS system for review and future usage.

[17] RAGS D Tables 7, 9, and 10 will be prepared. Table 8 of the RAGS D Table series, which pertains to radiation risks, is not needed for this BHHRA and will not be presented.

In addition, GE will work with USEPA to develop individual handouts for homeowners that summarize the results of the risk assessment for all EAs owned by them. These will indicate whether the maximum concentration used in the SLA exceeded the conservative screening level, and will present the results of each phase of the BHHRA that was evaluated for that EA.

4 ECOLOGICAL RISK ASSESSMENT

This section of the RI/FS Work Plan describes the approach for conducting the Ecological Risk Assessment (ERA) for the UHR Floodplain under baseline conditions. This assessment will evaluate the exposure of and risk to terrestrial and aquatic species of biota in the UHR Floodplain from PCBs present in Floodplain soils, as well as in the sediments and surface water in standing water areas in the Floodplain. For the purpose of this assessment, Floodplain soil is defined as terrestrial or wetland surface soils (i.e., 0- to 1-foot depth) located within the UHR Floodplain. The sediments and surface water in standing water areas will consist of the surface sediments (i.e., 0- to 1-foot depth) and overlying water in such areas within the Floodplain. Additional data will be collected at a subset of sample locations, based on data needs and exposure considerations, consistent with previous sampling (i.e., from the 0- to 6-inch and 6- to 12-inch depth intervals). A subset of samples will also be collected to a greater depth if appropriate. The UHR Floodplain ERA is designed to identify ecological receptors and areas of the UHR Floodplain of potential concern that can subsequently be used to help guide appropriate risk management decisions for the UHR Floodplain.

The ERA will be conducted in phases with initial phases relying on conservative assumptions and subsequent phases employing more representative (though still conservative) assumptions and methods. Consistent with USEPA guidance, the ERA will include the following elements of an ecological risk assessment:

- Problem Formulation, which describes the ecological setting and habitat characterization, identifies the constituents of potential ecological concern (in this case, PCBs), provides an ecological conceptual site model (ecological CSM), and identifies potential exposure routes and related assessment endpoints (AEs) and measurement endpoints (MEs) for evaluation in the ERA;
- Exposure Assessment, which estimates receptor exposure based on the exposure pathways and AEs outlined in the problem formulation;
- Effects Assessment, which describes the effects of the constituent of potential concern (in this case, Total PCBs) on the receptors, sometimes expressed as toxicity reference

values (TRVs), and links those effects with the selected assessment and measurement endpoints; and

- Risk Characterization, which integrates the exposure and effects information to characterize potential ecological risks related to the AEs, and evaluates their significance and any uncertainties.

In developing the approach for the UHR Floodplain ERA, relevant USEPA guidance documents have been and will continue to be considered, including the following:

- *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988);
- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997c);
- *Guidelines for Ecological Risk Assessment* (USEPA 1998); and
- *Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles* (USEPA 1999).

This section of the RI/FS Work Plan discusses the basis and approach for the ERA and describes the major deliverables that will be submitted to USEPA for review and approval. Specifically:

- Section 4.1 presents the preliminary ecological CSM for the ERA;
- Section 4.2 provides an overview of the ERA process, the key principles for the ERA, and a description of a comprehensive list of AEs to be used as a starting point for the ERA; and
- Sections 4.3 through 4.8 describe the sequence of tasks and key deliverables in the ERA process, including the Screening Level Ecological Risk Assessment (SLERA), the Baseline Ecological Risk Assessment Work Plan (BERA Work Plan), the proposal for collection of additional data to support Phase 1 of the BERA, Phase 1 of the BERA, the proposal for collection of additional data to support Phase 2 of the BERA, and the performance of Phase 2 of the BERA along with preparation of the Final BERA Report.

4.1 Preliminary Ecological Conceptual Site Model

Land use in the Study Area is a mosaic consisting of industrial, commercial, agricultural, recreational, residential, and seasonal properties, and undeveloped habitats. Vegetation mapping conducted for the Floodplain (ARCADIS 2009) and adjacent areas identified the following vegetative cover types: agricultural, wetland, deciduous forest, evergreen forest, mixed forest, residential lawns, infrastructure associated with commercial/industrial/ transportation usage, and open water. These cover types comprise habitats which contain a variety of ecological receptors that could potentially be exposed to PCBs in the Floodplain. Such exposures could occur through direct contact with, or ingestion of, PCB-containing Floodplain soils or (where applicable) sediment and surface water in standing water areas, or through ingestion of prey items containing PCBs from abiotic media or lower-trophic-level biota.

Based on consideration of these potential exposure pathways, a preliminary ecological CSM has been developed to identify the potentially complete exposure pathways that will be considered in the ERA for each general class of receptors (i.e., plants, invertebrates, fish, amphibians, reptiles, birds, and mammals). That preliminary CSM is shown in Figure 4-1.[18] As indicated in Figure 4-1, most receptors can be exposed via multiple pathways. For some receptors, these multiple exposure pathways may be quantified individually and summed, as in food web models for birds and mammals. In other cases, multiple exposure pathways may be indirectly incorporated. For example, soil screening benchmarks for terrestrial invertebrates inherently incorporate both direct contact and ingestion pathways, as do tissue-based TRVs.

As also shown in Figure 4-1, some potentially complete exposure pathways for some receptors are considered insignificant, and others do not have adequate methods or data for evaluation. These pathways will not be evaluated quantitatively in the ERA. For example, while direct contact with Floodplain soil, as well as with the sediment and surface water in standing water areas (where applicable), is a potentially complete pathway for birds and mammals, the presence of fur and feathers on the epidermis of birds and mammals results in

[18] Note that because the overall ERA process is phased, several of the receptors and complete exposure pathways shown in Figure 4-1 may need to be evaluated only in the early phases of the ERA process (i.e., the SLERA) as described below.

the absorbed dermal dose being much lower than the absorbed oral dose (USEPA 2005b). Similarly, scales and carapaces limit dermal exposure for reptiles. Thus, the direct contact pathway will not be quantitatively evaluated in the ERA for birds, mammals, and reptiles.

Exposure of ecological receptors to PCBs in air is also a potentially complete pathway, but will not be further evaluated in the ERA. The PCBs in the Floodplain have low vapor pressure (ATSDR 2000) and do not tend to volatilize into ambient air. In addition, while inhalation of particulates derived from the resuspension of surface soil may also occur, available ecological exposure models indicate that inhalation of particulates generally contributes less than 0.1% of total exposure (USEPA 2005b). Additionally, generation of airborne dust particles in the UHR Floodplain is further reduced due to the vegetated nature of the Floodplain and the moist character of Floodplain soil.

4.2 Ecological Risk Assessment Process and Principles

This section provides an overview of the phased ERA process, sets forth the key principles for the ERA, and describes a comprehensive list of AEs and MEs on which GE and USEPA have agreed as a starting point for the ERA.

4.2.1 Overview of Phased Approach

The ecological risk evaluation will follow a phased approach. The initial phases will be based on available information and conservative assumptions about potential exposure and toxicity that are intentionally designed to overestimate potential risks. The goal of the initial phases is to distinguish between receptors and areas of the UHR Floodplain that are very unlikely to pose a potential risk and do not require further evaluation in subsequent phases of the ERA from receptors and areas that warrant further evaluation in subsequent phases. The later phases of the ERA will be more site-specific, relying on data or assumptions that are more representative of potential exposures and risks to particular receptors in the UHR Floodplain.

The key steps and deliverables associated with this phased process are briefly summarized below in the sequence that they are anticipated to occur.

- Screening-Level Ecological Risk Assessment: The SLERA will be an initial conservative evaluation of potential ecological risks associated with PCBs in the UHR

Floodplain to identify areas and receptors that warrant further evaluation and exclude areas and receptors not requiring further evaluation. An initial identification of data gaps associated with these areas and receptors will also be provided for consideration in subsequent phases. The evaluation will utilize conservative estimates of exposure within selected generic areas (e.g., upper-bound estimates of Floodplain soil concentrations within a river mile (RM), local region, etc.) and will compare them to conservative toxicity benchmarks or other conservative estimates of potential risk. Relevant qualitative information will also be considered when determining receptors and UHR Floodplain areas warranting further evaluation.

- Baseline Ecological Risk Assessment (BERA) Work Plan: The BERA Work Plan will identify the approach to be used to evaluate further the AEs, receptors, and local areas identified by the SLERA as requiring further evaluation, taking into account the initial data gaps identified in the SLERA as well as any others identified during development of this work plan.
- Phase 1 BERA data collection: A plan will be developed for the collection of data to fill the data gaps identified in the BERA Work Plan, and thus to support the completion of Phase 1 of the BERA. Following the initial collection of such data, this step may have to be repeated in order to obtain sufficient abiotic, biotic, and habitat data to complete Phase 1. The data collected will be presented in a Data Summary Report.
- Phase 1 of BERA: Phase 1 of the BERA will use data from the Revised FCR and the Phase 1 BERA data collection activities to refine and further evaluate potential exposures and risks to receptors identified in the SLERA Report as requiring further evaluation. The refinements may include, but will not necessarily be limited to, revised EPCs, development of more representative dietary model uptake assumptions, refined TRVs, and refinement of EAs to more closely match expected usage of the UHR Floodplain and its vicinity by each receptor. Receptors and areas of the UHR Floodplain identified by Phase 1 of the BERA as unlikely to have unacceptable risks will not be evaluated further. Receptors and areas of the UHR Floodplain identified in Phase 1 as still being of potential concern and warranting further evaluation will be retained for further evaluation in Phase 2 of the BERA, and any further data needs for that evaluation will be identified.

- Phase 2 BERA data collection: Data gaps associated with the remaining UHR Floodplain areas and receptors requiring further evaluation will be addressed. This data collection effort may include the design and implementation of population-level field studies to characterize risks.
- Phase 2 of BERA and Final BERA Report: Phase 2 of the BERA will use data from the Final FCR and the Phase 2 BERA data collection activities to evaluate potential risks to receptors and areas of the UHR Floodplain identified in the Phase 1 BERA Report as warranting further evaluation. At the conclusion of Phase 2, the Final BERA Report will summarize the results of the baseline ERA for all AEs, receptors, and areas of the UHR Floodplain. This report will use a weight-of-evidence approach to integrate all of the data from Phases 1 and 2 of the BERA to estimate the potential for adverse effects of PCBs on each AE, receptor, and area.

The above-listed steps and associated deliverables are described in more detail in Sections 4.3 through 4.8.

4.2.2 Key Principles

In accordance with USEPA guidance (USEPA 1999), the ERA will be based on the guiding principle that the risks will be assessed for local populations and communities of the ecological receptors (rather than at the level of individual organisms). Specifically, as discussed further in Sections 4.2.3, the AEs will consist of reproduction and survival (and, for some receptors, growth) sufficient to sustain the local population or community of the receptor. Given this objective, EAs will likewise be developed based on the protection of local populations or communities.

4.2.3 Assessment Endpoint Table

USEPA coordinated an Ecological Problem Formulation Workshop with stakeholders to identify AEs, candidate receptor species, candidate risk questions, and associated MEs for initial evaluation as part of the problem formulation for the ERA. That effort resulted in the development of a table listing the candidate AEs, receptors, risk questions, and MEs considered for inclusion in the ERA. That table is attached as Table 4-1 and will be the starting point for the ERA. This table will be used as follows in the ERA:

- Consistent with the guiding principle specified above, Table 4-1 recognizes that the AEs will be evaluated at the level of the local population or community of the ecological receptors. Thus, the specific endpoints listed for each receptor (i.e., reproduction, survival, and/or growth) will be evaluated as they relate to sustaining the local population or community of that receptor.
- The overall list of candidate AEs, receptors, and MEs considered in Table 4-1 was comprehensive. Table 4-1 includes a determination as to whether each candidate ME will be retained for the SLERA problem formulation, along with a rationale for that determination.[19] The list of retained AEs and MEs for that initial evaluation in the SLERA is comprehensive and ensures that all receptors potentially exposed to PCBs within the UHR Floodplain will be given consideration. However, not all of those AEs and MEs will be carried through the entire ERA. It is expected that, based on the initial quantitative or qualitative assessment in the SLERA, a number of those AEs and MEs will be screened out at that stage, thus reducing the number of them that will be retained for further quantitative or qualitative evaluation in Phase 1 of the BERA.
- All MEs listed in Table 4-1 as retained for the problem formulation will be addressed in some manner during the SLERA, but will not necessarily be evaluated quantitatively, nor will their evaluation in the ERA necessarily require the collection of additional field data to address the ME.
- For those MEs where additional data collection is undertaken, such data may be collected from representative areas and the results used to draw conclusions for the remainder of the Study Area.
- As noted in Table 4-1, risk questions and MEs that relate specifically to the evaluation of potential effects associated with PCB concentrations in eggs depend on the availability of adequate site-specific egg data (measured or modeled) for the receptor in question and on the availability of a suitable TRV to complete the evaluation.

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[19] For some MEs, in the "Retain for Problem Formulation" column, the table indicates "No, but…" This signifies that the ME is considered unnecessary for assessment of the pertinent AE, but that the measure specified will need to be obtained for other purposes – e.g., as input for dietary dose models for higher-trophic-level receptors.

- It is anticipated that Phase 1 of the BERA will be sufficient to complete the evaluation of some of the AEs and MEs retained following the SLERA, and that only a further reduced number will need to be carried forward into Phase 2 of the BERA.
- It is expected that the evaluations of the retained AEs and MEs will become increasingly detailed and site-specific through each stage of the ERA.
- At each stage of the ERA process, the toxicity data used will be applicable and suitable for evaluating the receptor species and AE being evaluated.

In summary, consistent with the points outlined above, Table 4-1 will be used as a starting point to guide the ERA process. The table lists the AEs and MEs that will be considered at the outset, but not all of them will be addressed quantitatively, and it is anticipated that the list of AEs and MEs carried forward through each phase of the ERA will get progressively shorter as additional data are collected and assumptions are refined.

4.3 Screening-Level Ecological Risk Assessment

The SLERA for the UHR Floodplain will itself be conducted in steps. It will start with a comparison of upper-bound estimates of exposure with conservative toxicity benchmarks. If this comparison is sufficient to show that specific receptors or areas of the UHR Floodplain would not experience unacceptable risks from PCB exposure in the Floodplain, there will be no need to evaluate them further. If the comparison is not sufficient to support that outcome for particular receptors and/or areas, those receptors and areas will be subject to more refined screening using more realistic but still conservative exposure and toxicity assumptions. Refinements may involve incorporation of alternate conservative EPCs and/or ranges for exposure parameters and toxicity benchmarks. In addition, qualitative information will be considered when available, including comparisons to the conclusions of USEPA's Ecological Risk Assessment for the UHR (River ERA; USEPA 2000b), where relevant. AEs, MEs, and areas of the UHR Floodplain shown to be unlikely to experience unacceptable risks based on the refined screening analysis will not be evaluated further in the BERA. The goal of the SLERA is to help ensure that the later, more resource-intensive, phases of the ERA focus on the receptors and UHR Floodplain areas of potential concern.

4.3.1 Problem Formulation and Ecological Conceptual Site Model

The SLERA will begin with the preliminary problem formulation, including a description of the UHR Floodplain and the ecological CSM discussed in Section 4.1. The SLERA will include a general description of the environmental setting, PCB distribution, general fate and transport, mechanisms of ecotoxicity, exposure pathways, and assessment and measurement endpoints. It will then identify for evaluation in the SLERA the AEs and MEs listed in Table 4-1 as retained for the problem formulation.

4.3.2 Exposure Assessment

As noted above, the SLERA will evaluate each of the AEs and MEs listed in Table 4-1 as retained for the problem formulation. For each of the receptors listed, conservative assumptions will be made to estimate exposure, focusing on conservative estimates of PCB concentrations within defined EAs and the manner in which the receptor is exposed (i.e., the exposure pathway). The SLERA approach for each of these exposure assessment components is described below.

For the SLERA, the EAs will be based on selected generic areas for each receptor, defined by pre-established boundaries, such as river mile, local region (as described in Section 2), or (for receptors with a large range) river reach. Within these areas, the EAs for aquatic receptors will be limited to standing water areas of sufficient size and duration of inundation to support local aquatic populations, while the EAs for terrestrial receptors will be based on Floodplain soil areas that exclude standing water areas. After careful consideration of the potential for ecological impacts, GE can propose to USEPA to remove a standing water area from consideration. To evaluate high-end exposures, the EAs will be confined to the 100-year Floodplain, assuming that the receptors spend all of their time in the Floodplain, and will not include suitable habitat in adjacent areas outside the Floodplain. Further, the SLERA will not take into account habitat quality or preferences. All receptors that could be present within or use a given type of habitat will be conservatively assumed to be exposed equally to that habitat type throughout each of the EAs that contain that habitat type.

For each EA, EPCs for abiotic media will be developed based on the intersection of the EA boundaries and the underlying PCB concentration data. Distinct EPCs will be developed for

Floodplain soil, sediment in standing water areas, and surface water. The EPCs to be used in the SLERA for each EA comprising Floodplain soil or standing water sediments will include both the maximum PCB concentration in any flood frequency unit (FFU) in the EA and a statistically based value representing an upper bound on the mean or central tendency, as proposed by GE and approved by USEPA, as set forth in the FCR. For surface water, as well as biotic tissue and prey items, the EPCs will consist of measured, modeled, or estimated PCB concentrations, using maximum and other conservative estimates of the EPC from the measured, modeled, or estimated data.

Estimates of exposure to plants, invertebrates, amphibians, reptiles, and fish will be based on exposure to abiotic media, using the soil, sediment, and/or surface water EPCs. In addition, for fish, aquatic amphibians, and aquatic reptiles, EPCs will be developed for tissue (e.g., whole body, eggs), as indicated in Table 4-1, using conservative measured or modeled PCB concentrations as described above. Estimates of exposure to birds and mammals will be based on dietary dose models using both the maximum and statistically calculated abiotic media EPCs, estimated EPCs in food/prey tissue items developed using literature-based methods for estimating bioaccumulation, and literature-based exposure parameters. In addition, for birds, measured or modeled concentrations in eggs will be used to develop egg EPCs, as indicated in Table 4-1, subject to the availability of an adequate quantity and quality of site-specific data for the receptor.[20] As noted above, in the event that exposure estimates using the maximum concentrations and other most conservative assumptions do not allow elimination of a given AE from further evaluation, more refined screening-level estimates will be made, such as those using the statistically calculated concentrations and dietary dose models with still conservative but more representative assumptions.

4.3.3 Effects Assessment

The SLERA will include a screening level evaluation of the potential toxicological effects associated with Total PCBs, based on the selected AEs and MEs shown in Table 4-1. The screening level effects assessment will be based on existing ecologically based screening benchmarks and derived screening level TRVs, as described below.

[20] If measured PCB concentration data on eggs are available, these data will be used in preference to modeled concentrations provided that there are sufficient site-specific egg data of adequate quality for the receptor.

Existing ecologically based screening benchmarks for PCBs in soil or sediment (as applicable) will serve as the basis for assessing potential effects on plants and invertebrates. Existing screening benchmarks for sediments and/or surface water will also be used in the effects assessment for aquatic organisms (i.e., fish, aquatic plants, aquatic amphibians) if appropriate screening benchmarks are available.[21] Benchmarks to be used for this screening evaluation will be identified from regulatory guidance (if applicable and appropriate) and/or the peer-reviewed literature. Selected benchmarks will be applicable to the UHR Floodplain AEs and will be based on data capable of characterizing causal concentration-response relationships for effects of PCBs on receptors representing the AE of interest.

Screening-level TRVs will be derived for avian and mammalian receptors as well as aquatic reptiles, following the process described in Appendix D, to the extent that suitable ecotoxicity information is available. Screening-level TRVs may also be derived for fish or amphibians as appropriate (e.g., if appropriate screening benchmarks are not available or are not sufficient to address relevant exposure pathways). Screening-level TRVs will represent exposure levels below which there is high confidence that an adverse effect will not occur. As described in Appendix D, TRVs will be identified from information available from the scientific literature, as well as site-specific effects studies, if available. Depending on the receptor species and the availability of exposure and effects data, TRVs may take a variety of forms. Screening-level TRVs may be developed based on PCB concentrations in abiotic media, diet, or tissue (including eggs), or they may be expressed as a dose (i.e., in milligrams PCB per kilogram body weight per day; mg/kg-day). As discussed in Appendix D, screening-level TRVs for use in the SLERA will be identified from all studies that meet the minimum requirements for consideration (e.g., appropriate test species, adequate data quality, etc.), but without evaluating further balancing considerations (e.g., taxonomic relationship to receptor species, applicability to site-specific PCB mixture composition, etc.). Further, screening-level TRVs will include, at a minimum, values representing no observed adverse effects levels (NOAELs) or low-level EDx values (up to ED20) to the extent that such values are available, but may also include values based on other measures of effects, such as lowest observed

[21] As indicated in Table 4-1, there are no available soil-based screening benchmarks for terrestrial amphibians or reptiles, nor are there available sediment- or water-based benchmarks for aquatic reptiles.

adverse effect levels (LOAELs). A range of TRVs may be considered based on the data available.

For some AEs and MEs, existing screening-level benchmarks may be unavailable, or the data may be insufficient to derive screening-level TRVs. In such cases, these AEs or MEs will be discussed in a qualitative narrative assessment in the SLERA, and the uncertainties in those assessments will be recognized.

4.3.4 Risk Characterization

The SLERA will provide risk estimates for all AEs and MEs listed in Table 4-1 as retained for the problem formulation. Some MEs consist of a single evaluation or line of evidence while several lines of evidence are possible for others. For any given ME, each line of evidence may be evaluated more than once, using different assumptions. For each ME, the SLERA will include, as one line of evidence, a comparison using the most conservative assumptions – e.g., a comparison of the maximum PCB concentration applicable to a given receptor in an EA to the most conservative screening benchmark from the literature, or a comparison of the most conservative estimate of a dietary dose (using the maximum EPC and the most conservative uptake factors) with the most conservative TRV from the literature. If that comparison indicates that the EPC is below the benchmark or the estimated dietary dose is below the TRV (i.e., a hazard quotient [HQ] less than 1), then receptors representing the AE in the subject EA (e.g., a local region) will be assumed not to have an unacceptable risk and will be excluded from further evaluation in subsequent phases of the ERA.

If that is not the case, then additional screening-level evaluations will be conducted as appropriate. For comparisons to benchmarks, such additional evaluations may include using an alternate but still conservative EPC, such as the statistically calculated concentration, and/or a range of screening-level benchmarks. For dietary modeling, such refined screening-level evaluations may include use of an alternate EPC and uptake factors from the literature (possibly modified based upon UHR Floodplain-specific data if available) to develop an alternate but still conservative estimate of the dietary dose, and/or comparison to a range of TRVs available from the literature. Such refined screening-level assessments will result in a range of estimated risks or HQs, which can then be considered in determining whether, based on the overall range of comparisons, the receptor and/or EA should be retained for further evaluation in the BERA.

In addition to these quantitative evaluations, the SLERA may include qualitative evaluations. For example, in addition to considering the comparison of upper-bound soil concentrations to relevant ecological benchmarks to evaluate the potential risk to plants, available information regarding the health and vitality of plant communities in the Floodplain will be considered. As another example, information relating to the mechanism of potential PCB toxicity to a receptor species may be considered. For instance, since PCB toxicity is mediated through the aryl hydrocarbon (Ah) receptor, species lacking an Ah receptor are typically less sensitive to the effects of PCBs and can be assumed to be less affected by exposure to PCBs than species that have the Ah receptor. In addition, the SLERA may include comparisons to the conclusions of USEPA's River ERA (USEPA 2000b). For example, if the River ERA concluded that there was little or no unacceptable risk to a given receptor from PCB exposures in the River, and it can be shown that the PCB exposures to the same (or a very similar) receptor in the Floodplain are lower (and that there are no other significant differences), such a comparison would constitute an important line of evidence that would support screening out that receptor from further evaluation in subsequent stages of the ERA.

The final evaluation of an AE in the SLERA will be based upon the combined outcome of all lines of evidence for all MEs used to evaluate that AE. AEs for which all or most lines of evidence indicate minimal or no concern likely will not require further evaluation in the BERA, but this decision will be discussed on a case-by-case basis with USEPA to ensure that the strength of the various lines of evidence are appropriately considered and that the final decision is defensible. AEs for which all or most lines of evidence indicate a potential concern will be retained for further evaluation in Phase 1 of the BERA. For AEs that have limited data available to conduct the evaluations represented by MEs in the SLERA, other outcomes are possible. The range of outcomes from the SLERA are summarized below in Section 4.3.5.

4.3.5 Possible Outcomes of the SLERA

The six possible outcomes for each AE and EA combination in the SLERA are:

1. **Exclude from further evaluation in the BERA due to negligible or no unacceptable risk:** The SLERA quantitatively and/or qualitatively addressed the MEs for the AE and concluded that there is negligible or no unacceptable risk. Thus, further evaluation of this AE and EA combination is not necessary.
2. **Exclude from further evaluation in the BERA due to insufficient toxicity data:** The SLERA could not fully address the AE due to lack of suitable toxicity data, and concluded that adequate toxicity data are unlikely to be developed in the BERA. Uncertainty regarding AEs included in this category will be addressed in the uncertainty discussion in the Final BERA Report.
3. **Retain for further evaluation in the BERA due to data gaps in the risk characterization:** The SLERA could not fully address the AE due to lack of either sufficient exposure data or suitable toxicity data, but concluded that it would be appropriate to retain the AE for additional evaluation in the BERA assuming that suitable exposure and/or toxicity data can be developed.
4. **Retain for further quantitative evaluation in the BERA:** The SLERA evaluated the MEs for the AE and concluded that PCB exposure in the EA has the potential to result in unacceptable risk and that quantitative evaluation in the BERA is warranted.
5. **Retain for qualitative evaluation in the BERA:** The SLERA evaluated the MEs for the AE and concluded that PCB exposure in the EA has the potential to result in unacceptable risk, but that, due to limitations in the toxicity or exposure data or other factors, qualitative evaluation in the BERA would be appropriate. (Note that if the qualitative evaluation determines that an unacceptable risk remains possible for the AE, a further quantitative evaluation may be conducted in the BERA.)
6. **Retain for further evaluation in the BERA contingent on results for another AE:** The SLERA evaluated the MEs for the AE and concluded that PCB exposure in the EA has the potential to result in unacceptable risk to the receptor, but that further evaluation in the BERA will be contingent on the BERA risk characterization results for a more exposed or a more sensitive receptor in the same taxonomic class (e.g., herbivorous mammals are assumed to be less exposed to PCBs than insectivorous mammals). If the more exposed or sensitive receptor is determined in the BERA to have negligible or no unacceptable risk, the contingent AE will not be evaluated in the BERA and the

absence of unacceptable risk will be discussed in the Final BERA Report. If, however, the more exposed or sensitive receptor is found to have a potentially unacceptable risk, the contingent AE may be evaluated quantitatively or qualitatively in the BERA.

4.3.6 Screening-Level Ecological Risk Assessment Report

Upon completion of the analyses described above, a SLERA Report will be prepared and submitted to USEPA for review and approval. This report will include a description of the SLERA and its results, including a description of the outcome of the SLERA for each AE and EA evaluated (as discussed in Section 4.3.5) and the rationale for that outcome.

4.4 Baseline Ecological Risk Assessment Work Plan

Following USEPA's approval of the SLERA Report, a BERA Work Plan describing the approach for further evaluating the AEs, receptors, and local areas identified by the SLERA as warranting further evaluation will be prepared. The BERA Work Plan will present a refined problem formulation and a refined ecological CSM for the BERA, summarize the AEs and EAs retained for evaluation in the BERA, and describe the phased approach to be used for such evaluation in the BERA. The BERA Work Plan will also describe the receptor-specific EAs to be used in the BERA, the metrics or methods to be used to determine EPCs for those EAs in Phase 1 of the BERA, the dietary dose models to be considered or used in Phase 1, the exposure parameters for those models (or the approach to be used to develop those parameters) and applicable dose equations, the TRVs or other toxicity values to be used in Phase 1, and the overall risk characterization approach(es). Finally, the BERA Work Plan will identify the data gaps that will need to be filled prior to initiation of Phase 1 of the BERA. A more detailed discussion is provided below.

4.4.1 Refinement of Exposure Assessment

The estimated exposure to each receptor species selected for evaluation of each AE retained for Phase 1 of the BERA is dependent on a variety of factors, including the size and shape of the EA, the EPC used to represent PCB concentrations in the EA, and, for any receptors that will be evaluated using a dietary dose model, the exposure parameters employed in that dietary dose model. The BERA Work Plan will include key information about each of these factors, as discussed below.

Exposure Areas. Each receptor that will be included in Phase 1 of the BERA has unique habitat requirements and preferences, all of which can affect the exposure of the receptor to PCBs. While the effect of habitat preferences on exposure will not be considered in the SLERA (as discussed above), Phase 1 of the BERA will include a more realistic assessment of actual exposures based on available information regarding habitat preferences and habitat area needed to support local populations. The EAs to be used in Phase 1 will be specific to each receptor species and will be identified in the BERA Work Plan. These EAs will take into account the habitat requirements and preferences of that species. The available vegetation map presented in the 2009 Mapping Report (ARCADIS 2009), with any updates through the time of the BERA Work Plan, will serve as the primary basis for that process; however, additional data on the presence or absence of specific cover types may be required to accurately depict the presence and quality of habitat for the various species.

The size of each EA will vary among receptors. For each receptor species, the size of the EA(s) will be consistent with the area of suitable habitat that is required to support the local population of that species (rather than individual foraging ranges). In addition, while the SLERA will focus on exposures only within the Floodplain, Phase 1 of the BERA will also evaluate the availability of suitable habitat for each receptor outside the Floodplain boundary and will include such habitat in the EA(s) when appropriate based on the size of the area used by the local population of the receptor. For aquatic receptors, EAs will be defined by the presence of standing water of sufficient size and sufficient duration of inundation to support local aquatic populations.

Exposure Point Concentrations. The BERA Work Plan will also identify the metrics or methods to be used to derive EPCs for Phase 1 of the BERA. In developing EPCs for abiotic media, a variety of spatially weighted averaging techniques will be evaluated to determine the approach that provides the most realistic estimate of exposure for each receptor, rather than using the maximum or high-end values used in the SLERA. It is anticipated that EPCs will generally consist of spatially weighted average concentrations of the FFU data in the receptor-specific EA (using the FFU metrics described in the Revised FCR and the PAR results if available), but other statistical averaging techniques (e.g., techniques that account for a receptor's habitat preferences or habitat quality) will also be considered in deriving representative EPCs. The approaches to be used to develop the EPCs may vary by receptor type, and will be presented in the BERA Work Plan. In any case, the length-weighted average concentration for the 0- to 12-inch soil depth increment at each sampling location will be used to derive EPCs for soil, the data from the 0- to 12-inch sediment depth increment will be used to derive EPCs for standing water sediments, and measured or predicted surface water concentrations will be used for standing water EPCs.

EPCs for biotic media will be either based on measured site-specific data or predicted by an appropriate measure used to estimate concentrations in the biotic media. (The approach for deriving EPCs for abiotic media was described above.) EPCs based on measured site-specific PCB concentrations in biota (e.g., whole body concentrations, egg concentrations) will use either average concentrations or values derived from another statistical method that best represents the underlying PCB concentrations in those biota within an EA.

Dietary Dose Models and Exposure Parameters. For avian and mammalian receptors (and possibly other receptor species if data exist), refined dietary dose models may be used in Phase 1 of the BERA. The BERA Work Plan will identify those models, the exposure parameters to be used in them, and the dose equations to be used, as well as any additional data needs to develop refined model inputs and complete the models. Refinements to dietary dose models used in the SLERA may include use of more realistic EAs and EPCs as described above, and may also include use of more realistic bioaccumulation models based on site-specific data and information.

4.4.2 Refinement of Toxicity Reference Values

Building on the screening-level TRV selection conducted for the SLERA, refined TRVs will be identified in the BERA Work Plan for each receptor species identified in the SLERA as warranting further evaluation in Phase 1 of the BERA. The process for selecting the TRVs for the BERA will follow the approach outlined in Appendix D, including evaluation of the balancing considerations identified there, such as taxonomic relationship to receptor species or applicability to site-specific PCB mixture composition. TRVs may represent NOAELs, LOAELs, or concentrations associated with a specific degree of effect, such as 20% effect concentrations (EC20s) or other effect levels considered to be protective for the receptor species at the population or community level, or they may reflect dose-response relationships. TRVs may be identified as single values, ranges, or distributions. Selected TRVs for a given receptor species must be related or applicable to that species, as well as to the population or community AE. If suitable TRVs for a given receptor species or AE cannot be identified, that will be noted.

4.4.3 Risk Characterization

The risk characterization for Phase 1 of the BERA will use a weight-of-evidence approach, combining available qualitative and quantitative lines of evidence for each receptor and EA, to estimate potential risk to the local population or community of the receptor (as applicable). The BERA Work Plan will describe that approach, including the types of comparisons and evaluations of the results that will or may be conducted in Phase 1 of the BERA and the basis for the weighting of different lines of evidence, as discussed further in Section 4.6.

4.4.4 Identification of Data Gaps

Based on the findings of the SLERA and information summarized in the BERA Work Plan, the BERA Work Plan will identify the data gaps associated with the retained AEs and MEs that will need to be filled to complete Phase 1 of the BERA. These data gaps will be identified following USEPA's Data Quality Objectives (DQO) process (USEPA 2000c) and will focus on the additional ecologically related data necessary to refine estimates of potential risks for ecological receptors and EAs identified as warranting further evaluation by the SLERA. It is anticipated that the data gaps will include the need for additional sampling (especially of biotic media and potentially co-located abiotic media) to complete site characterization, develop site-specific exposure assumptions and uptake factors for use in dietary dose models, and refine TRVs. Data gaps are also expected to include the need for habitat mapping, collection of data on the condition of terrestrial and aquatic vegetation in the UHR Floodplain (as well as in reference areas), and collection of other biological information to establish areas of the UHR Floodplain preferred by various receptors retained for further evaluation in Phase 1 of the BERA. It is not expected that data gaps will be identified for all AEs.

4.5 Data Collection for Phase 1 of the Baseline Ecological Risk Assessment

Following USEPA's approval of the BERA Work Plan, a detailed Phase 1 BERA Data Collection Plan for the collection of data to fill data gaps identified for Phase 1 of the BERA will be developed and submitted to USEPA for review and approval. The Phase 1 BERA Data Collection Plan will establish DQOs for the proposed data collection efforts. It will be accompanied by an appropriate Field Sampling Plan/Quality Assurance Project Plan (FSP/QAPP).

Multiple phases of data collection may be necessary to meet all DQOs. Following each phase of data collection, the data will be evaluated to determine whether the DQOs have been met or whether additional data collection is necessary. If all DQOs have not been met, an Addendum to the Data Collection Plan (with FSP/QAPP Addendum if necessary) will be prepared and submitted to USEPA. Data collection will continue with subsequent Addenda as needed until all DQOs have been met. Phase 1 BERA data collection will be considered complete when all of the DQOs identified in the Phase 1 BERA Data Collection Plan (and Addenda) have been met. When all data necessary for Phase 1 of the BERA have been collected, a Data Summary Report (DSR) will be prepared and submitted to USEPA.

4.6 Phase 1 of the Baseline Ecological Risk Assessment

After the BERA Work Plan has been completed and approved and Phase 1 data collection is complete, Phase 1 of the BERA will be conducted. This assessment will rely upon data collected during the Phase 1 BERA data collection, as well as prior data and data presented in the Revised FCR, to refine the evaluation of those AEs and EAs identified in the SLERA Report as warranting further evaluation. The Phase 1 evaluation, including site-specific exposure estimates, effects assessment, and risk characterization, will be consistent with the relevant outcome of the SLERA for the given AE and EA combination (as discussed in Section 4.3.5) and will follow the approach and methods outlined in the BERA Work Plan (as described in Section 4.4).

Phase 1 of the BERA will evaluate multiple lines of evidence for each AE/receptor and each EA subject to quantitative evaluation, using a weight-of-evidence approach (as outlined in the BERA Work Plan). That approach will give greater weight to lines of evidence that are more directly relevant to the objective of assessing risks to the local population or community of the receptor (as applicable). It is anticipated that these evaluations for the majority of lines of evidence for most AEs and EAs will consist of comparisons of exposed receptors to allowable concentrations and/or exposures. Such comparisons may include, but are not limited to:

- Comparison of refined abiotic media EPCs (based on data presented in the Refined FCR) to abiotic media benchmarks, which may be based on information from the literature or derived from findings of no effect at other sites, to the extent that additional information for such comparison has become available since the SLERA;
- Comparison of UHR Floodplain biota concentrations (or other measures of biological effect) to concentrations of PCBs (or other measures of biological effect) in similar biota in background or reference areas;
- Comparison of estimates of dietary exposures to a dietary dose TRV or a range of dietary dose TRVs; and/or
- Comparison of measured or predicted body burdens (e.g., egg concentrations) to body burden-based TRVs or a range of such TRVs.[22]

The results of these comparisons will be evaluated in terms of their implications for the local populations or communities of the receptors. In addition, if suitable data are available to support population-level modeling for one or more receptors identified as warranting further evaluation based on the above comparisons, quantitative population-level modeling may be conducted for such receptor(s) to provide more refined information on the impacts on the local population(s) than is possible through dietary dose model assumptions.

The Phase 1 evaluations may also include qualitative evaluations for some AEs, again focused on the local populations or communities of the receptor. Such evaluations may include consideration of relevant mechanistic information about the receptor or observational information regarding presence or absence of a given habitat or regarding the health of the local population of the species. These evaluations may also include comparisons of the

[22] The TRVs selected in the BERA Work Plan will be updated during Phase 1 if additional relevant toxicity information becomes available (e.g., new toxicity studies are published).

sensitivity and/or exposure of the receptor species to those of other species that were also evaluated quantitatively in Phase 1. They may also include comparisons of the concentrations of PCBs in the media to which the receptor would be exposed in the UHR Floodplain (or in the tissue of such receptors) to concentrations found in similar media in the River ERA or in studies at other sites to have no significant adverse effects on the receptor. If the qualitative evaluation determines that an unacceptable risk remains possible for a given AE, a quantitative evaluation may be conducted, either in Phase 1 or in Phase 2.

Finally, for those AEs that were identified in the SLERA Report as being subject to contingent evaluation in the BERA depending on the BERA risk characterization results for a more exposed or a more sensitive receptor in the same taxonomic class, the results for that more exposed or a more sensitive receptor will be reviewed to determine the need for the contingent evaluation. If the more exposed or sensitive receptor was found in Phase 1 of the BERA to have negligible or no unacceptable risk, the contingent AE will not be evaluated and the absence of unacceptable risk will be noted. If, however, the more exposed or sensitive receptor was found to have a potentially unacceptable risk, the contingent AE may be evaluated quantitatively or qualitatively in Phase 1.

The possible outcomes of Phase 1 of the BERA for each AE and EA combination are:

1. **Negligible or no unacceptable risk; no need for further evaluation:** Phase 1 of the BERA quantitatively and/or qualitatively addressed the MEs for the AE and concluded that there is negligible or no unacceptable risk. Thus, further evaluation of this AE and EA combination is not necessary.
2. **Insufficient data to address AE, but no need for further evaluation:** Phase 1 of the BERA could not fully address the AE due to lack of either sufficient exposure data or suitable toxicity data, and there is no likelihood of obtaining such data through further efforts. Uncertainty regarding AEs included in this category will be addressed in the uncertainty discussion in the Final BERA Report.
3. **Potential for unacceptable risk, but no need for further evaluation:** Phase 1 of the BERA evaluated the MEs for the AE and concluded that PCB exposure in the EA has the potential to result in unacceptable risk; and there is no need for further evaluation of the AE and/or EA.

4. **Data gaps in Phase 1 risk characterization; retain for further evaluation in Phase 2 of the BERA:** Phase 1 of the BERA could not fully address the AE due to lack of either sufficient exposure data or suitable toxicity data, but concluded that it would be appropriate to retain the AE for additional evaluation in Phase 2 of the BERA assuming that suitable exposure and/or toxicity data can be developed.
5. **Potential for unacceptable risk; retain for further evaluation in Phase 2 of the BERA:** Phase 1 of the BERA evaluated the MEs for the AE and concluded that PCB exposure in the EA has the potential to result in unacceptable risk and that further evaluation in Phase 2 of the BERA is warranted.

Upon completion of this analysis, a Phase 1 BERA Report will be prepared and submitted to USEPA for review and approval. This report will include a description of Phase 1 of the BERA and its results, including a description of the outcome for each AE and EA evaluated (as discussed above) and the rationale for that outcome.

In addition, for the AEs and MEs identified as warranting further evaluation in Phase 2 of the BERA, the Phase 1 BERA Report will present the results of a data gap evaluation to identify additional data to be collected to refine the risk characterization of that AE and ME in Phase 2 of the BERA. It is anticipated that data collection efforts for Phase 2 will be focused primarily on field studies targeting evaluation of potential population-level effects on specific species retained following completion of Phase 1. In addition, however, some additional data may be necessary (to the extent not collected during the Phase 1 BERA data collection effort) to further refine the EAs, the EPCs (particularly for biotic media), and/or dietary dose model exposure parameters, including development of site-specific information about the bioavailability of PCBs in the UHR Floodplain.

4.7 Supplemental Data Collection for Phase 2 of the Baseline Ecological Risk Assessment

Following USEPA's approval of the Phase 1 BERA Report, a detailed Supplemental BERA Data Collection Plan for the collection of data to fill the identified remaining data gaps will be developed and submitted to USEPA for review and approval, accompanied, if necessary, by revisions or additions to the FSP/QAPP. Data collection may include additional sampling or habitat characterization if necessary, collection of data to refine dietary dose model exposure parameters, and/or the performance of field studies designed to determine whether PCBs in the EAs identified by Phase 1 of the BERA as requiring further evaluation pose an unacceptable risk to the local population of receptors within those EAs. To the extent that field studies are proposed, the plan will include a detailed work plan(s) for the proposed field studies.

If, following the evaluation of the initial Phase 2 data collection effort, it is determined that not all of the DQOs have been met, an Addendum to the Supplemental BERA Data Collection Plan will be prepared and submitted to USEPA, with an FSP/QAPP Addendum if necessary. Supplemental data collection will continue as needed until all DQOs are met. When all DQOs for Phase 2 of the BERA have been met, a DSR for the supplemental data collection will be prepared and submitted to USEPA, and the relevant data will subsequently be incorporated into the Final FCR (see Section 2.5.6).

4.8 Phase 2 of Baseline Ecological Risk Assessment and Final Baseline Ecological Risk Assessment Report

After all data collection for Phase 2 of the BERA has been completed and approved, Phase 2 of the BERA will be conducted. Phase 2 of the BERA will re-evaluate potential risks to those receptors identified in the Phase 1 BERA Report as warranting further evaluation. This further evaluation will incorporate the data collected during the Phase 2 data collection effort and presented in the Final FCR, including the results of any field studies performed. Multiple lines of evidence will be evaluated for each AE in Phase 2, including both quantitative and qualitative evaluations (as described above for Phase 1) as well as the results of any field studies. Again, a weight-of-evidence approach will be used, focusing on the relevance of the various lines of evidence to the sustainability of the local population or community of the receptor group being evaluated.

Upon completion of the Phase 2 evaluations, the Final BERA Report will be prepared and submitted to USEPA for review and approval. The Final BERA Report will include an overview and summary of the findings of the entire ERA process, including the SLERA, Phase 1 of the BERA, and Phase 2 of the BERA. It will describe the results of the various data collection efforts and summarize the findings for all AEs included in the ERA.

The Final BERA Report will include a discussion of the uncertainties in the overall ERA, including the sources of uncertainty in the problem formulation, exposure assessment, effects assessment, and risk characterization. This will include a discussion of the uncertainties resulting from a lack of sufficient exposure data or suitable toxicity information for particular receptors and from inter-species extrapolations. It will also include an evaluation of the extent to which potential risks to particular receptors may be overestimated or underestimated, and a discussion of the uncertainties in using the evaluations of the selected representative receptor species to draw conclusions for the overall AEs, including other species covered by those AEs. Further, the uncertainty analysis will make an effort to place the risk estimates in the ERA within the overall context of what is known and not known about the local populations and communities of wildlife in the UHR Floodplain.

Lastly, the Final BERA Report will discuss the ERA results in the context of the six risk management principles set forth in USEPA's Final Guidance on Ecological Risk Assessment and Risk Management Principles (USEPA 1999).

The Final BERA Report will be included in the RI Report, as discussed in Section 2.5.8.

5 FEASIBILITY STUDY

Following completion and USEPA approval of the RI Report (including the risk assessments), the Feasibility Study (FS) for the UHR Floodplain will be initiated. The FS will be performed in accordance with this Work Plan and with the following:

- *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988);
- Applicable provisions of the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) regulations contained in 40 CFR Part 300;
- *Guide for Conducting Treatability Studies Under CERCLA, Final* (USEPA 1992e);
- *Treatability Studies under CERCLA: an Overview* (USEPA 1989b); and
- *The Role of Cost in the Superfund Remedy Selection Process* (USEPA 1996b).

The FS will include the following tasks:

1. Developing remedial action objectives (RAOs) and preliminary remediation goals (PRGs);
2. Identifying applicable or relevant and appropriate requirements (ARARs);
3. Developing General Response Actions (GRAs);
4. Identifying and screening remedial technologies applicable to each GRA;
5. Determining the need for treatability studies and implementing treatability studies, if appropriate;
6. Developing remedial action alternatives to address the RAOs;
7. Evaluating the remedial action alternatives under the criteria in the NCP; and
8. Identification and collection of data necessary to develop remedial alternatives (beyond the data collected for the purposes of completing the remedial investigation or risk assessments), including data needs for PCB delineation, technology evaluations, and evaluations of RAOs/PRGs.

The FS will be completed in several phases and documented in the following deliverables:

- RAO/PRG Proposal – this report will document Tasks 1 and 2;
- Feasibility Study Screening Report (FS Screening Report) – this report will document Tasks 3, 4, and 6, along with the assessment of need for additional studies in Task 5;
- Treatability Study Work Plan and Treatability Study Evaluation Report, if treatability study(ies) are proposed – these deliverables would document Task 5; and
- FS Report – this report will document Tasks 1 through 7.

These tasks and deliverables will focus primarily on PCB-containing Floodplain soils. In general, references to Floodplain soils in this section also include sediments in standing water areas in the Floodplain. However, in some respects, the PRGs, ARARs, and/or remedial technologies may be different for sediments in standing water in the Floodplain than for the soil in other portions of the Floodplain. In addition, the PRGs, ARARs, and/or remedial technologies may be different for the near-shore sediment areas. Any such differences will be noted in the appropriate deliverable(s).

For the FS, consideration will be given to the types and number of exposure areas (EAs) identified; for constructability and feasibility purposes, EAs may be grouped as appropriate (e.g., multiple residential property EAs may be grouped together) for the purposes of developing and evaluating remedial alternatives and selecting a remedial action.

The FS tasks and deliverables listed above are described in more detail in the following sections.

5.1 Proposal of Remedial Action Objectives and Preliminary Remediation Goals

The RAOs will be used as the basis for determining the anticipated effectiveness of each remedial technology and remedial action alternative. Using information developed during the human health and ecological risk assessments, PRGs will also be developed to address the RAOs. In addition, the ARARs and to-be-considered (TBC) information to be used in the evaluation of remedial action alternatives will be identified and will be considered in the development of PRGs.

GE will submit for USEPA approval a proposal containing specific RAOs and PRGs for PCBs in Floodplain soil (RAO/PRG Proposal). This proposal will distinguish among RAO or PRGs for general Floodplain soil, those for standing water areas in the Floodplain, and those for near-shore sediment areas. The RAOs will consist of narrative statements of the objectives and desired outcomes of the remediation of the UHR Floodplain. The PRGs will consist of numerical concentration-based goals for PCBs in Floodplain soil (and sediments if appropriate) in various types of EAs and will serve as points of departure in evaluating potential remedial alternatives. These PRGs are not necessarily cleanup levels: cleanup levels will be specified in the remedy decision document. PRGs will be developed for the relevant human exposure scenarios evaluated in the BHHRA and for protection of local populations or communities of the ecological receptors evaluated in the BERA. These risk-based PRGs will be formulated to apply to the human health and ecological EAs on the same basis (i.e., using the same averaging approach) as that used to develop the final EPCs for those EAs in the BHHRA and the BERA (see Section 3 and 4).

In addition, the RAO/PRG Proposal will identify the federal and state ARARs and TBCs to be used in evaluating the remedial alternatives for the UHR Floodplain. Proposed ARARs and TBCs will be categorized as follows:

- Chemical-specific ARARs: These ARARs define acceptable exposure levels and would include any promulgated federal or state standards that would apply to Floodplain soils (or standing water sediments in the Floodplain).
- Location-specific ARARs: These ARARs are promulgated federal or state requirements governing the conduct of activities based on an activity's location within the environment, such as in floodplains and wetlands.
- Action-specific ARARs: These ARARs are usually technology- or activity-based promulgated requirements or limitations on actions taken as part of site cleanup.
- TBC Information: TBCs are non-promulgated criteria and guidance that are not legal requirements. However, in developing RAOs and evaluating remedial alternatives, consideration will be given to such criteria or guidelines that, based on professional judgment, are appropriate to consider in the evaluation. However, any such criteria or guidelines that specify numerical cleanup values will not replace or supersede the site-specific risk-based PRGs.

In the event that GE believes that any identified ARARs should be waived on the grounds identified in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (§ 121(d)(4)) and the NCP (40 CFR § 300.430(f)(1)(ii)(C)), the basis for a proposed waiver will be provided.

5.2 Feasibility Study Screening Report

Following USEPA approval of the RAO/PRG Proposal, GE will perform the initial technology screening steps of the FS and will develop remedial alternatives to be evaluated in detail in the FS. These steps will be documented in the FS Screening Report. In addition, the need for treatability studies or other additional data will be determined and documented in the FS Screening Report.

5.2.1 Development of General Response Actions

General Response Actions (GRAs) will be developed for attaining the RAOs described in the RAO/PRG Proposal. The GRAs will take into account requirements for protectiveness as identified in the RAOs and the physical and chemical characteristics of the Study Area. Typical GRAs to address soils include no action, monitoring, institutional controls, containment, treatment, and removal. GRAs may address both on-site actions (actions to address PCBs *in situ*) and off-site actions (e.g., off-site treatment/disposal alternatives). These GRAs may be applied alone or in combination to achieve the RAOs.

5.2.2 Identification and Screening of Remedial Technologies

Remedial technologies that are potentially applicable to each GRA for addressing PCB-containing Floodplain soils (or, where applicable, standing water sediments) will be identified. The identification of remedial technologies will involve a review of available vendor information and relevant USEPA guidance documents such as *Superfund Innovative Technology Evaluation (SITE) Program: Technology Profiles - Eleventh Edition* (USEPA 2003b).

Potential technologies will initially be screened based on technical implementability to eliminate technologies that could not be effectively implemented or are clearly unworkable at the site. The technologies remaining after the initial screening will be further evaluated, and, where appropriate, a representative process option will be selected for each retained technology using the criteria of effectiveness, implementability, and cost, as follows:

- Effectiveness: This screening criterion refers to the ability of the remedial technology to reduce the toxicity, mobility, and/or volume of PCBs, and the ability to provide protection of human health and the environment.
- Implementability: Technical implementability will be considered again in this screening step, and will focus on the ability to construct and reliably operate the technology/process option. In addition, this second screening step will consider administrative feasibility (e.g., the ability to obtain the necessary approvals, the availability and capacity of the necessary services, and the availability of any necessary specific equipment or technical specialists).
- Cost: At the screening stage, the relative costs of applying potential technologies will be considered.

Based on the results of the preliminary screening, remedial technologies and/or process options will be eliminated, retained, or identified as needing further information to fully evaluate (e.g., a treatability study is warranted). Remedial technologies (and their representative process options) that are ultimately retained will subsequently be used to formulate remedial action alternatives for detailed analysis. The results of this screening effort, including the basis for excluding or retaining each remedial technology and process option, will be documented in the FS Screening Report.

5.2.3 Development of Remedial Action Alternatives

The potential remedial technologies/process options that are retained following the screening process will be combined as appropriate to form remedial action alternatives for a more detailed evaluation in the FS. It is anticipated that two categories of remedial alternatives will be developed: (1) alternatives for remediation of Floodplain soils (including standing water sediments in the Floodplain) and near-shore sediment areas; and (2) alternatives for managing materials that are removed from the Floodplain. It is further anticipated that the remedial alternatives in the first category (remediation alternatives) will include the following range of alternatives to the extent possible:

- A no-action alternative;
- Alternatives that remove PCB-containing materials to various extents (e.g., based on achieving different sets of PRGs); and
- Alternatives that prevent, minimize, or reduce potential exposure to PCBs through the use of in-place treatment or containment options and/or institutional controls.

The remedial alternatives in the second category will involve different methods of managing any removed materials and may include on-site consolidation/disposal, off-site disposal, and treatment of such materials. These are referred to as treatment/disposal alternatives.

For both categories, the range of remedial alternatives will represent a reasonable number of alternatives to carry through the detailed evaluation described below. The remedial alternatives developed for such detailed evaluation will be identified and described in the FS Screening Report.

That report will also describe the methodologies to be used for the detailed evaluation under the criteria discussed in Section 5.4.1. These will include the methodology for estimating the extent of Floodplain soil targeted for remediation (e.g., surface area, volume) under each remedial alternative. This methodology will involve application of an appropriate averaging technique to determine the areal extent and volume of soils that would need to be addressed in specific EAs to achieve particular post-remediation average PCB concentrations (e.g., based on a given set of PRGs).

5.2.4 Determining Need for Additional Studies

As potential remedial technologies are screened, additional information necessary to adequately evaluate certain remedial technologies may be identified. That, in turn, might indicate the need for treatability studies to evaluate the performance of specific remedial technologies. This evaluation may also indicate that additional data on the matrix (soils or sediments) to be remediated are needed to properly evaluate the feasibility of some technologies. Treatability studies may involve: (1) bench-scale testing to gather information to assess the feasibility of a technology; and/or (2) pilot-scale testing to provide quantitative performance, cost, and design information for remediation.

It is expected that additional data collection efforts will be identified in the FS Screening Report, such as additional sampling to better define the horizontal or vertical extent or characteristics of certain Floodplain soils subject to remediation. In such a case, the FS Screening Report will include a proposal for obtaining such data.

5.3 Treatability Studies Work Plan and Evaluation Report (if needed)

If it is determined in the FS Screening Report that a treatability study is needed, a Treatability Study Work Plan will subsequently be developed and submitted to USEPA for review and approval. The Treatability Study Work Plan will describe each technology to be tested, the type of testing (e.g., bench- or pilot-scale), test objectives, test equipment or systems, experimental procedures, treatability conditions to be tested, measurements of performance, field sampling procedures, analytical methods, data management and analysis, health and safety procedures, and residual waste management. The DQOs for the treatability study will also be documented.

After completion of the Treatability Study (if performed), a Treatability Study Evaluation Report will be prepared and submitted to USEPA that describes the performance of each technology tested. The report will include an evaluation of the remedial technology's effectiveness, implementability, estimated cost, and final results. The report will also evaluate full-scale application of the technology, including a sensitivity analysis identifying the key parameters affecting full-scale operation. The results of any treatability studies performed will be used in the detailed evaluation and comparative analysis of remedial alternatives, as discussed in Section 5.4.

5.4 Detailed Evaluation and Feasibility Study Report

Following USEPA approval of the FS Screening Report and completion of any additional studies (treatability studies or other data collection), the remedial alternatives identified in the FS Screening Report as approved by USEPA, with any modifications resulting from any additional studies, will be evaluated in detail and the results of FS activities documented in an FS Report.

5.4.1 Detailed Analysis of Remedial Action Alternatives

Each of the remedial alternatives will undergo a detailed analysis. Each of the alternatives will be evaluated in the FS relative to seven of the nine NCP criteria as follows:

- Overall protection of human health and the environment;
- Compliance with ARARs (or the basis for an ARAR waiver under CERCLA and the NCP);
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume of PCBs;
- Short-term effectiveness;
- Implementability; and
- Cost.

The other two NCP criteria are acceptance by the regulatory support agency and acceptance by the community. These are typically evaluated following public comment on the FS and USEPA's Proposed Remedial Action Plan.

A discussion of each of the seven evaluation criteria is presented below. A summary of the information generated by the evaluation of each remedial alternative using the seven criteria will be presented in the FS Report.

5.4.1.1 Overall Protection of Human Health and the Environment

This criterion evaluates the overall extent to which the remedial alternative provides protection of human health and the environment. This evaluation considers the assessment of other evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. This evaluation criterion would include an assessment of the estimated net risk reduction provided by each alternative, considering both short-term and residual risk. In applying this criterion, the extent to which each alternative would achieve the PRGs as approved by USEPA will be considered, but achievement of any particular PRGs will not be a prerequisite for demonstrating protection of human health and the environment. In addition, as explained in the NCP and in USEPA guidance (USEPA

1997c, 1999, 2005c), this criterion requires a balancing of the short-term and long-term adverse ecological impacts of the alternatives with the residual risks.

5.4.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

This criterion evaluates the compliance of the remedial alternatives with the chemical-specific, location-specific, and action-specific ARARs identified for the project, as approved by USEPA. This evaluation criterion also addresses if and how the remedial alternative would address TBC information (e.g., advisories and guidance). A description of the categories of ARARs and TBCs was provided in Section 5.1. This evaluation will also consider, as appropriate, whether the conditions for waiver of an ARAR or ARARs under CERCLA and the NCP are satisfied.

5.4.1.3 Long-term Effectiveness and Permanence

The evaluation of each remedial alternative relative to its long-term effectiveness and permanence will consider the risks that may remain following implementation of the alternative (i.e., residual risks). The following factors will be assessed to evaluate the long-term effectiveness and permanence of the alternatives:

- The ability of the remedial alternative to meet the established RAOs and PRGs and the length of time to do so;
- Long-term impacts to the community resulting from implementation of the alternative, and the effectiveness and reliability of protective measures;
- Potential long-term environmental impacts from PCBs remaining at the completion of the remedial alternative, including an estimate of residual risks using EPC estimates developed in a manner consistent with the risk assessments;
- Potential long-term ecological impacts as a result of loss of habitat (e.g., significant tree clearing that may be required for some remedial alternatives), considering the Habitat Delineation Report (ARCADIS and QEA 2008) and the Phase 1 and Phase 2 Habitat Assessment reports (BBL and Exponent 2005; Anchor QEA 2009) and associated database developed to support the UHR dredging design, as well as the

Human Use and Vegetation Mapping Summary Report developed for the UHR Floodplain (ARCADIS 2009);

- Other potential long-term environmental impacts resulting from implementation of the alternative;
- Potential impacts to cultural resources resulting from implementation of the alternative, using information presented in the Stage IB Cultural Resources Survey Report (described in Section 2.5.7.3); and
- The adequacy and reliability of controls that will be used to manage PCB-containing materials remaining after the completion of the remedial alternative.

5.4.1.4 Reduction of Toxicity, Mobility, or Volume

This criterion evaluates the degree to which each remedial alternative will permanently and significantly reduce the toxicity, mobility, or volume of the PCBs present in the Floodplain. The evaluation will be based on the following:

- The ability of the alternative to reduce the toxicity, mobility, or volume of the PCBs;
- The nature and quantity of PCB-materials that will remain following remediation; and
- The relative amount of PCBs that will be destroyed, treated, or recycled.

5.4.1.5 Short-term Effectiveness

The short-term effectiveness of each remedial alternative will be evaluated relative to its effect on human health and the environment during implementation. The evaluation of each remedial alternative with respect to its short-term effectiveness will consider the following:

- Short-term impacts to the community during implementation of the alternative, and the effectiveness and reliability of protective measures;
- Potential impacts to workers during implementation of the remedial alternative, and the effectiveness and reliability of protective measures; and

- Potential impacts of the remedial alternative on the environment, including potential loss of habitat, and the effectiveness and reliability of protective measures (considering the above-referenced Habitat Delineation Report and the Phase 1 and Phase 2 Habitat Assessment reports and associated database developed to support the UHR dredging design, as well as the Human Use and Vegetation Mapping Summary Report developed for the UHR Floodplain).

5.4.1.6 Implementability

This criterion addresses the technical and administrative feasibility of implementing the remedial alternative, including the availability of the various services and materials required for implementation. The evaluation of implementability will be based on the following:

- Technical Feasibility: This refers to the relative ease of implementing the remedial alternative based on site-specific constraints. In addition, the ease of construction, operational reliability, and the ability to monitor the effectiveness of the remedial alternative are considered.
- Administrative Feasibility: This refers to the feasibility/time required for acquiring the necessary administrative approvals to implement the remedial alternative (e.g., access agreements). Consideration will also be given to the presence of threatened, endangered, or other rare species, as well as identified cultural or archaeological resources. The FS Report will describe how any areas containing such species or resources will be treated appropriately, avoided, or evaluated further in the context of design and implementation of any potential remedial actions.[23]

5.4.1.7 Cost

This criterion evaluates the estimated total cost to implement the remedial alternative. The total cost of each alternative represents the sum of the direct capital costs (materials, equipment, and labor), indirect capital costs (engineering, oversight, and contingency allowances), and operation and maintenance (O&M) costs. O&M may include operating

[23] It is anticipated that, to the extent that any cultural or archaeological resources that would be impacted are determined to meet the criteria for eligibility for the National Register of Historic Places, such resources would be avoided to the extent practicable.

labor, energy, and sampling and analysis. These costs will be estimated with an anticipated accuracy between -30% and +50%. Present-worth costs will be calculated for alternatives expected to last more than two years.

5.4.2 Comparative Analysis of Alternatives

Following the detailed evaluation of remedial alternatives, a comparative analysis will be performed. In this evaluation, all alternatives in each category (i.e., the remediation alternatives and the treatment/disposal alternatives) will be compared to one another based on each criterion. The purpose of the comparative analysis will be to identify the relative advantages/disadvantages of each remedial alternative, to highlight the differences among the alternatives, and to assess the alternatives when evaluated relative to each other in the context of the seven criteria described in Section 5.4.1. The results of the comparative analysis will be presented in the FS Report.

5.4.3 Contents of Feasibility Study Report

As stated previously, for the purposes of the FS, consideration will be given to the types and number of EAs identified; for constructability and feasibility purposes, EAs may be grouped as appropriate (e.g., all residential property EAs may be grouped together) for the purposes of developing, evaluating, and recommending remedial alternatives. Different remedial alternatives may be appropriate for different areas of the UHR Floodplain, including the near-shore sediment areas. The FS Report will summarize the results of the prior screening of remedial technologies, present the results of any treatability studies or other studies conducted as part of the FS, describe the remedial action alternatives evaluated, present a detailed analysis of each remedial alternative under the criteria discussed in Section 5.4.1, and present a comparative analysis of alternatives as described in Section 5.4.2. The FS Report will be submitted to USEPA for review and approval.

6 SCHEDULE

This section provides the schedule for submission of deliverables to be prepared in support of the RI, human health and ecological risk assessments, and FS activities for the UHR Floodplain RI/FS, along with a schedule for implementing related work elements (e.g., field sampling efforts).

The schedule for these activities is presented in Table 6-1. Because the schedule for several tasks is contingent upon activities that are not within GE's control (e.g., seasonal constraints, access, USEPA review/approvals, the extent of data gaps, etc.), the schedule is provided relative to key milestones and other conditions.

Table 6-1
Remedial Investigation and Feasibility Study Schedule

Activity	Timeframe/Comments[1]
1. Submit FCR	Within 90 days following the effective date of the Agreement
2. Submit Stage IA Cultural Resources Assessment Work Plan	Within 90 days following the effective date of the Agreement
3. Submit SLA Report	Within 60 days following USEPA approval of the FCR
4. Submit SLERA Report	Within 90 days following USEPA approval of the FCR
5. Submit RI FSP/QAPP	Within 60 days following USEPA approval of the FCR
6. Submit RI HASP	Within 60 days following USEPA approval of the FCR
7. Complete field activities specified in RI FSP/QAPP and perform laboratory data validation	In accordance with the schedule provided in the RI FSP/QAPP, as approved by USEPA, subject to access/weather/seasonal constraints
8. Submit Additional RI Data Collection Proposal, if necessary[2]	Within 60 days following receipt of validated data from field activities specified in RI FSP/QAPP, if additional data are deemed necessary

Activity	Timeframe/Comments[1]
9. Submit RI FSP/QAPP/HASP Addenda, if necessary[2]	Within 45 days following USEPA approval of the Additional RI Data Collection Proposal
10. Submit RI DSR	Within 60 days following receipt of all validated data from investigations specified in RI FSP/QAPP and Addenda (if submitted), if RI data collection is deemed complete
11. Submit Revised FCR	Within 60 days following USEPA approval of RI DSR
12. Submit Stage IA Cultural Resources Survey Report, including proposal for Stage IB survey activities (if warranted)	In accordance with the schedule provided in the Stage IA Cultural Resources Assessment Work Plan, as approved by USEPA
13. Complete Stage IB Cultural Resources Survey work	In accordance with the schedule provided in the Stage IA Cultural Resources Survey Report, as approved by USEPA, subject to access/weather/seasonal constraints
14. Submit Stage IB Cultural Resources Survey Report	In accordance with the schedule provided in the Stage IA Cultural Resources Survey Report, as approved by USEPA
15. Submit PAR (including Probabilistic Work Plan if proposed)	Within 60 days following USEPA approval of SLA Report or Revised FCR, whichever occurs later
16. Additional Evaluation of Near-Shore Sediment Areas	Within 60 days following USEPA approval of the PAR
17. Submit Phase 1 BHHRA Report	Within 90 days following USEPA approval of the PAR
18. Submit Data Collection Plan (with FSP/QAPP) for Phase 2 BHHRA[2]	Within 60 days following USEPA approval of Phase 1 BHHRA
19. Complete data collection for Phase 2 BHHRA and perform laboratory data validation[2]	In accordance with the schedule provided in the Data Collection Plan for Phase 2 BHHRA, as approved by USEPA, subject to access/weather/seasonal constraints

Activity	Timeframe/Comments[1]
20. Submit DSR for Phase 2 BHHRA Data Collection	Within 45 days following receipt of all validated data from investigations specified in the Data Collection Plan(s) for Phase 2 BHHRA, as approved by USEPA, if Phase 2 BHHRA data collection is deemed complete
21. Submit BERA Work Plan	Within 120 days following USEPA approval of SLERA
22. Submit Phase 1 BERA Data Collection Plan (with FSP/QAPP)[2]	Within 60 days following USEPA approval of BERA Work Plan
23. Complete data collection for Phase 1 BERA and perform laboratory data validation[2]	In accordance with the schedule provided in the Data Collection Plan for BERA, as approved by USEPA, subject to access/weather/seasonal constraints
24. Submit DSR for Phase 1 BERA Data Collection	Within 60 days following receipt of all validated data from investigations specified in the Data Collection Plan(s) for BERA, as approved by USEPA, if BERA data collection is deemed complete
25. Submit Phase 1 BERA Report	Within 120 days following USEPA approval of the final DSR for BERA Data Collection or the Revised FCR, whichever occurs later
26. Submit Supplemental BERA Data Collection Plan (with FSP/QAPP and work plan for field studies if proposed)[2]	Within 60 days following USEPA approval of Phase 1 BERA report
27. Complete supplemental data collection for BERA and perform laboratory data validation as necessary[2]	In accordance with the schedule provided in the Supplemental Data Collection Plan for BERA, as approved by USEPA, subject to access/weather/seasonal constraints
28. Submit DSR for Supplemental BERA Data Collection	In accordance with the schedule provided in the Supplemental Data Collection Plan for BERA, as approved by USEPA, if supplemental BERA data collection is deemed complete
29. Submit Final FCR	Within 60 days following USEPA approval of final DSR for Phase 2 BHHRA Data Collection or final DSR for Supplemental BERA Data Collection, whichever occurs later

Activity	Timeframe/Comments[1]
30. Submit BHHRA Report	Within 90 days following USEPA approval of Final FCR
31. Submit BERA Report	Within 120 days following USEPA approval of Final FCR
32. Submit RI Report	Within 30 days following USEPA approval of the Stage 1B Cultural Resources Survey Report, the BHHRA Report, or the BERA Report, whichever occurs latest
33. Submit RAO/PRG Proposal	Within 60 days following USEPA approval of RI Report
34. Submit FS Screening Report	Within 120 days following USEPA approval of the RAO/PRG Proposal
35. Submit Treatability Study Work Plan (if treatability studies are recommended)	In accordance with the schedule presented in the FS Screening Report, as approved by USEPA
36. Complete treatability studies (if studies are proposed), including preparation and submittal of Treatability Study Evaluation Report to USEPA	In accordance with the schedule presented in the Treatability Study Work Plan, as approved by USEPA
37. Submit FS Report	Within 180 days following USEPA approval of the Treatability Study Report or the FS Screening Report, whichever occurs later

Notes:

1. Timeframes presented above are in calendar days and are estimated based upon anticipated level of effort at the time of preparation of this Work Plan. Alternate timeframes may be proposed by GE for review by USEPA.
2. These steps may be repeated more than once in the event that it is determined that additional data are necessary to complete the steps.

BERA – Baseline Ecological Risk Assessment

BHHRA – Baseline Human Health Risk Assessment

DSR – Data Summary Report

FS – Feasibility Study

FSP – Field Sampling Plan

FCR – Floodplain Characterization Report

QAPP – Quality Assurance Project Plan

HASP – Health and Safety Plan

PAR – Pathways Analysis Report

PRG – Preliminary Remediation Goal

RAO – Remedial Action Objective

RI – Remedial Investigation

SLA – Screening Level Assessment

SLERA – Screening Level Ecological Risk Assessment

USEPA – U.S. Environmental Protection Agency

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TABLES

Table 3-1

Selection of Site-Specific Exposure Pathways for Phase 2 - Upper Hudson River Floodplain

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis[a]	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Soil	Surface Soil	Floodplain	Resident 1	Young child: 1 - 6 yrs Older child: 7 - 18 yrs Adult: > 18 yrs	Incidental Ingestion	Quant	Residential 1 scenario assumes that current homes are located in or near the floodplain and any potential future construction also would occur near the floodplain. Both children and adults are potential receptors. Exposures to floodplain soil might occur via incidental ingestion of soil, dermal contact with soil and inhalation of both outdoor and indoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface Soil	Surface Soil	Floodplain	Resident 2	Young child: 1 - 6 yrs Older child: 7 - 18 yrs Adult: > 18 yrs	Incidental Ingestion	Quant	Residential 2 scenario assumes that current homes are far removed from the floodplain and any future construction would also occur well away from the floodplain. Both children and adults are potential receptors. Exposures to floodplain soil might occur via incidental ingestion of soil, dermal contact with soil and inhalation of outdoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface Soil	Surface Soil	Floodplain	Seasonal Resident	Young child: 1 - 6 yrs Older child: 7 - 18 yrs Adult: > 18 yrs	Incidental Ingestion	Quant	Seasonal residential scenario assumes camps or seasonal residences are located in or near the floodplain. Both children and adults are potential receptors. Exposures to floodplain soil might occur via incidental ingestion of soil, dermal contact with soil and inhalation of both indoor and outdoor dust. It is assumed that these exposures are limited to June, July, and August.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface Soil	Surface Soil	Floodplain	Recreational 1	Young child: 1 - 6 yrs Older child: 7 - 18 yrs Adult: > 18 yrs	Incidental Ingestion	Quant	Recreational 1 scenario assumes that adults and children have contact with soil in areas in or near the floodplain that are established recreational areas (e.g., parks, playgrounds). Exposures to soil might occur via incidental ingestion of soil, dermal contact with soil and inhalation of outdoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface Soil	Surface Soil	Floodplain	Recreational 2	Young child: 1 - 6 yrs Older child: 7 - 18 yrs Adult: > 18 yrs	Incidental Ingestion	Quant	Recreational 2 scenario assumes that adults and children might contact soil in areas in or near the floodplain on public land where access is possible, but there is no established recreational area. This scenario is also intended to be inclusive of potential trespassing activities on private land. Potential exposures to soil might occur via incidental ingestion of soil, dermal contact with soil and inhalation of outdoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface Soil	Surface Soil	Floodplain	Recreational 3	Older child: 7 - 18 yrs Adult: > 18 yrs	Incidental Ingestion	Quant	Recreational 3 scenario assumes that adults and older children might have limited contact with soil during recreational or trespassing use in areas of private or public land that are in or near the floodplain, are steep or heavily overgrown and would likely never be established for recreational activities. Exposures to soil might occur via incidental ingestion of soil, dermal contact with soil and inhalation of outdoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface Soil	Surface Soil	Floodplain	School	Child: TBD Adult: > 18 yrs	Incidental Ingestion	Quant	School scenario assumes that adults and children might contact soil in areas in or near the floodplain during the school day and during sporting events. The child age group to be considered for each school will be determined on a site-specific basis. This scenario also considers potential exposures to school maintenance workers who may be involved in work activities in the floodplain. Exposures may occur via ingestion of soil, dermal contact, and
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface Soil	Surface Soil	Floodplain	Commercial/ Industrial 1 (Outdoor Worker)	Adult	Incidental Ingestion	Quant	Commercial/Industrial 1 scenario assumes that an outdoor adult worker might have daily contact with soil in unpaved areas at their work site. Exposures to soil might occur via incidental ingestion of soil, dermal contact with soil and inhalation of outdoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface Soil	Surface Soil	Floodplain	Commercial/ Industrial 2 (Grounds-keeper)	Adult	Incidental Ingestion	Quant	Commercial/Industrial 2 scenario assumes that an adult worker might have intermittent contact with soil in unpaved areas during groundskeeping activities on parcels with limited unpaved areas. Exposures might occur via incidental ingestion of soil, dermal contact with soil and inhalation of outdoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface and Subsurface Soil	Surface and Subsurface Soil	Floodplain	Utility Worker	Adult	Incidental Ingestion	Quant	Utility worker scenario assumes that an adult worker might have contact with soil in utility corridor areas located in or near the floodplain . For this scenario, surface and subsurface soils are evaluated. Potential exposures might occur via incidental ingestion of soil, dermal contact with soil and inhalation of outdoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	

Table 3-1
Selection of Site-Specific Exposure Pathways for Phase 2 - Upper Hudson River Floodplain

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis[a]	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface and Subsurface Soil	Surface and Subsurface Soil	Floodplain	Construction Worker	Adult	Incidental Ingestion	Quant	Construction worker scenario assumes that an adult worker might have contact with surface and subsurface soil in areas located in or near the floodplain where construction might be allowed. Potential exposures might occur via incidental ingestion of soil, dermal contact with soil and inhalation of outdoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Quant	
Current/Future	Surface Soil	Surface Soil	Floodplain	Agriculture	Young child: 1 - 6 yrs Older child: 7 - 18 yrs Adult: > 18 yrs	Incidental Ingestion	Quant	Agricultural scenario assumes that a farm family home is located in or near the floodplain. Both children and adults are potential receptors. Exposures to floodplain soil might occur via incidental ingestion of soil, dermal contact with soil and inhalation of both outdoor and indoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Qual	
Current/Future	Surface Soil	Home grown crops	Floodplain	Agriculture	Young child: 1 - 6 yrs Older child: 7 - 18 yrs Adult: > 18 yrs	Consumption of Home-grown Food	Quant	Agricultural scenario assumes that adults and children living on an agricultural property may consume crops or livestock-derived products grown in soil in or near the floodplain. Specific crops grown on each parcel will be considered individually.
Current/Future	Surface Soil	Soil	Floodplain	Agricultural Worker	Adult	Incidental Ingestion	Quant	Agricultural worker scenario assumes that adult farm workers might have direct contact with soil in areas located in or near the floodplain during farming activities. Potential exposures might occur via incidental ingestion of soil, dermal contact with soil and inhalation of outdoor dust.
						Dermal Contact	Quant	
						Inhalation of Dust	Quant	
Current/Future	Surface Soil	Home grown crops	Floodplain	Residential	Young child: 1 - 6 yrs Older child: 7 - 18 yrs Adult: > 18 yrs	Consumption of Home-grown Food	Quant	Residential garden scenario assumes that adults and children might consume crops grown in backyard garden soil in or near the floodplain.

Notes:
Quant = quantitative assessment
Qual = qualitative assessment
TBD = to be determined on a site-specific basis

Table 3-2
Presentation Table for Parcel Specific Risk Estimates

Parcel Identification				Screening Evaluation		Phase 1 BHHRA										Phase 2 BHHRA											
Unique Identifier	Tax Parcel ID	Reach	Mainland or Island	Max. PCB level used (mg/kg)	Exceeds Default Residential Screening Conc. of 0.24 mg/kg?	Number of EAs Evaluated	Current Use Category	Future Use Category	Phase I Use(s) Evaluated[a]	Basis for Uses Evaluated	Phase 1 EPC (mg/kg)	Phase 1 Lifetime Cancer Risk	Phase 1 Non-cancer Hazard Index	Risk or HI exceeds bench-mark for Phase 1?	Figure No.	Scenario Evaluated[b]	Min. PCB conc. (mg/kg)	Max. PCB Conc. (mg/kg)	Mean PCB Conc. (mg/kg)	95th UCL PCB Conc. (mg/kg)	Phase 2 EPC (mg/kg)	Basis for Phase 2 EPC	Refined Estimated Lifetime Cancer Risk	Refined Estimated Non-cancer Hazard Index	Future Construction	Future Utility	Future Garden
FPP-PRO-XXXX	105.-X-X	8	Mainland	0.55	Yes	1	Agricultural	Agricultural	Agriculture	Current and future use	0.39	1E-06	0.6	Yes	1	Agriculture											
FPP-PRO-XXXX	144.-X-X	6	Mainland	0.04	No	NE	NE	NE	NE	NE	NE	NE	NE	NE	2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
FPP-PRO-XXXX	171.-X-X	8	Mainland	2.6	Yes	1	Commercial	Commercial	Commercial	Current and future use	2.3	3E-07	0.1	No	3	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
									Construction	Potential future use	0.3	1E-08	0.6														
FPP-PRO-XXXX	171.-X-X	8	Island	9.79	Yes	1	Residential	Residential	Residential	Current and future use	5.6	3E-06	0.7	Yes	4	Res 1											
									Construction	Potential future use	0.6	1E-08	1														
FPP-PRO-XXXX	171.-X-X	8	Mainland	124	Yes	1	Recreational	Recreational	Recreation	City park	89	4E-05	4	Yes	5	Rec 1											
									Construction	Potential future use	4	4E-08	5														
FPP-PRO-XXXX	179.-X-X	8	Island	15	Yes	2	Recreational/ Residential	Residential	Residential	Residential has highest potential for exposure	4.2	2E-05	2	Yes	6	Res 2											
FPP-PRO-XXXX	64.-X-X	8	Mainland	4.0	Yes	2	Utility	Utility	Construction	Two potential EAs. Recreational use is less frequent but has potential for exposure to young children.	0.4	1E-08	3	No	7	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
									Commercial		1.6	2E-07	0.2														
									Construction		0.2	1E-08	0.8														
							Recreational	Recreational	Recreation	Construction is potential future use	1.6	7E-07	0.6	No	7	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
									Construction		0.1	1E-08	0.9														
FPP-PRO-XXXX	65.-X-X	8	Mainland	0.65	Yes	1	Seasonal Residential	Seasonal Residential	Recreation	State-owned land. Permit restricts other usage and development.	0.41	2E-07	0.03	No	8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
FPP-PRO-XXXX	79.-X-X	8	Mainland	7.6	Yes	1	Seasonal Residential	Residential	Residential	Private ownership	3.4	2E-06	0.2	Yes	9	Res 1											
									Construction		0.9	1E-08	0.7														
FPP-PRO-XXXX	79.-X-X	8	Mainland	0.01	No	NE	NE	NE	NE	NE	NE	NE	NE	NE	10	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Notes:

[a] Exposure assumptions for the Phase Residential, Recreational, Commercial, Agricultural Worker and Construction Worker scenarios are provided in Tables A, B, C, D and E, respectively.

[b] Exposure assumptions for the Phase 2 scenarios are provided in Tables A through X.

BHHRA = Baseline Human Health Risk Assessment

EPC = Exposure Point Concentration

mg/kg = milligrams per kilogram

NE = Not evaluated

PCB = polychlorinated biphenyl

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
TERRESTRIAL RECEPTORS							
Terrestrial Community Receptors							
Terrestrial Plants (S,G)	Local Community	Protection of terrestrial plants from adverse effects on survival and growth associated with exposure to PCBs within UHR floodplain soil.	All terrestrial plants	1. Are PCB levels in soil from the UHR floodplain greater than or equal to benchmarks for the survival or growth of terrestrial plants?	1. PCB concentrations in soil and associated physical/chemical measurements.	Yes	Benchmark comparisons are an adequate level of analysis for terrestrial plants, which are less sensitive to PCBs than wildlife. This assessment endpoint is likely to screen out in the SLERA, except perhaps in isolated areas. Provided that risk estimates for wildlife are demonstrated to be protective of terrestrial plants, additional evaluation of terrestrial plants beyond the SLERA may not be necessary.
				2. Is there field evidence of adverse impacts to terrestrial plants in the UHR floodplain compared with reference areas?	2. Qualitative or quantitative observations of plant community composition, biomass, or other applicable attributes.	No, but…	This information will be collected as part of the habitat assessment work to assist with habitat identification. It would be helpful if this information were collected as part of the RI to help understand wildlife use of terrestrial habitats in the floodplain.
				3. Is survival or growth of terrestrial plants exposed to soil from the UHR floodplain significantly lower than in reference area soils?	3. Survival or growth of laboratory-reared terrestrial plants in laboratory toxicity tests with site and reference area soil. Would require matching chemistry and toxicity samples.	No	Not needed given the low sensitivity of plants to PCBs compared with wildlife. Because risks to terrestrial plants are not expected to drive EPA risk-management decisions at the site, rigorous evaluation using multiple lines of evidence is considered unnecessary for this assessment endpoint.
Terrestrial Invertebrates (S,G,R)	Local Community	Protection of terrestrial invertebrates from adverse effects on survival, growth, and reproduction associated with exposure to PCBs within UHR floodplain soil.	All terrestrial invertebrates	1. Are PCB levels in soil from the UHR floodplain greater than or equal to benchmarks for the survival, growth, or reproduction of terrestrial invertebrates?	1. PCB concentrations in soil and associated physical/chemical measurements.	Yes	Benchmark comparisons are an adequate level of analysis for terrestrial invertebrates, which are less sensitive to PCBs than wildlife. This assessment endpoint is likely to screen out in the SLERA, except perhaps in isolated areas. Provided that risk estimates for wildlife are demonstrated to be protective of terrestrial invertebrates, additional evaluation of terrestrial invertebrates beyond the SLERA may not be necessary.
				2. Are PCB levels in terrestrial-invertebrate tissues (whole-body) from the UHR floodplain greater than or equal to critical tissues residues for survival, growth, or reproduction of terrestrial invertebrates?	2. Measured or modeled PCB concentrations in terrestrial-invertebrate tissues (whole body) and associated variables.	No, but...	This measure is considered unnecessary for assessment of the terrestrial invertebrate AE, but is needed as input for food web models with invertivorous wildlife. Note that this risk question/measure for the terrestrial invertebrate AE can be dropped as this measure will be considered under the Candidate Measures for terrestrial invertivorous wildlife receptors.
				3. Is survival, growth, or reproduction of terrestrial invertebrates exposed to soil from the UHR floodplain significantly lower than in reference area soils?	3. Survival, growth, and/or reproduction of laboratory-reared terrestrial invertebrates (e.g., *Eisenia foetida*) in laboratory toxicity tests with site and reference area soil or floodplain PCB mix. Would require matching chemistry and toxicity samples.	No	Not needed given the low sensitivity of terrestrial invertebrates to PCBs compared with wildlife. Because risks to terrestrial invertebrates are not expected to drive EPA risk-management decisions, rigorous evaluation using multiple lines of evidence is considered unnecessary for this assessment endpoint.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
Terrestrial Herptiles							
Amphibians (S,G,R)	Local Population	Protection of terrestrial amphibians from adverse effects on survival and growth, and reproduction associated with exposure to PCBs within UHR floodplain soil.	Wood Frog (Adult), Salamander. Toad	1. Are PCB levels in soil from the UHR floodplain greater than or equal to benchmarks for the survival, growth, or reproduction of amphibians?	1. PCB concentrations in soil and associated physical/chemical measurements.	Yes	Soil-based benchmarks for amphibians are lacking. Qualitative narrative assessment only is expected in SLERA. Discuss in SLERA uncertainty section. Risks to amphibians in general should focus on surface water, sediment, and/or tissue-based exposure pathways for aquatic egg and/or larval life stages. Risk estimates for wildlife are expected to be protective of terrestrial-phase amphibians; this is, however, an uncertainty. Not needed for BERA, but BERA should refer to SLERA regarding rationale for not quantitatively evaluating this AE in the BERA.
				2. Are PCB levels in amphibian tissues (whole-body, egg, or other tissues) from the UHR floodplain greater than or equal to tissue screening benchmarks for the survival, growth, or reproduction of amphibians?	2. Measured or modeled PCB concentrations in amphibian tissues (whole-body) and associated variables. Existing adult frog and other amphibian tissue data for the site should be used if available and of acceptable quality, and if they reflect floodplain exposure.	No, but…	This measure is considered unnecessary for assessment of the adult amphibian AE (given lack of receptor-specific tissue toxicity thresholds), but is needed as input for food web models for wildlife that prey on amphibians. New data may need to be collected for the BERA if existing site-specific amphibian tissue data are inadequate or modeled data are too uncertain. Note that this risk question/measure for the terrestrial amphibian AE can be dropped as this measure will be considered under the Candidate Measures for wildlife receptors that prey on amphibians.
				3. Is survival, growth, or reproduction of amphibians exposed to soil from the UHR floodplain significantly lower than in reference area soils?	3. Survival, growth, and/or reproduction of laboratory-reared amphibians in laboratory toxicity tests with site and reference area soil or floodplain PCB mix. Would require matching chemistry and toxicity samples.	No	Risks to amphibians in general should focus on surface water, sediment, and tissue-based exposure pathways. However, not recommending any site-specific bioassays at this time.
Reptiles (S,G,R)	Local Population	Protection of reptiles from adverse effects on survival, growth, and reproduction associated with exposure to PCBs within UHR floodplain soil.	Garter Snake, Box Turtle	1. Are PCB levels in soil from the UHR floodplain greater than or equal to benchmarks for the survival, growth, or reproduction of reptiles?	1. PCB concentrations in soil and associated physical/chemical measurements.	Yes	Soil-based benchmarks for reptiles are lacking. Qualitative narrative assessment only is expected in SLERA. Discuss in SLERA uncertainty section. Risk estimates for wildlife are expected to be protective of terrestrial reptiles; this is, however, an uncertainty. Not needed for BERA, but BERA should refer to SLERA regarding rationale for not quantitatively evaluating this AE in the BERA.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
				2. Are PCB levels in reptile tissues (whole-body) from the UHR floodplain greater than or equal to tissue screening benchmarks for the survival, growth, or reproduction of reptiles?	2. Measured or modeled PCB concentrations in reptile tissues (whole body) and associated variables. Existing turtle and other reptile data for the site should be used if available and of acceptable quality, and if they reflect floodplain exposure.	No, but…	This measure is considered unnecessary for assessment of the terrestrial reptile AE (given lack of receptor-specific tissue toxicity thresholds), but is needed as input for food web models for wildlife that prey on reptiles. New data may need to be collected for the BERA if existing site-specific reptile data are inadequate and modeled data are too uncertain. Note that this risk question/measure for the terrestrial reptile AE can be dropped as this measure will be considered under the Candidate Measures for wildlife receptors that prey on terrestrial reptiles.
				3. Is survival, growth, or reproduction of reptiles exposed to soil from the UHR floodplain significantly lower than in reference area soils?	3. Survival, growth, and/or reproduction of laboratory-reared reptiles in laboratory toxicity tests with site and reference area soil or floodplain PCB mix. Would require matching chemistry and toxicity samples.	No	Not recommending any site-specific bioassays.
Terrestrial Avian Receptors							
Herbivorous Birds (S,R)	Local Population	Protection of herbivorous birds from adverse effects on survival and reproduction associated with exposure to PCBs within UHR floodplain soil.	Sparrow, Canada Goose	1. Does the daily dose of PCBs received by herbivorous birds from ingestion of plants, soil, and water in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in soil, water, and food items and associated measurements. This may require modeled estimates or measured data on PCB levels in an array of plant tissues, including, for example, seeds, fruit, and foliage.	Yes	This risk question and measure are needed to evaluate potential risks to herbivorous terrestrial birds. Number of model species included in BERA may be reduced based on SLERA results.
				2. Do PCB concentrations in eggs of herbivorous birds in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled concentrations of PCBs in eggs and associated measurements. Use existing egg data for taxonomically and trophically similar species, as available. Utility of this measure depends on availability of a suitable egg TRV and quality and quantity of site-specific egg data for herbivorous birds.	Yes	This risk question and measure are a second line of evidence to evaluate potential risks to herbivorous terrestrial birds.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
Omnivorous Birds (S,R)	Local Population	Protection of omnivorous birds from adverse effects on survival and reproduction associated with exposure to PCBs within UHR floodplain soil.	American Robin, Catbird	1. Does the daily dose of PCBs received by omnivorous birds from ingestion of prey, soil, and water in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in soil, water, and food items and associated measurements. This may require modeled estimates or measured data on PCB levels in representative food items including, for example, earthworms and berries.	Yes	This risk question and measure are needed to evaluate potential risks to omnivorous terrestrial birds. Number of model species included in BERA may be reduced based on SLERA results.
				2. Do PCB concentrations in eggs of omnivorous birds in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled concentrations of PCBs in eggs and associated measurements. Use existing egg data for taxonomically and trophically similar species, as available. Utility of this measure depends on availability of a suitable egg TRV and quality and quantity of site-specific egg data for omnivorous birds.	Yes	This risk question and measure are a second line of evidence to evaluate potential risks to omnivorous terrestrial birds.
Insectivorous Birds (S,R)	Local Population	Protection of insectivorous birds from adverse effects on survival and reproduction associated with exposure to PCBs within UHR floodplain soil.	Wren	1. Does the daily dose of PCBs received by insectivorous birds from consumption of prey, soil, and water in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in soil, water, and food items and associated measurements. This may require modeled estimates or measured data on PCB levels in representative food items including, for example, terrestrial insects and spiders.	Yes	This risk question and measure are needed to evaluate potential risks to insectivorous terrestrial birds.
				2. Do PCB concentrations in eggs of insectivorous birds in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled concentrations of PCBs in eggs and associated measurements. Use existing egg data for taxonomically and trophically similar species, as available. Utility of this measure depends on availability of a suitable egg TRV and quality and quantity of site-specific egg data for insectivorous birds.	Yes	This risk question and measure are a second line of evidence to evaluate potential risks to insectivorous terrestrial birds.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
Ground-feeding Invertivorous Birds (S,R)	Local Population	Protection of ground-feeding invertivorous birds from adverse effects on survival and reproduction associated with exposure to PCBs within UHR floodplain soil.	Woodcock	1. Does the daily dose of PCBs received by ground feeding invertivorous birds from consumption of prey, soil, and water in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in soil, water, and prey and associated measurements. This may require modeled estimates or measured data on PCB levels in representative prey items including, for example, earthworms and other soil-dwelling invertebrates.	Yes	This risk question and measure are needed to evaluate potential risks to ground-feeding invertivorous birds.
				2. Do PCB concentrations in eggs of ground-feeding insectivorous birds in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled concentrations of PCBs in eggs and associated measurements. Use existing egg data for taxonomically and trophically similar species, as available. Utility of this measure depends on availability of a suitable egg TRV and quality and quantity of site-specific egg data for ground-feeding invertivorous birds.	Yes	This risk question and measure are a second line of evidence to evaluate potential risks to ground-feeding invertivorous birds.
Carnivorous Birds (S,R)	Local Population	Protection of carnivorous birds from adverse effects on survival and reproduction associated with exposure to PCBs within UHR floodplain soil.	Red-tailed Hawk	1. Does the daily dose of PCBs received by carnivorous birds from consumption of prey, soil, and water in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in soil, water, and prey and associated measurements. This may require modeled estimates or measured data on PCB levels in representative prey items including, for example, small mammals, birds, and snakes.	Yes	This risk question and measure are needed to evaluate potential risks to carnivorous birds.
				2. Do PCB concentrations in eggs of carnivorous birds in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled concentrations of PCBs in eggs and associated measurements. Use existing egg data for taxonomically and trophically similar species, as available. Utility of this measure depends on availability of a suitable egg TRV and quality and quantity of site-specific egg data for carnivorous birds.	Yes	This risk question and measure are a second line of evidence to evaluate potential risks to carnivorous birds.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
Terrestrial Mammalian Receptors							
Herbivorous Mammals (S,R)	Local Population	Protection of herbivorous mammals from adverse effects on survival and reproduction associated with exposure to PCBs within UHR floodplain soil.	Meadow Vole	1. Does the daily dose of PCBs received by herbivorous mammals from consumption of plants, soil, and water in the UHR floodplain equal or exceed TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in soil, water, and food items and associated measurements. This may require modeled estimates or measured data on PCB levels in an array of plant tissues, including, for example, seeds, fruit, and foliage.	Yes	This risk question and measure are needed to evaluate potential risks to herbivorous terrestrial mammals.
				2. Do PCB levels in tissues of herbivorous mammals in the UHR floodplain equal or exceed tissue-based TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled whole-body PCB concentrations and associated measurements. Existing vole and other herbivorous small mammal data for the site should be used if available and of acceptable quality.	No, but…	This measure is considered unnecessary for assessment of the herbivorous mammal AE, but is needed as input for food web models for wildlife that prey on small mammals. New data may need to be collected for the BERA if existing site-specific tissue data for herbivorous small mammals are inadequate. Note that this risk question/measure for the herbivorous mammal AE can be dropped as this measure will be considered under the Candidate Measures for wildlife receptors that prey on small mammals.
Omnivorous Mammals (S,R)	Local Population	Protection of omnivorous mammals from adverse effects on survival and reproduction associated with exposure to PCBs within UHR floodplain soil.	Deer Mouse	1. Does the daily dose of PCBs received by omnivorous mammals from consumption of food, soil, and water in the UHR floodplain equal or exceed TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB concentrations in soil, water, and food items and associated measurements. This may require modeled estimates or measured data on PCB levels in representative food items, such as seeds, terrestrial insects, and earthworms.	Yes	This risk question and measure are needed to evaluate potential risks to omnivorous terrestrial mammals.
				2. Do PCBs levels in tissues of omnivorous mammals in the UHR floodplain equal or exceed tissue-based TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled whole-body PCB concentrations and associated measurements. Existing mouse or other omnivorous small mammal data for the site should be used if available and of acceptable quality.	No, but…	This measure is considered unnecessary for assessment of the omnivorous mammal AE, but is needed as input for food web models for wildlife that prey on small mammals. New data may need to be collected for the BERA if existing site-specific tissue data for omnivorous small mammals are inadequate. Note that this risk question/measure for the omnivorous mammal AE can be dropped as this measure will be considered under the Candidate Measures for wildlife receptors that prey on small mammals.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
Insectivorous/ Invertivorous Mammals (S,R)	Local Population	Protection of insectivorous/ invertivorous mammals from adverse effects on survival and reproduction associated with exposure to PCBs in UHR floodplain soil.	Short-tailed Shrew	1. Does the daily dose of PCBs received by insectivorous/ invertivorous mammals from consumption of prey, soil, and water in the UHR floodplain equal or exceed TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in soil, water and food items and associated measurements. This may require modeled estimates or measured data on PCB levels in representative food items, such as earthworms, insects, and other soil invertebrates.	Yes	This risk question and measure are needed to evaluate potential risks to invertivorous terrestrial mammals.
				2. Do PCB concentrations in tissues of insectivorous/invertivorous mammals in the UHR floodplain equal or exceed tissue-based TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled whole-body PCBs concentrations and associated measurements. Existing shrew data for the site should be used if available and of acceptable quality.	No	This measure is considered unnecessary for assessment of the insectivorous mammal AE. Further, although small mammal tissue data are needed to support the assessment of risks to wildlife receptors at higher trophic levels, prey generally consist of the more abundant herbivore and omnivore small mammals. Insectivores are less abundant and less often prey.
Carnivorous Mammals (S,R)	Local Population	Protection of carnivorous mammals from adverse effects on survival and reproduction associated with exposure to PCBs within UHR floodplain soil.	Mink	1. Does the daily dose of PCBs received by carnivorous mammals from consumption of prey, soil, and water in the UHR floodplain equal or exceed TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in soil, water, and food items and associated measurements. This may require modeled estimates or measured data on PCB levels in representative prey items, such as small mammals, amphibians, and snakes.	Yes	This risk question and measure are needed to evaluate potential risks to carnivorous mammals.
				2. Do PCB concentrations in tissues of carnivorous mammals in the UHR floodplain equal or exceed tissue-based TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled liver or other tissue PCBs concentrations and associated measurements.	No	Not recommending collection of mink tissue data.

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Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
AQUATIC RECEPTORS							
Aquatic Communities							
Aquatic Plants (S,G)	Local Community	Protection of aquatic plants from adverse effects on survival and growth associated with exposure to PCBs in aquatic areas of the UHR floodplain.	All Aquatic Plants	1. Are PCB levels in sediment and water from aquatic areas of UHR floodplain greater than or equal to ecologically based sediment and surface water benchmarks for the survival or growth of aquatic plants?	1. Measured or modeled PCB concentrations in sediment and surface water and associated physical/chemical measurements.	Yes	Benchmark comparisons are an adequate level of analysis for aquatic plants, which are less sensitive to PCBs than wildlife. This assessment endpoint is likely to screen out in the SLERA, except perhaps in isolated areas. Provided that risk estimates for wildlife are demonstrated to be protective of aquatic plants, additional evaluation of aquatic plants beyond the SLERA may not be necessary. Using soil screening levels to evaluate potential risks to aquatic plants from chemicals in sediment includes an acknowledged, but unknown, level of uncertainty.
				2. Is there field evidence of adverse impacts to aquatic plants in the UHR floodplain compared with reference areas?	2. Qualitative or quantitative observations of aquatic plant community composition, biomass, or other applicable attributes. Use existing qualitative or quantitative information as a supporting line of evidence.	Yes, but…	This information may be collected as part of the habitat assessment work to inform remedy design. However, it would be helpful if the data were collected during the RI so that it would be available for the BERA for two reasons: (1) to help understand wildlife use of aquatic habitats in the floodplain; and (2) as a qualitative measure of impacts to aquatic plants.
				3. Is survival or growth of aquatic plants in aquatic habitats in the UHR floodplain significantly lower than in reference areas?	3. Survival or growth of laboratory-reared aquatic plants in laboratory toxicity tests with site and reference area surface water. Would require matching chemistry and toxicity samples.	No	Not needed given the low sensitivity of aquatic plants to PCBs compared with wildlife. Because risks to aquatic plants are not expected to drive EPA risk-management decisions at the site, rigorous evaluation using multiple lines of evidence is considered unnecessary for this assessment endpoint**.**
Benthic Macroinvertebrates (S,G,R)	Local Community	Protection of benthic macroinvertebrates from adverse effects on survival, growth, and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Benthic Macro-invertebrates	1. Are PCB levels in sediment and water from aquatic areas of the UHR floodplain greater than or equal to ecologically based sediment and surface water benchmarks for the survival, growth, or reproduction of benthic macroinvertebrates?	1. Measured or modeled PCB concentrations in sediment and surface water and associated physical/chemical measurements.	Yes	Benchmark comparisons are an adequate level of analysis for benthic macroinvertebrates, which are much less sensitive to PCBs than wildlife. This assessment endpoint is likely to screen out in the SLERA, except perhaps in isolated areas. Provided that risk estimates for wildlife are demonstrated to be protective of benthic macroinvertebrates, additional evaluation of benthic macroinvertebrates beyond the SLERA may not be necessary.
				2. Is there field evidence of adverse impacts to benthic macroinvertebrates in the UHR floodplain compared with reference areas?	2. Qualitative or quantitative observations of benthic macroinvertebrate composition, biomass, or other applicable attributes.	No	Not needed given the low sensitivity of benthic macroinvertebrates to PCBs compared with wildlife.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
				3. Is survival, growth, or reproduction of benthic macroinvertebrates exposed to UHR floodplain significantly lower than in reference area sediment?	3. Survival, growth, and/or reproduction of laboratory-reared benthic macroinvertebrates in laboratory toxicity tests with site and reference area sediment. Would require matching chemistry and toxicity samples.	No	Not needed given the low sensitivity of benthic macroinvertebrates to PCBs compared with wildlife. Because risks to benthic macroinvertebrates are not expected to drive EPA risk-management decisions, rigorous evaluation using multiple lines of evidence is considered unnecessary for this assessment endpoint.
				4. Are PCB levels in benthic macroinvertebrate tissues (whole-body) from aquatic habitats in the UHR floodplain greater than or equal to critical tissues residues for survival, growth, or reproduction of benthic macroinvertebrates?	4. Measured or modeled PCB concentrations in benthic macroinvertebrate tissues (whole body) and associated variables.	No, but …	This measure is considered unnecessary for assessment of the benthic invertebrate AE, but is needed as input for food web models with invertivorous wildlife. Note that this risk question/measure for the benthic macroinvertebrate AE can be dropped as this measure will be considered under the Candidate Measures for aquatic invertivorous wildlife receptors.
Fish (S,G,R)	Local Community	Protection of fish from adverse effects on survival, growth, and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Community present in habitat	1. Are PCB levels in surface water, sediment, or prey items from aquatic areas of the UHR floodplain that represent suitable fish habitat greater than or equal to ecologically relevant surface water, sediment, or prey item screening benchmarks for survival, growth, or reproduction of fish?	1. Measured or modeled PCB concentrations in surface water, sediment, or prey items.	Yes	Compare PCB concentrations in water, sediment, or prey with ecologically based water, sediment, or prey-tissue screening benchmarks, respectively.
				2. Are PCB levels in fish tissue (whole-body, liver, etc.) from aquatic areas of the UHR floodplain that represent suitable fish habitat greater than or equal to tissue-based TRVs for the survival, growth, or reproduction of fish?	2. Measured or modeled PCB concentrations in fish (whole-body, liver, etc.) samples and associated parameters.	Yes	Needed as input for wildlife food-web models. Also can be used to assess potential risks to fish. Tissue-based TRVs for PCBs for effects on fish are available.
				3. Is survival, growth, or reproduction of fish in aquatic habitats in the UHR floodplain that represent suitable fish habitat significantly lower than in reference areas?	3. Survival, growth, and/or reproduction of laboratory-reared fish in laboratory toxicity tests with site and reference area surface water. Would require matching chemistry and toxicity samples.	No	Not recommending any site-specific bioassays for fish.
Aquatic Herptiles							
Aquatic Amphibians (S,G,R)	Local Population	Protection of amphibians from adverse effects on survival, growth, and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Wood Frog (Larval/ Embryo), Bullfrog/Green Frog (Larval/ Embryo/ Adult),	1. Are PCB levels in sediment and surface water from aquatic areas of the UHR floodplain greater than or equal to benchmarks for the survival, growth, or reproduction of amphibians?	1. Measured or modeled PCB concentrations in surface water and sediment from aquatic areas and associated physical/chemical measurements.	Yes	Compare water PCB concentrations with ecologically based water quality benchmarks. Also amphibian-specific water or sediment effect levels may be available from published sources. Number of model species included in BERA may be reduced based on SLERA results.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
			Salamander (Larval/ Embryo/Adult)	2. Are PCB levels in amphibian tissues (e.g., whole-body, eggs) from aquatic areas in the UHR floodplain greater than or equal to tissue screening benchmarks for the survival, growth, or reproduction of amphibians?	2. Measured or modeled PCB concentrations in amphibian tissues (e.g., whole body, eggs) and associated variables. Existing amphibian data for the site should be used if available and of acceptable quality, and if suitable TRV(s) are available.	Yes	Needed as input for food-web models for wildlife receptors that prey on amphibians and perhaps also to evaluate impacts to amphibians. Amphibian tissue concentration data are available from bioassays conducted for the Housatonic BERA. Those data may be useful for establishing a tissue-based TRV for amphibians, but the Housatonic tissue-based TRV would need to be adjusted for the different potency of PCBs between the Hudson and Housatonic sites.
				3. Is survival, growth, or reproduction of amphibians exposed to sediment and surface water in aquatic areas of the UHR floodplain significantly lower than in reference areas?	3. Survival, growth, and/or reproduction of laboratory-reared amphibians in laboratory toxicity tests with site and reference area sediment and water. Would require matching chemistry and toxicity samples.	No	Not recommending any site-specific bioassays at this time.
Aquatic Reptiles (S,G,R)	Local Population	Protection of reptiles from adverse effects on survival, growth, and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Snapping Turtle, Northern Water Snake	1. Are PCB levels in sediment and surface water in aquatic areas of the UHR floodplain greater than or equal to benchmarks for survival, growth, or reproduction of reptiles?	1. Measured or modeled PCB concentrations in surface water and sediment from aquatic areas and associated physical/chemical measurements.	Yes	Qualitative narrative assessment only expected in SLERA. Discuss in BERA uncertainty section, if needed. Number of model species included in BERA may be reduced based on SLERA results.
				2. Are PCB levels in reptile tissues (e.g., eggs, whole-body, etc.) from aquatic areas in the UHR floodplain greater than or equal to tissue screening benchmarks for the survival, growth, or reproduction of reptiles?	2. Measured or modeled PCB concentrations in reptile tissues (e.g., egg, whole body, etc.) and associated variables. Existing snapping turtle egg data and other reptile tissue data should be used if they are of acceptable quality and if suitable TRV(s) are available.	Yes	This measure is needed to evaluate risks to reptiles (i.e., snapping turtle) and may also be useful as input for food web models for wildlife that prey on reptiles.
				3. Is survival, growth, or reproduction of reptiles exposed to sediment and surface water in aquatic areas of the UHR floodplain significantly lower than in reference areas?	3. Survival, growth, and/or reproduction of laboratory-reared reptiles in laboratory toxicity tests with site and reference area sediment and water. Would require matching chemistry and toxicity samples.	No	Not recommending any site-specific bioassays.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
Aquatic Avian Receptors							
Aquatic Herbivorous Birds (S,R)	Local Population	Protection of aquatic herbivorous birds from adverse effects on survival and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Mallard, Wood Duck	1. Does the daily dose of PCBs received by aquatic herbivorous birds from ingestion of plants, sediment, and water from aquatic areas in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in sediment, water, and food items and associated measurements. This may require modeled estimates or measured data on PCB levels in representative aquatic plant tissues consumed by waterfowl.	Yes	This risk question and measure are needed to evaluate potential risks to aquatic herbivorous birds. Number of model species included in BERA may be reduced based on SLERA results.
				2. Do PCB concentrations in eggs of aquatic herbivorous birds from aquatic areas in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled concentrations of PCBs in eggs and associated measurements. Use existing egg data for taxonomically and trophically similar species as available. Utility of this measure depends on availability of a suitable egg TRV and quality and quantity of site-specific egg data for herbivorous birds.	Yes	This risk question and measure are a second line of evidence to evaluate potential risks to aquatic herbivorous birds.
Sediment Probing Birds (S,R)	Local Population	Protection of sediment probing birds from adverse effects on survival and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Sandpiper	1. Does the daily dose of PCBs received by sediment-probing birds from ingestion of prey, sediment, and water from aquatic areas in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in sediment, water, and food items and associated measurements. This may require modeled estimates or measured data on PCB concentrations in representative prey items, such as amphipods and aquatic insect larvae.	Yes	This risk question and measure are needed to evaluate potential risks to sediment-probing birds.
				2. Do PCB concentrations in eggs of sediment-probing birds from aquatic areas in the UHR floodplain exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled concentrations of PCBs and associated measurements. Use existing egg data for taxonomically and trophically similar species, as available. Utility of this measure depends on availability of a suitable egg TRV and quality and quantity of site-specific egg data for sediment-probing birds.	Yes	This risk question and measure are a second line of evidence to evaluate potential risks to sediment-probing birds.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
Insectivorous Birds (S,R)	Local Population	Protection of insectivorous birds from adverse effects on survival and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Marsh Wren	1. Does the daily dose of PCBs received by insectivorous birds from ingestion of prey, sediment, and water from aquatic areas in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in sediment, water, and prey and associated measurements. This may require modeled estimates or measured data on PCB concentrations in representative prey items of insectivorous birds, including aquatic invertebrates, other insects, and spiders.	Yes	This risk question and measure are needed to evaluate potential risks to insectivorous aquatic birds.
				2. Do PCB concentrations in eggs of insectivorous birds from aquatic areas in the UHR floodplain exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled concentrations of PCBs in eggs and associated measurements. Use existing egg data for taxonomically and trophically similar species, as available. Utility of this measure depends on availability of a suitable egg TRV and quality and quantity of site-specific egg data for insectivorous birds.	Yes	This risk question and measure are a second line of evidence to evaluate potential risks to insectivorous aquatic birds.
Piscivorous Birds (S,R)	Local Population	Protection of piscivorous birds from adverse effects on survival and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Heron, Kingfisher	1. Does the daily dose of PCBs received by piscivorous birds from ingestion of prey, sediment, and water from aquatic areas in the UHR floodplain equal or exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in sediment, water, and prey and associated measurements. This may require modeled estimates or measured data on PCB concentrations in representative forage fish from aquatic areas.	Yes	This risk question and measure are needed to evaluate potential risks to piscivorous birds. Number of model species included in BERA may be reduced based on SLERA results.
				2. Do PCB concentrations in eggs of piscivorous birds from aquatic areas in the UHR floodplain exceed TRVs for survival or reproduction of birds? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled concentrations of PCBs and associated measurements. Use existing egg data for taxonomically and trophically similar species, as available. Utility of this measure depends on availability of a suitable egg TRV and quality and quantity of site-specific egg data for piscivorous birds.	Yes	This risk question and measure are a second line of evidence to evaluate potential risks to piscivorous birds.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
Aquatic Mammalian Receptors							
Herbivorous Mammals (S,R)	Local Population	Protection of herbivorous mammals from adverse effects on survival and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Muskrat	1. Does the daily dose of PCBs received by herbivorous mammals from ingestion of plants, sediment, and water from aquatic areas in the UHR floodplain equal or exceed TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in sediment, water, and aquatic plant tissues and associated measurements. This may require modeled estimates or measured data on PCB levels in representative aquatic plant tissues consumed by the muskrat.	Yes	This risk question and measure are needed to evaluate potential risks to aquatic herbivorous mammals.
				2. Do PCB levels in tissues of herbivorous mammals from aquatic areas in the UHR floodplain equal or exceed tissue-based TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled whole-body and other tissue PCB concentrations and associated measurements. Existing muskrat and other aquatic herbivorous small mammal data from the UHR floodplain should be used if available and of acceptable quality.	No, but…	This measure is considered unnecessary for assessment of the herbivorous mammal AE, but is needed as input for food web models for wildlife that prey on these mammals. New data may need to be collected for the BERA if existing site-specific tissue data are inadequate. Note that this risk question/measure for the herbivorous mammal AE can be dropped as this measure will be considered under the Candidate Measures for wildlife receptors that prey on these mammals.
Omnivorous Mammals (S,R)	Local Population	Protection of omnivorous mammals from adverse effects on survival and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Raccoon	1. Does the daily dose of PCBs received by omnivorous mammals from ingestion of food, sediment, and water from aquatic areas in the UHR floodplain equal or exceed TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in sediment, water, and food items and associated measurements. This would require modeled estimates or measured data on PCB levels in representative aquatic prey species consumed by the raccoon, such as crayfish and amphibians.	Yes	This risk question and measure are needed to evaluate potential risks to omnivorous mammals.
Insectivorous Mammals (S,R)	Local Population	Protection of insectivorous mammals from adverse effects on survival and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Little Brown Bat	1. Does the daily dose of PCBs received by insectivorous mammals from consumption of prey, sediment, and water from aquatic areas in the UHR floodplain equal or exceed TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in sediment, water, and prey and associated measurements. This may require modeled estimates or measured data on PCB levels in representative prey (such as aerial aquatic insects) consumed by bats.	Yes	This risk question and measure are needed to evaluate potential risks to insectivorous mammals.

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments
				2. Do PCB concentrations in tissues (brains) of insectivorous mammals from aquatic areas in the UHR floodplain equal or exceed tissue-based TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	2. Measured or modeled PCB concentrations in the brain and associated measurements. Utility of this measure depends on availability of suitable bat tissue TRVs and quality and quantity of site-specific bat tissue data.	Yes	This risk question and measure are a second line of evidence for insectivorous mammals. Site-specific data on PCB levels in brains of little brown bats and big brown bats are available. Also, a tissue screening concentration for PCBs in brain tissue is available. The available data for the big brown bat probably are more relevant to the floodplain BERA given that this species feeds mostly on terrestrial insects. Not needed for wildlife food web models.
Carnivorous Mammals (S,R)	Local Population	Protection of carnivorous mammals from adverse effects on survival and reproduction associated with exposure to PCBs in aquatic areas of the UHR floodplain.	Mink	1. Does the daily dose of PCBs received by carnivorous mammals from consumption of prey, sediment, and water from aquatic areas in the UHR floodplain equal or exceed TRVs for survival or reproduction of mammals? TRV selection will consider differences in taxonomic classification and PCB sensitivity between the AE model species and laboratory test species.	1. Measured or modeled PCB levels in sediment, water, and prey and associated measurements. This may require modeled estimates or measured data on PCB levels in representative prey species consumed by the mink, such as crayfish, forage fish, amphibians, and muskrats.	Yes	This risk question and measure are needed to evaluate potential risks to carnivorous mammals.

Key:

AE = Assessment endpoint
BERA = Baseline ecological risk assessment
EPA = Environmental Protection Agency (U.S.)
PCBs = Polychlorinated biphenyls
RI/FS = Remedial Investigation / Feasibility Study
SLERA = Screening-level ecological risk assessment
(S,G) = Survival, growth
(S,G,R) = Survival, growth, reproduction
(S,R) = Survival and reproduction
TOC = Total organic carbon
TRV = Toxicity reference value
UHR = Upper Hudson River

Table 4-1. Comprehensive List of Candidate Assessment Endpoints, Risk Questions, and Measures. Hudson River Floodplain Problem Formulation Workshop.

Candidate Assessment Endpoint (AE)	Level of Organization	Candidate Assessment Endpoint Statement	Candidate Model Species	Candidate Risk Question	Candidate Measures[a, b, c]	Retain for Problem Formulation[d]	Rationale / Comments

Notes:

[a] Site and reference area data may be needed for some sample media (biological tissues, floodplain soil, aquatic sediment, and surface water).

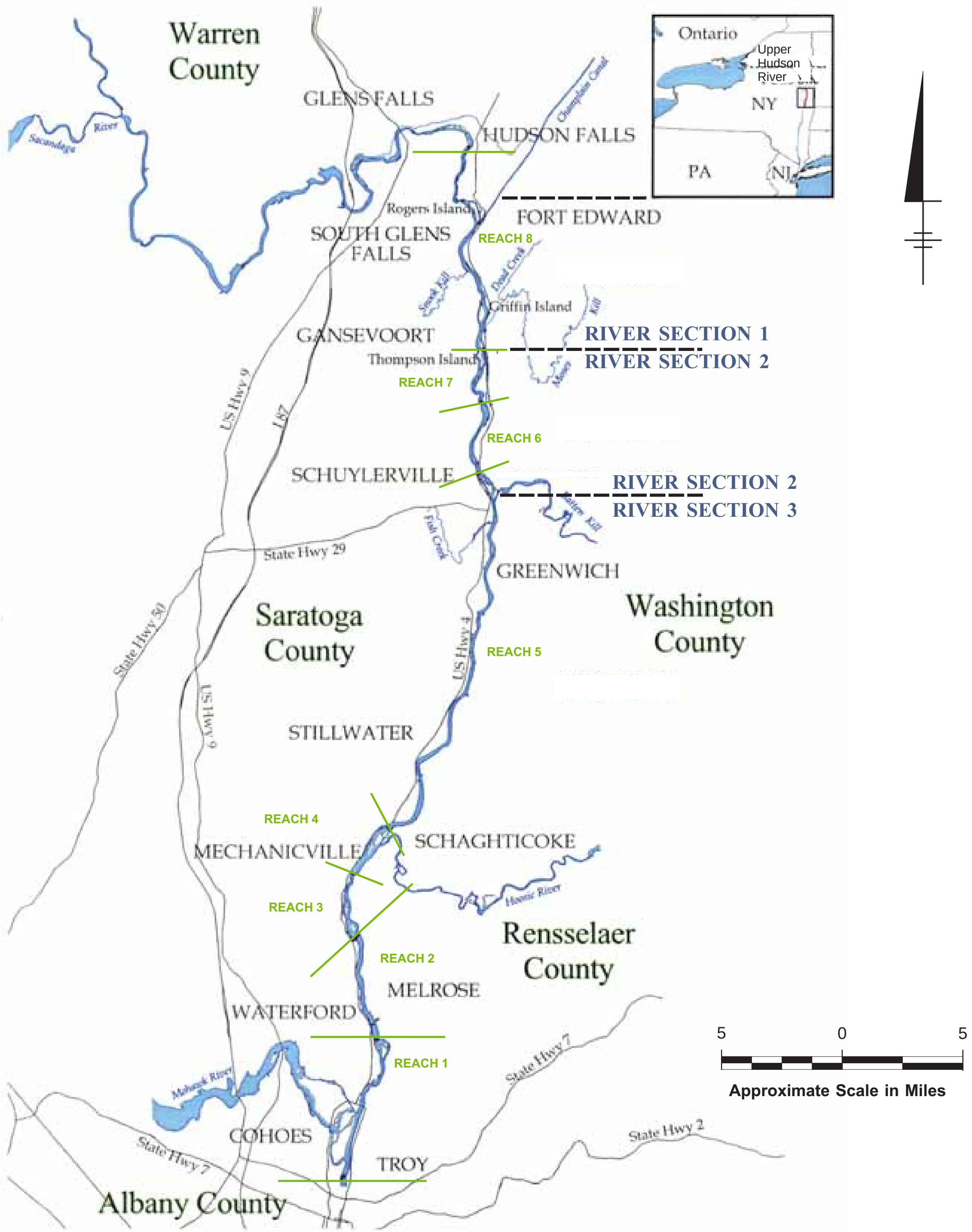
[b] Associated measurements vary with sample media. Examples include TOC for soil and sediment; water content and % lipids for bird eggs; and species, tissue type, water content, and % lipids for earthworm, small mammal, plant and other biological sample types.

[c] As necessary, consideration should be given to adding field-based population studies as a measure in a second tier of investigation.

[d] Possible SLERA outcomes for an Assessment Endpoint (AE), based on multiple lines of evidence (if available), include:

1. Negligible or no unacceptable risk (i.e., screens out). No further evaluation of AE needed in BERA.
2. Uncertain risk.
   - A. Due to insufficient data. AE needs further evaluation in BERA.
   - B. No further evaluation of AE in BERA. Refer to SLERA for rationale.
3. Unacceptable screening-level risk.
   - A. Quantitatively evaluate AE in BERA.
   - B. Qualitatively evaluate AE in BERA.
   - C. Contingent evaluation of AE in BERA. Need for evaluation (quantitative or qualitative) will be contingent on results of evaluation of more exposed or more sensitive species in the same taxonomic class.

FIGURES



04/25/2014 SYRACUSE, NY-ENV/CAD D.HOWES, L.POSENAUER
C/B0031175/0000/00001/CDR/31175N01.CDR

NOTES:

1. All locations are approximate.
2. Adapted from EPA Feasibility Study (December 2000).

UPPER HUDSON RIVER FLOODPLAINS PROJECT

REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN

LOCATION MAP - UPPER HUDSON RIVER

September 2014 – Corrected November 2014

FIGURE 1-1

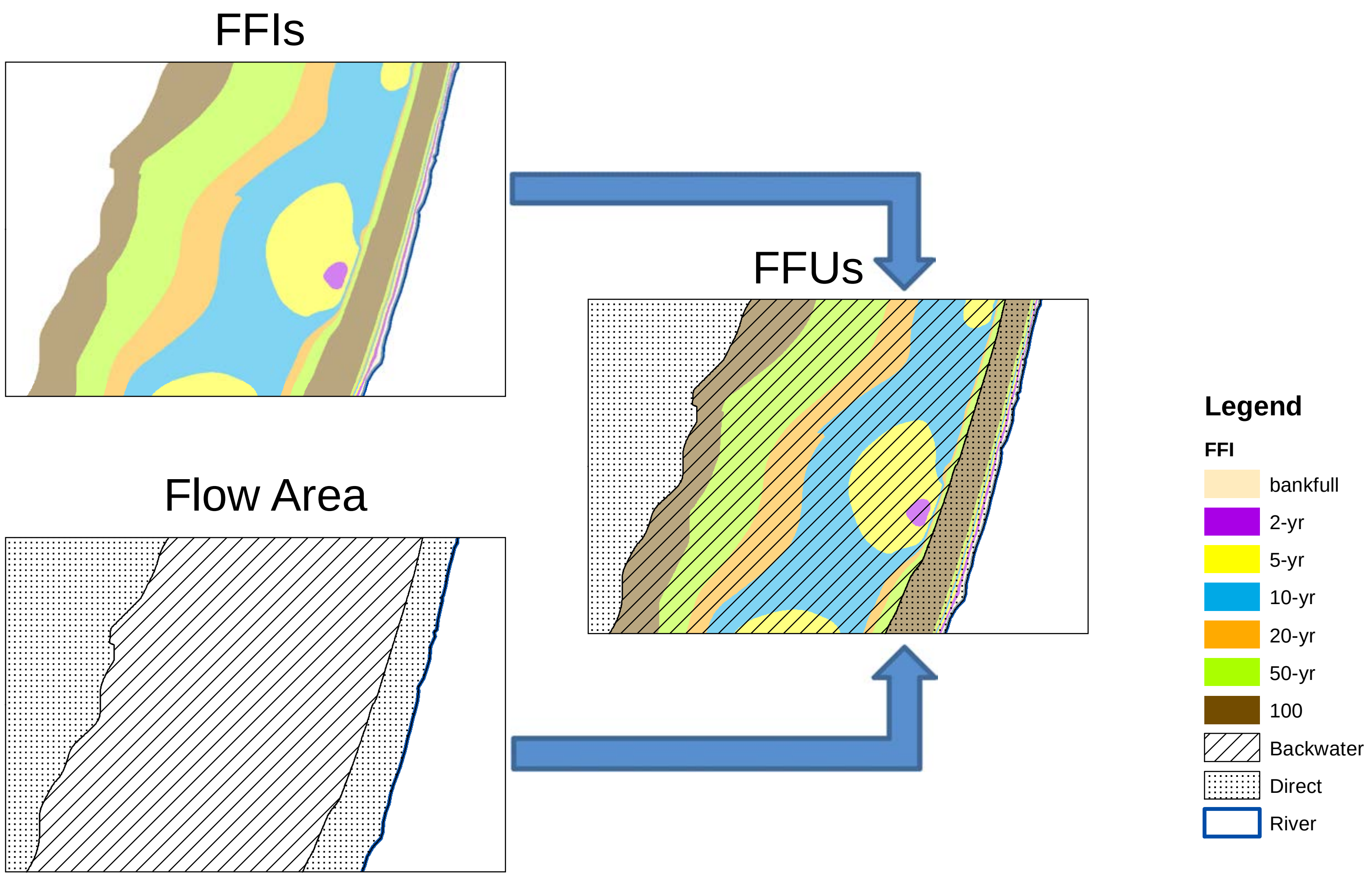


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Figure 2-1
Illustration of the Flood Frequency Unit Components: Flood Frequency Intervals, Backwater and Direct Flow Areas
Remedial Investigation/Feasibility Study Work Plan

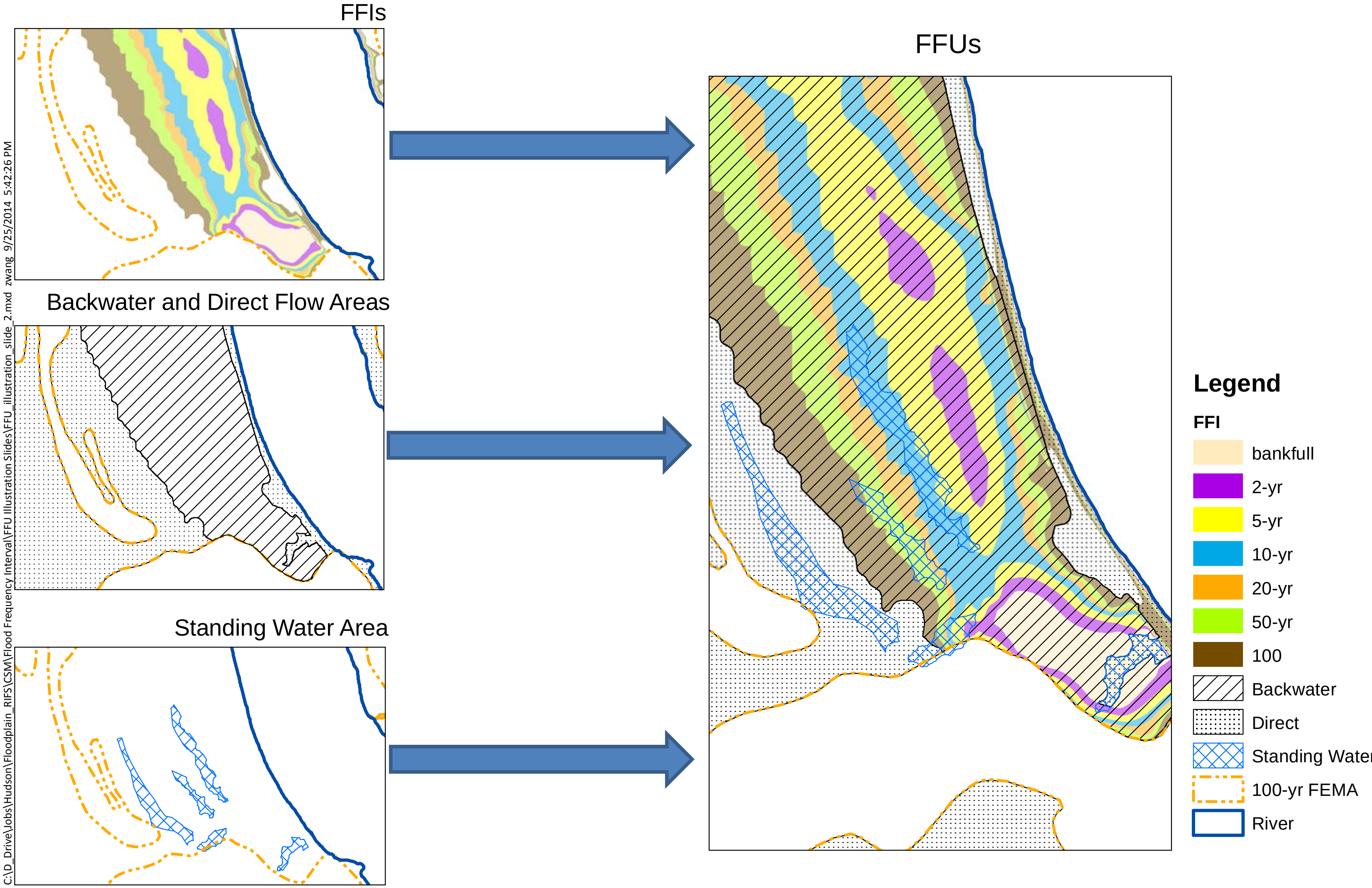

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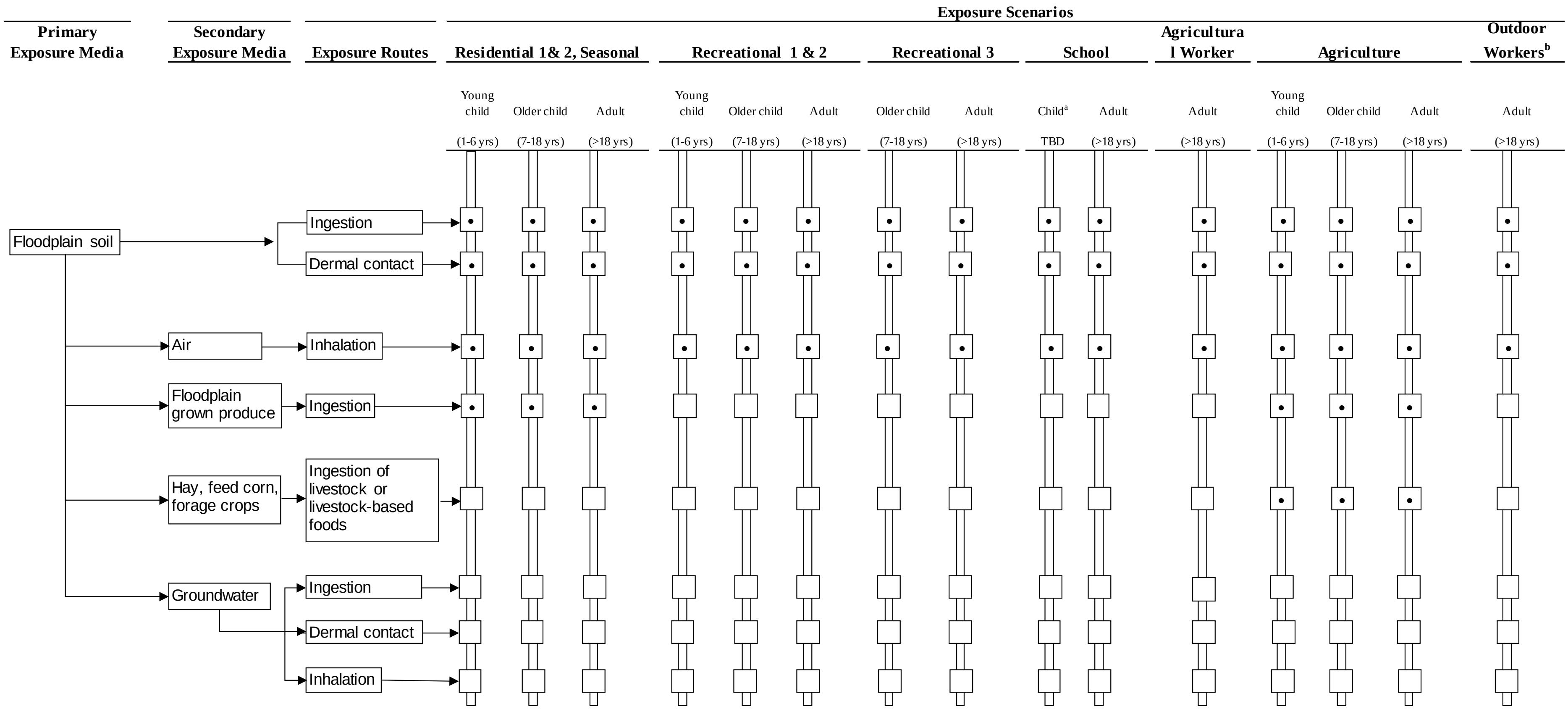
Figure 2-2

Illustration of the Flood Frequency Unit Components: Flood Frequency Intervals, Backwater and Direct Flow Areas, and Standing Water Areas

Remedial Investigation/Feasibility Study Work Plan



Complete exposure pathway

Incomplete exposure pathway

TBD = To be determined.

[a]Age of children will vary and will be determined on a school-specific basis. Range of potential ages will be between 5 and 18 years but will include children less than 5 years of age if there is a Pre-Kindergarten program at the school.

[b] Includes outdoor workers, groundskeepers, utility workers, and construction workers.

TABLE 2.3

OCCURRENCE AND DISTRIBUTION OF PCBS

Upper Hudson River Floodplain

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

Exposure Point Unique Identifier	Exposure Point Tax ID #	River Reach	Minimum FFI Concentration for Parcel (Qualifier) (1)	Maximum FFI Concentration (Qualifier) (1)	Units	Location of Maximum FFI Concentration	Detection Frequency For Maximum FFI	Range of Detection Limits	Maximum Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	Parcel Flag (Y/N)	Rationale for Selection or Deletion (5)
PRO-XXX-XXXX	XX-XX-X1	8	0.01 (ND)	125	mg/kg	XXXX	37/37	XXX	125	XXXX	0.24 (C)	TBD	TBD	Y	ASL
PRO-XXX-XXXX	XX-XX-X2	8	0.01 (ND)	0.020	mg/kg	XXXX	4/37	XXX	0.020	XXXX	0.24 (C)	TBD	TBD	N	BSL

Footnote Instructions:

TBD = To be determined

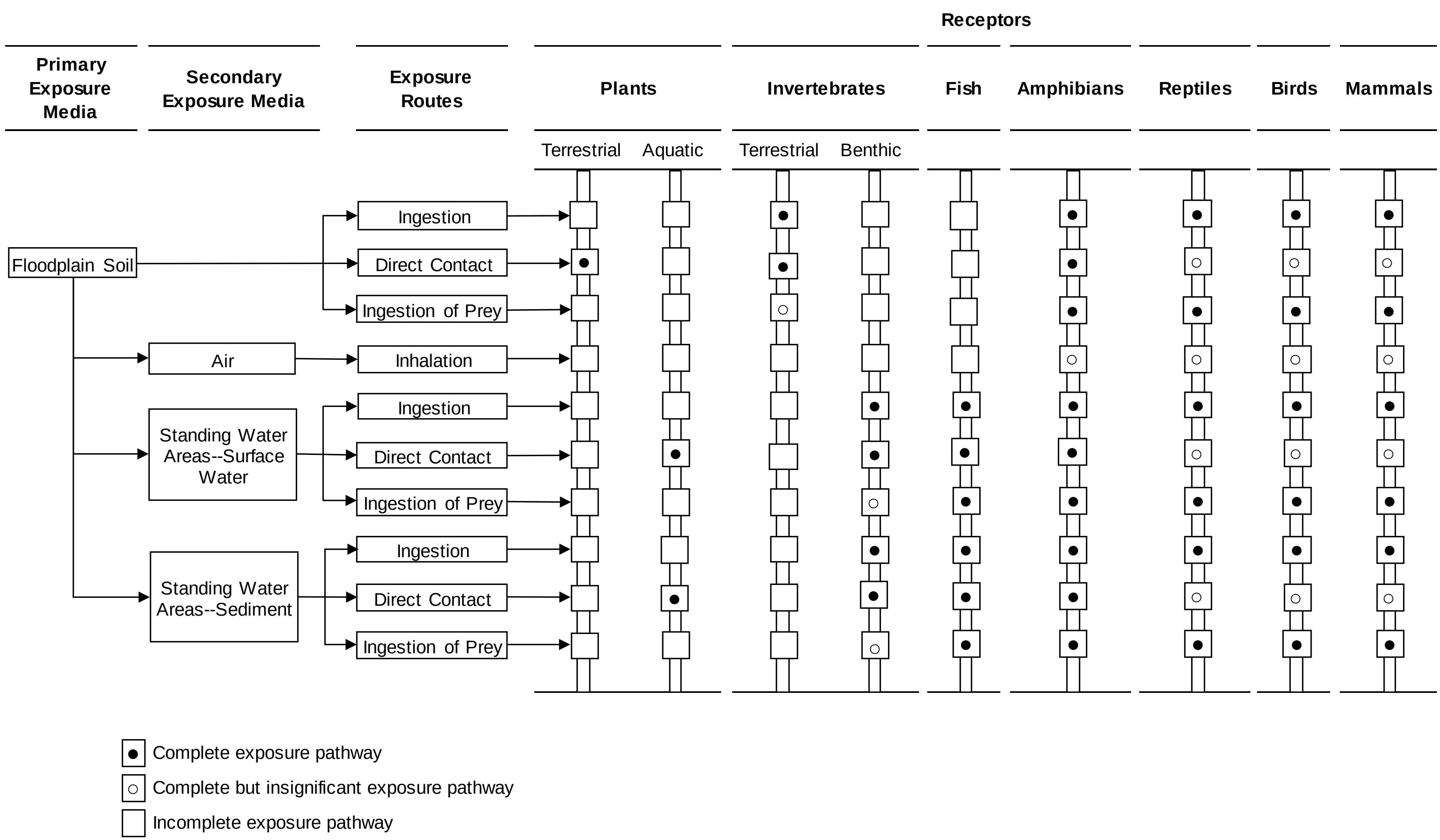
(1) Define the "(Qualifier)" codes used for the "Minimum Concentration" and "Maximum Concentration".

(2) Specify source(s) for the "Concentration Used for Screening".

(3) Specify source(s) for the "Background Value".

(4) Specify source(s) for the "Screening Toxicity Value".

(5) Define the codes used for the "Rationale for Selection or Deletion".



September 2014 – Corrected November 2014

Figure 4-1
Preliminary Conceptual Site Model for the Ecological Risk Assessment of the Upper Hudson River Floodplain
Remedial Investigation/Feasibility Study Work Plan

APPENDIX A

SELECTION OF EXPOSURE AREAS FOR HUMAN HEALTH RISK ASSESSMENT

September 2014 – Corrected November 2014

INTRODUCTION

The physical characteristics and usages of the Upper Hudson River (UHR) Floodplain and the Floodplain properties are highly variable. In some cases, the Floodplain is very steep and narrow and is confined to the river banks; in others it is wide and gently sloped so that it includes a substantial amount of terrain that is distant from the river itself. Portions of the Floodplain are developed for residential, recreational, commercial, industrial, or agricultural use while other portions include vast expanses of undeveloped woodlands and wetlands. In addition, Floodplain substrates include bedrock, gravel, sand, mud, and soil; land cover includes aquatic vegetation, rock, maintained lawns, and unmaintained grassland, shrubs, and trees.

The Baseline Human Health Risk Assessment (BHHRA) will be focused on privately and publicly owned tax parcels as the primary areas of potential exposure. However, it is recognized that there are situations in which the entire parcel may not be an appropriate approximation of the likely use or exposure area (EA). Specifically, on some parcels, particularly large parcels, multiple uses may occur on different portions of the parcel and/or Floodplain. On such parcels, to assume that the parcel boundaries accurately define the EA may not be appropriate and could potentially mischaracterize concentrations of polychlorinated biphenyls (PCBs) to which individuals are potentially exposed. In such cases, it may be appropriate to subdivide the parcel into smaller EAs. If a parcel is subdivided into smaller EAs, all of the subdivided EAs will be evaluated. In addition, there may be some areas in which it may be most appropriate to combine multiple properties into a single EA, rather than evaluate them separately. Such combined parcels might include, for example, neighborhoods or contiguous parcels that have similar physical characteristics, flooding frequency, and usage patterns, or circumstances in which a single receptor is anticipated to engage in a single activity (e.g., hiking or farming) using multiple, adjacent parcels. However, decisions will be made on individual properties.

This appendix presents the approach that has been developed for identifying EAs. A series of decision trees has been developed (Figures A-1 through A-6) to help in identifying EAs in a systematic and consistent manner. These decision trees take into consideration the type(s) of usage that occur now or may occur in the future there, evidence of Floodplain usage, and physical features that may obstruct access to all or portions of the parcel. The developed approach is intended to ensure that regular use areas that are portions of large parcels are not overlooked or diluted by automatically assuming that the entire parcel is the EA.

OVERVIEW OF APPROACH

Figure A-1 outlines the first step to be used in identifying EAs on all parcels. The entire area of each tax parcel, including any area outside of the Floodplain, will be used as the starting point to move through the decision tree outlined in Figure A-1. GE will then evaluate whether there are physical characteristics or use patterns at each parcel that would indicate that a portion or portions of the parcel would involve a distinct or more frequent use from other portions. If there are such physical characteristics or distinct uses in different parts of the parcel, the parcel may be sub-divided into smaller EAs. This will include subareas (if any) associated with a greater exposure potential or more intensive use than the rest of the EA.

As indicated in Figure A-1, for those parcels where it may be appropriate to consider selecting a subarea of the parcel as the EA, it will be necessary to consider additional characteristics to determine the relevant EA(s) for the risk assessment. One of five current general usage classifications assigned to each parcel (i.e., residential, agricultural, commercial/industrial, recreational, and school) will identify the appropriate decision tree to be used to identify the EA(s) for that parcel. Figures A-2 through A-6 present the EA-selection approach for residential, agricultural, commercial/industrial, recreational, and school parcels, respectively. Each decision tree considers both current and reasonably anticipated future use of the parcel to define EAs for Phases 1 and 2 of the BHHRA. In some cases, portions of the Floodplain on a given parcel may be used for different purposes. When this occurs, multiple EAs and usage types may be identified for a single parcel. Where current and future uses differ, distinct EAs for each may be selected. The boundaries for EAs may also differ under current and reasonably anticipated future use scenarios. The selection of EAs for each type of usage is discussed below.

Residential

There are many different types of residential parcels in the UHR. Some are very small properties; others are very large. In some cases, the houses and yards of the property are in or near the Floodplain, while in others, there is substantial distance between the Floodplain boundary and those portions of the yard that appear to be regularly used. Still others are divided by roads, rights-of-way, and publicly owned land.

Residential parcels for which more than one EA may be considered will be evaluated to determine whether regular residential use currently occurs in the Floodplain (Figure A-2). This determination will be based on factors including the distance from existing homes to the Floodplain boundary, evidence of yard maintenance in the Floodplain areas, debris or furniture on the Floodplain, and the presence of a dock or boats along the shoreline. If there are no signs of Floodplain usage, the parcel will be evaluated to determine whether there are physical features such as steep slopes or wetland areas that obstruct access from the house to portions or all of the Floodplain. For those parcels where an obstruction may prevent residential use of the Floodplain area, the Floodplain area will be evaluated to determine whether it could be used for a different purpose. If there are currently signs of usage or if use is reasonably anticipated in the future, the EA(s) will be selected based on the type of usage that is occurring or reasonably anticipated to occur and the proximity of the use areas to the Floodplain itself. In any case, the EA(s) may include areas outside of the Floodplain if such areas are part of the same use area(s) as the Floodplain portion.

Agricultural

There are a variety of agricultural parcels present in the UHR Floodplain. Some are large, cohesive tracts of land, while others are composed of multiple segments that are separated by other parcels, utility corridors, and/or roads, and still others are areas designated as separate tax parcels (i.e., different tax IDs) but are owned and used by the same farmer. In some cases, portions of the cultivated area fall within the Floodplain; in other cases, the cultivated land is elevated above the Floodplain so that only the uncultivated, bank area falls within the Floodplain. Finally, other properties are only partially cultivated, due to physical characteristics such as wet areas and steep slopes that prevent ready access for cultivation.

Selection of EAs for the agricultural parcels will depend on where the crop (including homegrown produce) or grazing land is located in relation to the Floodplain (Figure A-3). If crop or grazing land is present in the Floodplain, the EA will be selected based on the area that is actually being used for that purpose (including the portion outside the Floodplain). If there is no crop or grazing land in the Floodplain, it will be important to consider whether the Floodplain portion of the parcel is currently or is reasonably anticipated to be used for a different purpose, such as recreation. If there is no apparent or likely use of the Floodplain area, then the parcel may be proposed for exclusion if there are no other categories of exposure.

Commercial/Industrial

Commercial/industrial properties in the UHR Floodplain also vary considerably. There are a few large, industrial complexes and many small commercial businesses located there. In some cases, the commercially used land falls within the Floodplain, while in others, the Floodplain is more remote and/or confined to the river bank area and may in fact be used for other purposes.

Selection of EAs for the commercial parcels where more than one EA may be considered will depend on whether the commercial use area is located entirely or in part within the Floodplain, whether the entire parcel is being used for commercial/industrial purposes, and, if not, the current and reasonably anticipated future uses of the Floodplain area (Figure A-4). If the portion of the parcel in the Floodplain is being used for commercial/industrial purposes, the EA will be defined based on the usage patterns for that enterprise (including the portion outside the Floodplain). If, however, the commercial/industrial use area does not include the Floodplain, then it will be necessary to consider whether the Floodplain portion of the parcel is currently or is reasonably anticipated to be used for recreational purposes. If this is the case, the EA will be selected based on the area of recreational usage. If the commercial/industrial area does include the Floodplain, the reasonably anticipated future use of that area will also be considered. If there is no indication that the Floodplain portion is being used currently or is likely to be used in the future, then the parcel may be proposed for exclusion if there are no other categories of exposure.

Recreational

Recreational use will be evaluated for all land that has been developed for that purpose, land that has not been developed for another purpose, and land that is not likely to be developed in the future. This includes publicly owned land and established parks. In some cases, it also includes privately owned, undeveloped land that is not likely to be developed for another purpose due to difficult access and/or its physical characteristics.

In selecting the EAs for recreational parcels where more than one EA may be considered, key considerations will be whether there is a defined use area that includes the Floodplain and, if not, whether there are use or development restrictions that would likely preclude future development/use (Figure A-5). If there is no defined use area in the Floodplain and there are future use restrictions in place, the parcel will be proposed for exclusion from further consideration. However, if there are no development or use restrictions, the EA will be selected based on the current or reasonably anticipated future use area (including the portion, if any, outside the Floodplain).

School

There are a number of schools that have property within the UHR Floodplain. Some are small properties with no associated athletic facilities, while others are larger properties that have athletic fields and maintained schoolyard areas that fall, in part, within the Floodplain. Still others have Floodplain areas that are remote from the maintained portions of the school property and are not likely to be used by school children on a regular basis.

In selecting the EAs for the school parcels where more than one EA may be considered, the specific properties will be evaluated to determine where and what type of use occurs in the Floodplain (Figure A-6). This determination will consider whether there is evidence of schoolyard maintenance or athletic fields in the Floodplain area. If there are no maintained portions of the property within the Floodplain, then potential access to the Floodplain portion will be considered to determine whether the Floodplain area is currently or is reasonably anticipated to be used for other, non-school-related purposes. The EA(s) will be selected for these parcels based on the type(s) of use that are occurring and the proximity of the use areas to the Floodplain itself. In any case, the EA(s) may include areas outside of the Floodplain if such areas are part of the same use area(s) as the Floodplain portion.

Summary

In selecting EAs, the entire area of each tax parcel, including any area outside of the Floodplain, will be the basis of the approach. However, the approach described above has been developed in an effort to capture the variability in usage of the Floodplain and the impacts of its physical characteristics on usage. It is intended to ensure that regular use areas that are portions of large parcels are not overlooked or diluted by automatically assuming that the entire parcel is the EA, and that each EA is based on the extent of the area that is subject to the same basic use. Figures showing the EAs selected for each parcel that is carried into Phase 1 of the BHHRA will be provided as an attachment to the Pathway Analysis Report (PAR). Figures for EAs evaluated under Phase 2 of the BHHRA will be included as part of the Final BHHRA Report.

FIGURES

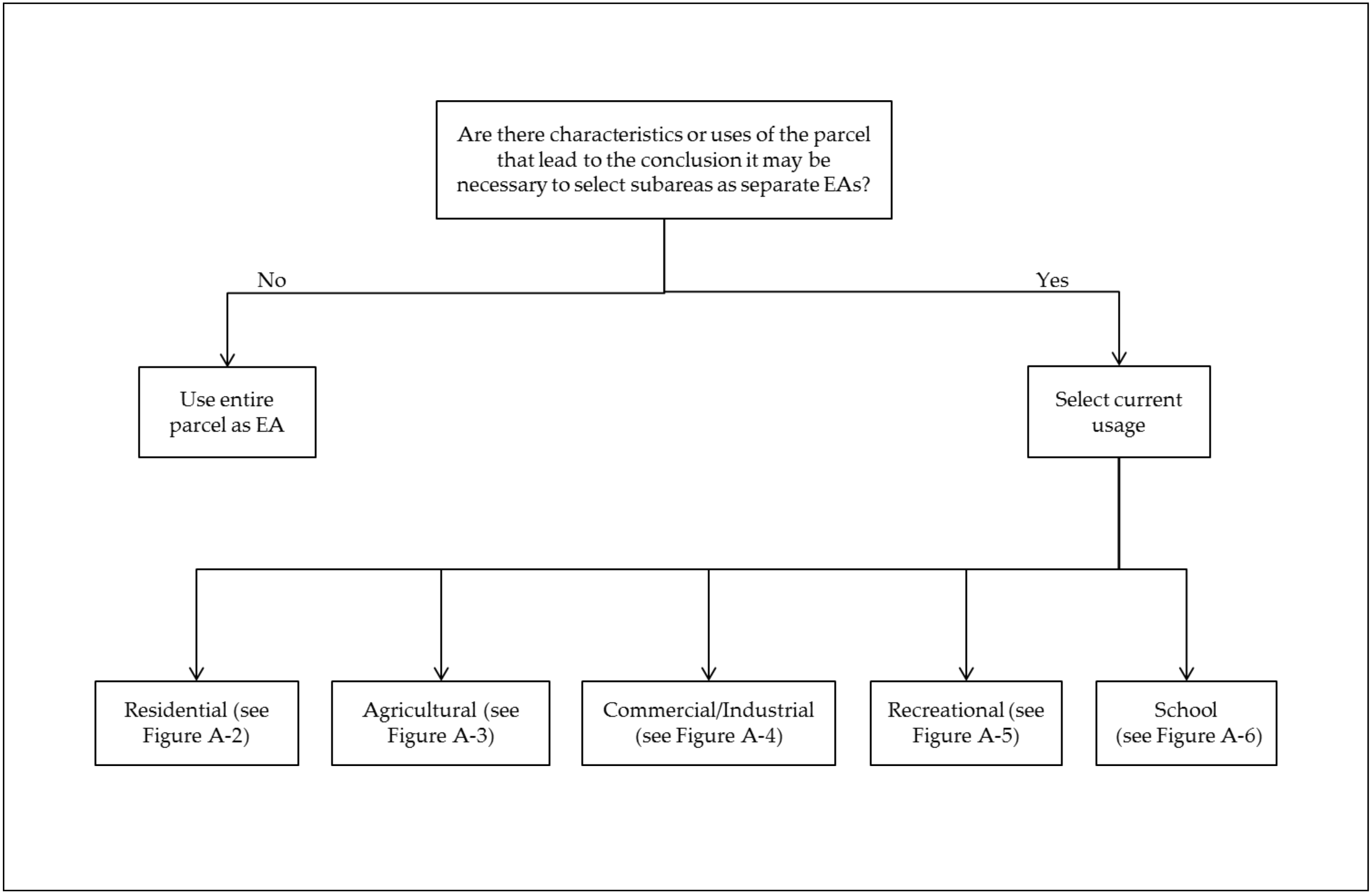
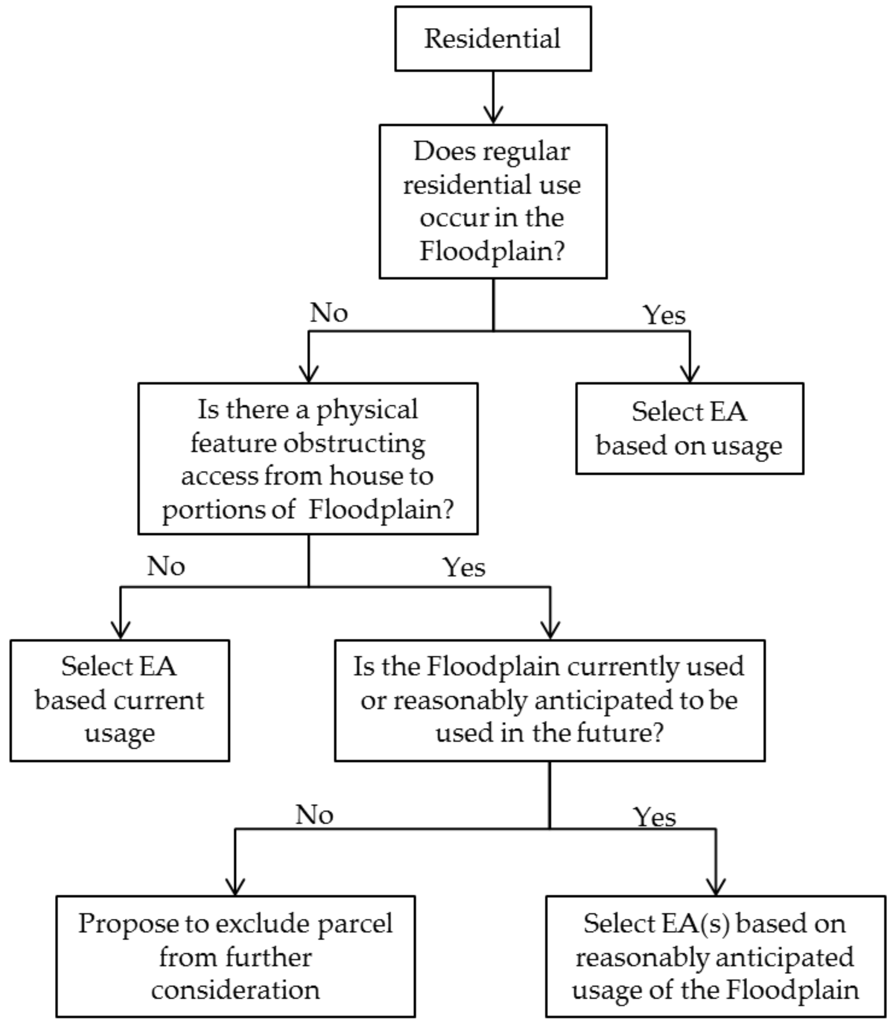
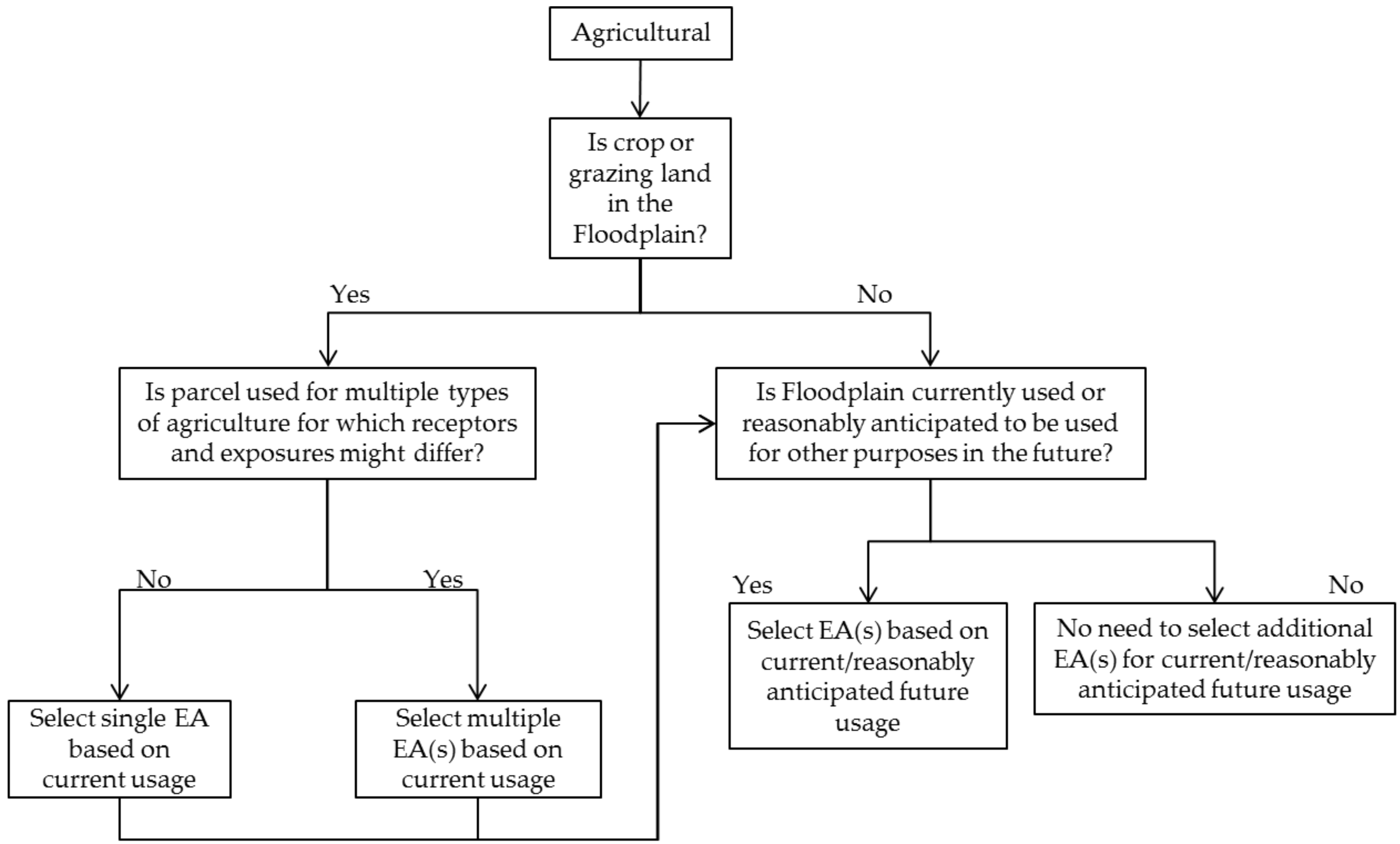


Figure A-1
Preliminary Steps in Overall Approach for Selecting Exposure Areas



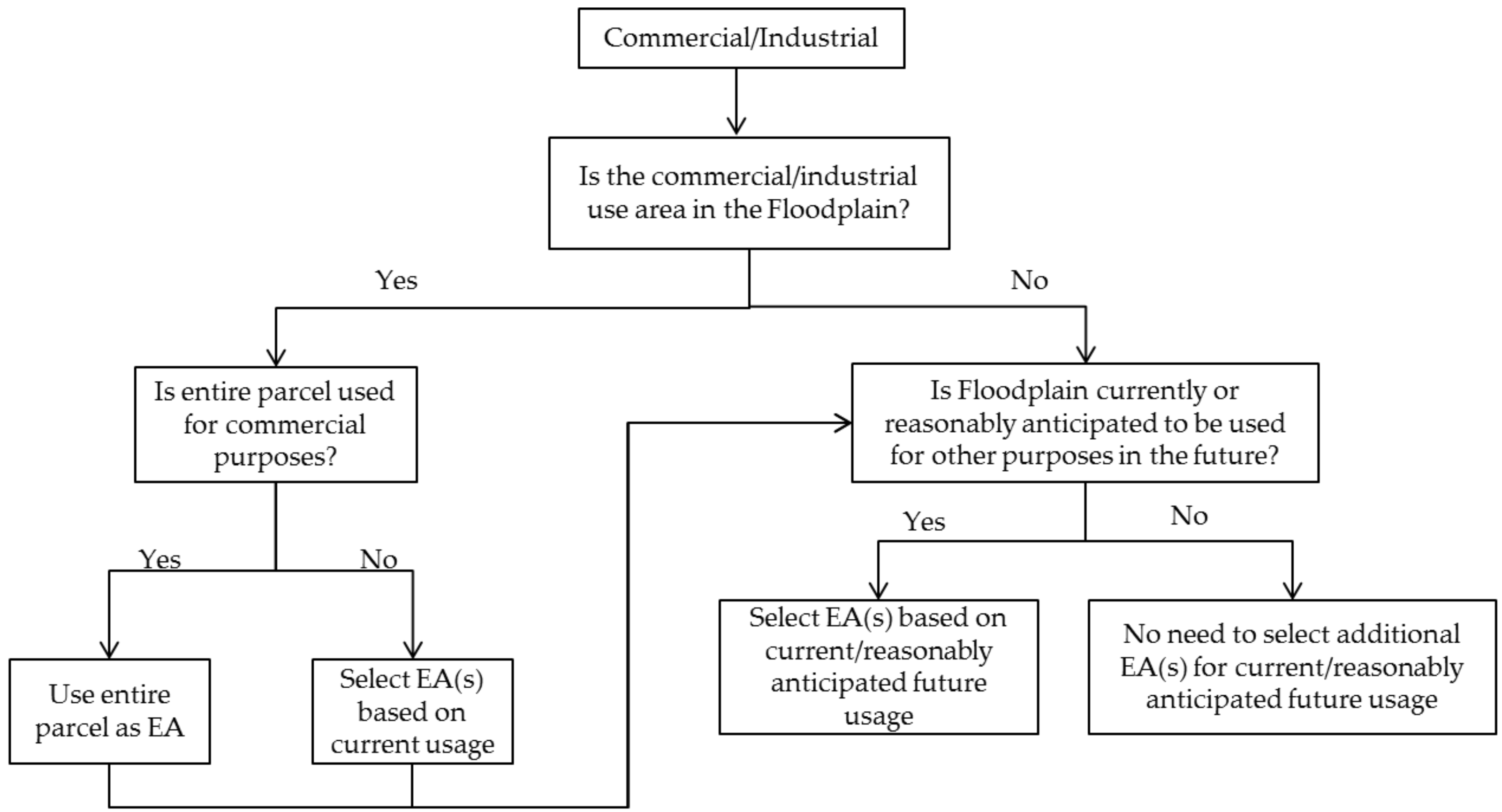
Note: In some cases, portions of the Floodplain may be used for different purposes. When this occurs, multiple EAs and usage types may be identified and evaluated for a single parcel.

Figure A-2
Overall Approach for Selecting Residential Exposure Areas
Remedial Investigation/Feasibility Study Work Plan



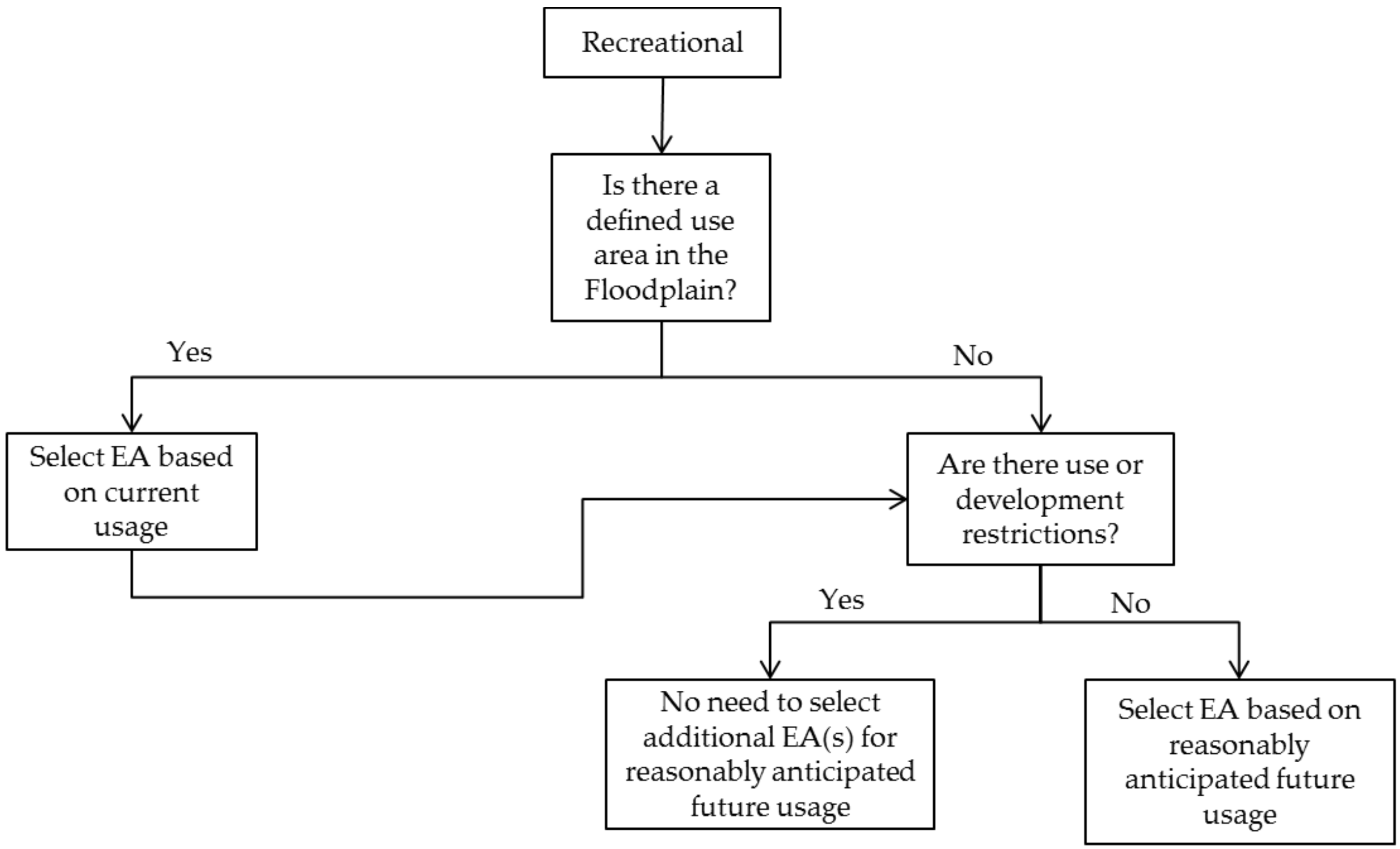
Note: In some cases, portions of the Floodplain may be used for different purposes. When this occurs, multiple EAs and usage types may be identified for a single parcel.

Figure A-3
Overall Approach for Selecting Agricultural Exposure Areas



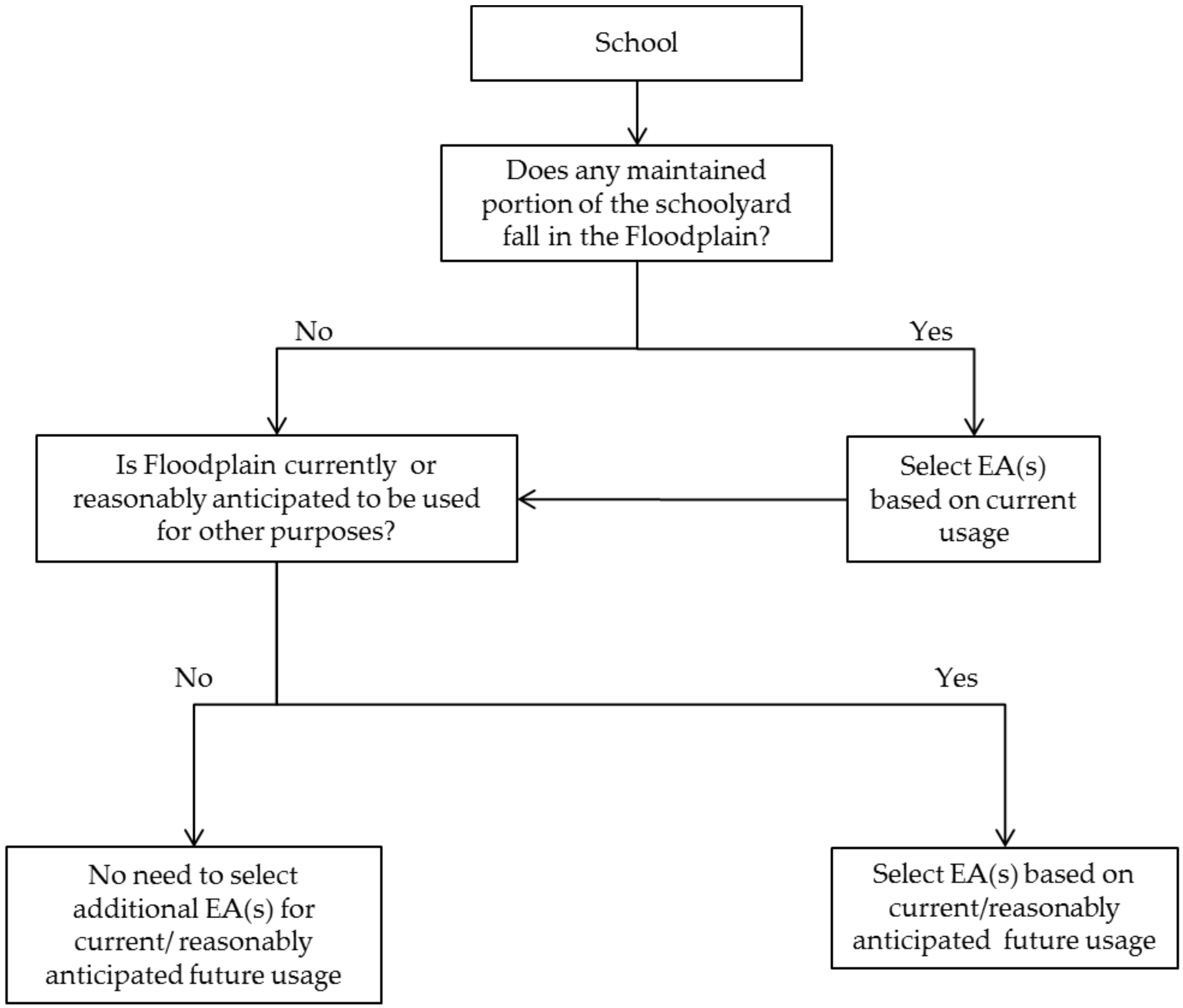
Note: In some cases, portions of the Floodplain may be used for different purposes. When this occurs, multiple EAs and usage types may be identified for a single parcel.

Figure A-4
Overall Approach for Selecting Commercial Exposure Areas



Note: In some cases, portions of the Floodplain may be used for different purposes. When this occurs, multiple EAs and usage types may be identified for a single parcel.

Figure A-5
Overall Approach for Selecting Recreational Exposure Areas



Note: In some cases, portions of the Floodplain may be used for different purposes. When this occurs, multiple EAs and usage types may be identified for a single parcel.

Figure A-6
Overall Approach for Selecting Exposure Areas on School Properties

APPENDIX B

PHASE 1 EXPOSURE PARAMETERS FOR HUMAN HEALTH RISK ASSESSMENT

September 2014 – Corrected November 2014

INTRODUCTION

Phase 1 of the Baseline Human Health Risk Assessment (BHHRA) for the Upper Hudson River (UHR) Floodplain will evaluate both the current and the reasonably anticipated future use of each exposure area (EA). As discussed in Section 3.5 of this Work Plan, one of four general use categories will be evaluated in Phase 1 for each EA. The category to be evaluated will be based on the specifically identified current or reasonably anticipated future use of the EA that is expected to result in the highest potential for exposure to soil. These four general use categories are: (1) residential; (2) agricultural; (3) commercial/industrial; and (4) recreational.[1] In addition, as discussed in Section 3.5, a construction worker scenario will also be evaluated for all identified EAs during Phase 1. This appendix presents the exposure parameters that will be used for Phase 1 of the BHHRA.

OVERVIEW OF EXPOSURE PARAMETERS

Phase 1 of the BHHRA will provide two sets of risk estimates based on two separate sets of screening-level exposure parameters. USEPA previously requested that the default exposure parameters presented in the 1991 OSWER guidance entitled *Standard Default Exposure Factors* (USEPA 1991) be used to calculate potential risks for the Phase 1 screening analysis. However, that guidance has been superseded by more recent guidance entitled *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, issued in February 2014 (USEPA 2014), which sets forth updated default exposure parameter values for use in human health risk assessments anywhere in the country (i.e., without considering regional climatic conditions). As a result, to address USEPA's request, one set of screening-level risk estimates will use the updated default reasonable maximum exposure (RME) factors listed by USEPA in that 2014 guidance and will assume year-round

[1] When Floodplain areas fall on school properties, the usage of the Floodplain area will be considered in selecting the most relevant general use category for Phase 1 of the BHHRA. If the Floodplain portion of the school property consists of maintained areas or playing fields of the school, it will be assigned to residential usage for Phase 1. If the Floodplain portion consists of an undeveloped area removed from the school yard, it will be assigned to recreational usage for Phase 1.

exposure to Floodplain soils indoors and outdoors.[2] This is referred to as the Default Refined Screening Analysis. To provide a more refined and realistic screening-level analysis, another set of Phase 1 risk estimates will use several of the updated default exposure factors listed by USEPA (2014), but will also use certain modified exposure factors that take account of the climatic conditions along the UHR Floodplain, which will affect the potential for exposures to outdoor soils during the colder months of the year, as well as other factors, using USEPA's 2011 *Exposure Factors Handbook*, that reflect a more refined conceptualization of the potential receptors in the Floodplain. This is referred to as the Adjusted Refined Screening Analysis. Both sets of exposure parameters have been selected to reflect conservative assumptions that characterize complete exposure pathways for human receptors, including incidental ingestion of surface soil and dermal contact with surface soil (see Figure 3-1 of this Work Plan).

Tables B-1 through B-5 (provided in RAGS D Table Series 4 format) outline the two sets of exposure parameters that will be used in Phase 1 of the BHHRA for residents, agricultural workers,[3] outdoor commercial/industrial workers, recreators, and construction workers.

The results of both the Default Refined Screening Analysis and the Adjusted Refined Screening Analysis will be presented in the Phase 1 BHHRA report for USEPA's consideration. GE will make a recommendation of the properties to be carried forward to Phase 2 based on these analyses. USEPA has not currently adopted the use of the non-default parameters proposed for Phase 1. GE can provide the rationale for the use of those

[2] At USEPA's further request, a default construction worker scenario will also be evaluated in Phase 1. Since the 2014 guidance does not provide all the default parameters for construction workers, the default parameters provided for that scenario in USEPA's 2002 *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* will be used in combination with relevant parameters from USEPA (2014) to complete this analysis.

[3] There is a wide range of practices at agricultural EAs in the UHR Floodplain that may result in varying exposures. These include dairy farms with homes, crops that are consumed or used to feed animals, sod farming, home grown produce, and livestock. Because practices vary from parcel to parcel, there is no justifiable way of developing a single generic agricultural scenario for inclusion in Phase 1 of the BHHRA to be applied to all agricultural EAs. When it is expected that the only exposures that may occur in an agricultural EA are exposures to agricultural workers during their work day these EAs will be considered under a general agricultural worker scenario. All other agricultural EAs will be carried forward to Phase 2 of the BHHRA.

parameters in the PAR and USEPA will review the information provided for potential consideration of their use.

Adjusted Refined Screening Analysis

The selected exposure parameters for the Adjusted Refined Screening Analysis are based on the assumption that all individuals will have exposure to Floodplain soils from the beginning of April through the end of October and that residents will also experience direct contact with indoor dust derived from outdoor soil throughout the year. The defined period for outdoor exposure considers climatic conditions of the UHR area. Average monthly temperatures for Glens Falls, the northernmost NOAA weather station within the UHR vicinity, range from 18 degrees F to 37 degrees F for November through March. Average monthly temperatures for Albany are slightly higher and range from 23 to 40 degrees F for November through March. Over these same months, average monthly snowfall ranges from 3.4 inches to 23.7 inches for Glens Falls and 2.8 to 17.6 inches for Albany (NOAA 2014). Although individuals may spend time outdoors in the Floodplain areas during the late fall, winter, or early spring, temperatures resulting in the wearing of heavy clothing, frozen ground, and snow cover will minimize any potential for direct contact exposure with soil during those months.

Residential exposure to indoor dust via incidental ingestion is assumed for both child and adult residents, while exposure via dermal contact is assumed for child residents between 1 and 6 years of age only. Residential exposure to adult residents via dermal contact with indoor dust is likely to be minor because these individuals do not contact surfaces where dust accumulates (e.g., floors, window sills) with bare skin regularly or to any substantial degree.

For child and adult residents who are exposed to outdoor soil and indoor soil-derived dust, age-specific incidental ingestion rates for soil and dust combined (USEPA 2011) have been selected to characterize exposures on days when both outdoor and indoor exposures are assumed to occur (i.e., from April through October). Age-specific incidental ingestion rates for dust only have been selected for the remainder of the year, in which only indoor exposures are assumed to occur (Tables B-6 and B-7). For child and adult recreators, USEPA's (2011) recommended incidental ingestion rates for outdoor soils are assumed. For outdoor commercial/industrial and, agricultural workers, USEPA's (2014) default incidental ingestion rate for outdoor workers is assumed.

USEPA's (2002) default soil ingestion rate for construction workers is 330 g/day. While this will be used for the Default Refined Screening Analysis, it was not selected for the Adjusted Refined Screening Analysis because it is highly uncertain and may substantially overestimate soil intake. This rate is the 95th percentile from a single soil ingestion study, and was driven by multiple days of accumulation contributing to a single sample, rather than a single day, as was assumed in the analysis. The 75th percentile intake rate in this same study was 49 mg/day. Thus, the rate of 330 g/day was not selected for the Adjusted Refined Screening Analysis. Instead, USEPA's (2014) default soil ingestion rate for outdoor workers of 100 g/day will be used for this analysis.

For child residents who are exposed to outdoor soil and indoor dust throughout the year, it is assumed that the exposed body parts will include face, hands, forearms, lower legs, and feet. For child recreators, who are exposed only to outdoor soil, potential body parts exposed will vary during different months of the year due to weather conditions. From May through September, the exposed body parts for the child recreator will include face, hands, forearms, lower legs, and feet. In the colder months of April and October, during which outdoor exposure is expected to occur but more clothing is likely to be worn, exposed body parts for the child recreator will include only hands, face, and forearms (Tables B-8 and B-9).

Similar assumptions are made for adult residents and recreators. For these receptor groups, it is assumed that from May through September the exposed body parts will include face, hands, forearms, and lower legs, while in April and October the exposed body parts will include face, hands, and forearms only (Tables B-8 and B-9).

Consistent with USEPA's (2002) recommendations for workers, it is assumed that the face, hands, and forearms of outdoor commercial/industrial, agricultural, and construction workers will be exposed during the work day (Table B-8).

All soil-to-skin adherence factors (AFs) are weighted by the body surface areas assumed for each receptor and age group. For young child residents, the AF is based on USEPA's (2011) recommendations for "Residential (indoor)" adherence for days when only indoor exposures occur, and those for "Daycare children (indoor and outdoor)" for days when both indoor and outdoor exposures occur. Soil-to-skin adherence for adult residents and recreators and for child recreators who are only exposed to outdoor soil are based on USEPA's (2011) recommendations for adult and child "Activities with Soil," respectively, while those for construction workers are based on USEPA's (2011) recommendations for "Construction Activities" (Table B-10 and B-11). For outdoor commercial/industrial and agricultural workers, USEPA's (2014) recommended adherence factor for outdoor workers has been selected.

In order to evaluate inhalation of particulates derived from soils under agricultural worker and construction worker scenarios, USEPA's (2014) recommended exposure time (ET) of 8 hours/day for outdoor workers has been selected.

Default Refined Screening Analysis

In response to USEPA's request to use the Agency's default exposure parameter values, the Default Refined Screening Analysis will use the updated default exposure factors recommended in USEPA's 2014 Update of Standard Default Exposure Factors where available (or, if none, those provided in the 1991 Guidance where available). For the construction worker scenario, the additional default exposure factors provided in USEPA's 2002 *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* will be used. Default factors have been developed for nation-wide application, without considering regional climatic conditions; and thus their use assumes that all individuals will have direct contact exposures to Floodplain soils outdoors throughout the year, including the winter months. Those default values are listed in the attached tables.

GE has indicated to USEPA that non-default parameters will be provided simultaneously but separately from the default parameters and include the rationale for use of those parameters for USEPA's consideration.

REFERENCES

NOAA (National Oceanic and Atmospheric Administration), 2014. *Climate Normals*. National Oceanic and Atmospheric Administration. Available at: http://www.ncdc.noaa.gov/land-based-station-data/climate-normals/1981-2010-normals-data

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USEPA, 2011. *Exposure Factors Handbook: 2011 edition.* EPA/600/R-090/052F. U.S. Environmental Protection Agency, National Center for Environmental Assessment, Washington, DC. 1466 pp. September.

USEPA, 2014. *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*. OSWER Directive 9200.1-120. February.

TABLES

Table B-1. Values Used for Daily Intake Calculations - Phase 1, Residential Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Units	Adjusted Refined Screening Analysis		Default Refined Screening Analysis		Intake Equation/ Model Name
							Value	Rationale/ Reference	Value	Rationale/ Reference	
Resident	Incidental Ingestion	Child	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	mg/day	110	Age- and frequency-weighted ingestion rates for indoor and outdoor soil (USEPA 2011. Table 5-1). See footnote 1.	200	Default for children (USEPA 2014)	
				ABS_o	Oral Absorption Factor	unitless	1	Conservative default	1	Conservative default	
				EF	Exposure Frequency	days/yr	350	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 2.	350	Default for residents (USEPA 2014); Assumes 2 weeks away from residence.	
				ED	Exposure Duration	yrs	6	Default for children (USEPA 2014)	6	Default for children (USEPA 2014)	
				BW	Body Weight	kg	18.8	Mean body weight for ages 1 to 6 (USEPA 2011, Table 8-1)	15	Default for children (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	2,190	ED x 365 days/yr (USEPA 1989)	2,190	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	mg/day	39	Age- and frequency-weighted rates for indoor and outdoor soil (USEPA 2011; Table 5-1). See footnote 1.	100	Default for adults (USEPA 2014)	
				ABS_o	Oral Absorption Factor	unitless	1	Conservative default	1	Conservative default	
				EF	Exposure Frequency	days/yr	350	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 2.	350	Default for residents (USEPA 2014); Assumes 2 weeks away from residence.	
				ED	Exposure Duration	yrs	20	Age-adjusted exposure duration (USEPA 2014)	20	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	7,300	ED x 365 days/yr (USEPA 1989)	7,300	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
	Dermal Contact	Child	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	cm^2/event	2,315	Assumes face, hands, forearms, lower legs and feet. Age-weighted mean surface area (USEPA 2011, Table 7-2). See footnote 3.	2,690	Default for child residents (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	unitless	0.14	USEPA 2004 based on Wester et al. 1993	0.14	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	mg/cm^2	0.026	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 4.	0.2	Default for child residents (USEPA 2014)	
				EF	Exposure Frequency	days/yr	350	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 2.	350	Default for residents (USEPA 2014); Assumes 2 weeks away from residence.	
				ED	Exposure Duration	yrs	6	Default for children (USEPA 2014)	6	Default for children (USEPA 2014)	
				EV	Event Frequency	events/day	1	Assumed default (USEPA 2004, Exhibit 3-5)	1	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	kg	18.8	Mean body weight for ages 1 to 6 (USEPA 2011, Table 8-1)	15	Default for children (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	2,190	ED x 365 days/yr (USEPA 1989)	2,190	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	cm^2/event	4,458	Assumes face, hands, forearms and lower legs from May through September. Assumes face, hands and forearms in April and October. Seasonally weighted mean surface areas for adults (USEPA 2011, Table 7-2). See footnote 3.	6,032	Default for adult residents (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	unitless	0.14	USEPA 2004 based on Wester et al. 1993	0.14	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	mg/cm^2	0.025	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 4.	0.07	Default for adult residents (USEPA 2014)	
				EF	Exposure Frequency	days/yr	350	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 2.	350	Default for residents (USEPA 2014); Assumes 2 weeks away from residence.	
				ED	Exposure Duration	yrs	20	Age-adjusted exposure duration (USEPA 2014)	20	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	events/day	1	Assumed default (USEPA 2004, Exhibit 3-5)	1	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	7,300	ED x 365 days/yr (USEPA 1989)	7,300	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined
[1] See Tables B-6 and B-7 for derivation.
[2] Residents are assumed to be exposed to indoor dust derived from outdoor soil for 350 days/year and to outdoor soil for 150 days/year. These exposure frequencies were used to derive weighted soil ingestion rates and soil adherence factors.
[3] See Tables B-8 for derivation of value for child and Tables B-8 and B-9 for derivation of values for adult.
[4] See Tables B-10 and B-11 for derivation.

Table B-2. Values Used for Daily Intake Calculations - Phase 1, Agricultural Worker Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Units	Adjusted Refined Screening Analysis		Default Refined Screening Analysis		Intake Equation/ Model Name
							Value	Rationale/ Reference	Value	Rationale/ Reference	
Agricultural Worker	Incidental Ingestion	Adult	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	mg/day	100	Default for outdoor workers (USEPA 2014)	100	Default for outdoor workers (USEPA 2014)	
				ABS_o	Oral Absorption Factor	unitless	1	Conservative default	1	Conservative default	
				EF	Exposure Frequency	days/year	150	Assumes 5 days/week for the season from April-October	225	Default for outdoor workers (USEPA 2014)	
				ED	Exposure Duration	yrs	25	Default for outdoor workers (USEPA 2014)	25	Default for outdoor workers (USEPA 2014)	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	9,125	ED x 365 days/yr (USEPA 1989)	9,125	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
	Dermal Contact	Adult	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	cm^2/event	2,632	Assumes face, hands, and forearms. Mean surface areas for adults (USEPA 2011, Table 7-2), See footnote 1	3,470	Default for outdoor workers (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	unitless	0.14	USEPA 2004 based on Wester et al. 1993	0.14	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	mg/cm^2	0.12	Default for outdoor workers (USEPA 2014)	0.12	Default for outdoor workers (USEPA 2014)	
				EF	Exposure Frequency	days/year	150	Assumes 5 days/week for the season from April-October	225	Default for outdoor workers (USEPA 2014)	
				ED	Exposure Duration	yrs	25	Default outdoor worker exposure duration (USEPA 2014)	25	Default outdoor worker exposure duration (USEPA 2014)	
				EV	Event Frequency	events/day	1	Assumed default (USEPA 2004, Exhibit 3-5)	1	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	9,125	ED x 365 days/yr (USEPA 1989)	9,125	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
	Inhalation	Adult	Particulates Derived from Surface Soil	C_A	Chemical Concentration in Air	mg/m^3	TBD	Approach to be used will be presented in PAR	TBD	Approach to be used will be presented in PAR	Exposure Concentration (mg/m^3) = CA x ET x EF x ED x CF x 1/AT
				ET	Exposure Time	hours/day	8	Default for outdoor workers (USEPA 2014)	8	Default for outdoor workers (USEPA 2014)	
				EF	Exposure Frequency	days/yr	150	Assumes 5 days/week for the season from April-October	225	Default for outdoor workers (USEPA 2014)	
				ED	Exposure Duration	yrs	25	Default outdoor worker exposure duration (USEPA 2014)	25	Default outdoor worker exposure duration (USEPA 2014)	
				CF	Conversion Factor	day/hours	0.04	--	0.04	--	
				AT_{nc}	Averaging Time (non-cancer)	days	9,125	ED x 365 days/yr (USEPA 1989)	9,125	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined
[1] See Table B-8 for derivation.

Table B-3. Values Used for Daily Intake Calculations - Phase 1, Outdoor Worker Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Units	Adjusted Refined Screening Analysis		Default Refined Screening Analysis		Intake Equation/ Model Name
							Value	Rationale/ Reference	Value	Rationale/ Reference	
Outdoor Worker	Incidental Ingestion	Adult	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	mg/day	100	Default for outdoor workers (USEPA 2014)	100	Default for outdoor workers (USEPA 2014)	
				ABS_o	Oral Absorption Factor	unitless	1	Conservative default	1	Conservative default	
				EF	Exposure Frequency	days/yr	150	Assumes 5 days/week for the season from April-October	225	Default for outdoor workers (USEPA 2014)	
				ED	Exposure Duration	yrs	25	Default for outdoor workers (USEPA 2014)	25	Default for outdoor workers (USEPA 2014)	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	9,125	ED x 365 days/yr (USEPA 1989)	9,125	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
	Dermal Contact	Adult	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	cm^2/event	2,632	Assumes face, hands, and forearms. Mean surface areas for adults (USEPA 2011, Table 7-2). See footnote 1	3,470	Default for outdoor workers (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	unitless	0.14	USEPA 2004 based on Wester et al. 1993	0.14	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	mg/cm^2	0.12	Default for outdoor workers (USEPA 2014)	0.12	Default for outdoor workers (USEPA 2014)	
				EF	Exposure Frequency	days/yr	150	Assumes 5 days/week for the season from April-October	225	Default for outdoor workers (USEPA 2014)	
				ED	Exposure Duration	yrs	25	Default for outdoor workers (USEPA 2014)	25	Default for outdoor workers (USEPA 2014)	
				EV	Event Frequency	events/day	1	Assumed default (USEPA 2004, Exhibit 3-5)	1	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	9,125	ED x 365 days/yr (USEPA 1989)	9,125	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined
[1] See Table B-8 for derivation.

Table B-4. Values Used for Daily Intake Calculations - Phase 1, Recreational Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Units	Adjusted Refined Screening Analysis		Default Refined Screening Analysis		Intake Equation/ Model Name
							Value	Rationale/ Reference	Value	Rationale/ Reference	
Recreator	Incidental Ingestion	Child	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	mg/day	125	Age-specific ingestion rate for outdoor soil (USEPA 2011, Table 1). See footnote 1.	200	Default for children (USEPA 2014)	
				ABS_o	Oral Absorption Factor	unitless	1	Conservative default	1	Conservative default	
				EF	Exposure Frequency	days/yr	90	Assumes 3 days per week for the season from April - October	90	Assumes 3 days per week for the season from April - October	
				ED	Exposure Duration	yrs	6	Default exposure duration for children (USEPA 2014)	6	Default exposure duration for children (USEPA 2014)	
				BW	Body Weight	kg	18.8	Mean body weight for ages 1 to 6 (USEPA 2011, Table 8-1)	15	Default for children (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	2,190	ED x 365 days/yr (USEPA 1989)	2,190	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	mg/day	20	Recommended soil ingestion rate for adults (USEPA 2011, 5-1)	100	Default for adults (USEPA 2014)	
				ABS_o	Oral Absorption Factor	unitless	1	Conservative default	1	Conservative default	
				EF	Exposure Frequency	days/yr	90	Assumes 3 days per week for the season from April - October	90	Assumes 3 days per week for the season from April - October	
				ED	Exposure Duration	yrs	20	Age-adjusted exposure duration (USEPA 2014)	20	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	7,300	ED x 365 days/yr (USEPA 1989)	7,300	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
	Dermal Contact	Child	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT; DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	cm^2/event	1,950	Assumes face, hands, forearms, lower legs and feet from May-Sept. Assumes face, hands, and forearms in April and October. Seasonally- and age-weighted mean surface areas (USEPA 2011, Table 7-2), See footnote 2.	2,690	Default for child residents (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	unitless	0.14	USEPA 2004 based on Wester et al. 1993	0.14	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	mg/cm^2	0.098	Age-. season- and surface area-weighted adherence (USEPA 2011). See footnote 3.	0.2	Default for child residents (USEPA 2014)	
				EF	Exposure Frequency	days/yr	90	Assumes 3 days per week for the season from April - October	90	Assumes 3 days per week for the season from April - October	
				ED	Exposure Duration	yrs	6	Default exposure duration for children (USEPA 2014)	6	Default exposure duration for children (USEPA 2014)	
				EV	Event Frequency	events/day	1	Assumed default (USEPA 2004, Exhibit 3-5)	1	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	kg	18.8	Mean body weight for ages 1 to 6 (USEPA 2011, Table 8-1)	15	Default for children (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	2,190	ED x 365 days/yr (USEPA 1989)	2,190	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT; DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	cm^2/event	4,453	Assumes face, hands, forearms and lower legs from May through September. Assumes face, hands and forearms in April and October. Seasonally and age-weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	6,032	Default for adult residents (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	unitless	0.14	USEPA 2004 based on Wester et al. 1993	0.14	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	mg/cm^2	0.059	Age-. season- and surface area-weighted adherence (USEPA 2011). See footnote 3.	0.07	Default for adult residents (USEPA 2014)	
				EF	Exposure Frequency	days/yr	90	Assumes 3 days per week for the season from April - October	90	Assumes 3 days per week for the season from April - October	
				ED	Exposure Duration	yrs	20	Age-adjusted exposure duration (USEPA 2014)	20	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	events/day	1	Assumed default (USEPA 2004, Exhibit 3-5)	1	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	7,300	ED x 365 days/yr (USEPA 1989)	7,300	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined
[1] See Table B-6 for derivation
[2] See Tables B-8 and B-9 for derivation
[3] See Tables B-10 and B-11 for derivation

Table B-5. Values Used for Daily Intake Calculations - Phase 1, Construction Worker Exposure to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Units	Adjusted Refined Screening Analysis		Default Refined Screening Analysis		Intake Equation/ Model Name
							Value	Rationale/ Reference	Value	Rationale/ Reference	
Construction Worker	Incidental Ingestion	Adult	Surface and Subsurface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	mg/day	100	Default for outdoor workers (USEPA 2014)	330	Default for construction workers (USEPA 2002)	
				ABS_o	Oral Absorption Factor	unitless	1	Conservative default	1	Conservative default	
				EF	Exposure Frequency	days/yr	130	Assumes 5 days/week for 6 months	250	Default for construction workers (USEPA 2002)	
				ED	Exposure Duration	yrs	1	Assumes 1 year of construction	1	Assumes 1 year of construction	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	365	ED x 365 days/yr (USEPA 1989)	365	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
	Dermal Contact	Adult	Surface and Subsurface Soil	C_s	Chemical Concentration in Soil	mg/kg	TBD	To be determined	TBD	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	cm^2/event	2,632	Assumes face, hands, and forearms. Mean surface areas for adults (USEPA 2011, Table 7-2), See footnote 1 .	3,300	Default for construction workers (USEPA 2002)	
				ABS_d	Dermal Absorption Factor	unitless	0.14	USEPA 2004 based on Wester et al. 1993	0.14	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	mg/cm^2	0.206	Surface area weighted adherence (USEPA 2011). See footnote 2.	0.3	Default for construction workers (USEPA 2002)	
				EF	Exposure Frequency	days/yr	130	Assumes 5 days/weekfor 6 months	250	Default for construction workers (USEPA 2002)	
				ED	Exposure Duration	yrs	1	Assumes 1 year of construction	1	Assumes 1 year of construction	
				EV	Event Frequency	events/day	1	Assumed default (USEPA 2004, Exhibit 3-5)	1	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	kg	80	Default for adults (USEPA 2014)	80	Default for adults (USEPA 2014)	
				CF	Conversion Factor	kg/mg	1.00E-06	--	1.00E-06	--	
				AT_{nc}	Averaging Time (non-cancer)	days	365	ED x 365 days/yr (USEPA 1989)	365	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	
	Inhalation	Adult	Particulates Derived from Surface and Subsurface Soil	C_A	Chemical Concentration in Air	mg/m^3	TBD	Approach to be used will be presented in PAR	TBD	Approach to be used will be presented in PAR	Exposure Concentration (mg/m^3) = CA x ET x EF x ED x CF x 1/AT
				ET	Exposure Time	hours/day	8	Default for outdoor workers (USEPA 2014)	8	Default for outdoor workers (USEPA 2014)	
				EF	Exposure Frequency	days/yr	130	Assumes 5 days/week for 6 months	250	Default for construction workers (USEPA 2002)	
				ED	Exposure Duration	yrs	1	Assumes 1 year of construction	1	Assumes 1 year of construction	
				CF	Conversion Factor	day/hours	0.04	--	0.04	--	
				AT_{nc}	Averaging Time (non-cancer)	days	365	ED x 365 days/yr (USEPA 1989)	365	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	days	25,550	365 days x 70 yrs (USEPA 1989, 2014)	25,550	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined
[1] See Table B-8 for derivation.
[2] See Tables B-10 and B-11 for derivation.

Table B-6. Recommended Age-Specific Soil Ingestion Rates

Age	Outdoor Soil Ingestion Rate (mg/day)		Indoor Dust Ingestion Rate (mg/day)		Soil and Dust Ingestion Rate (mg/day)	
	Central Tendency	Upper Percentile	Central Tendency	Upper Percentile	Central Tendency	Upper Percentile
1 to <6 years [a]	50	--	60	--	100	--
3 to <6 years [a]	--	200	--	100	--	200
6 to <21 years [a]	50	--	60	--	100	--
Weighted Ingestion Rate for 1 - 6 year old [b]	125		80		150	
Adult [a]	20	--	30	--	50	--

[a] Soil ingestion rates from USEPA 2011, Table 5-1.

[b] The weighted ingestion rate for 1 - 6 year olds is calculated using the central tendency value for ages 1, 2 and 6, and the upper percentile value for ages 3, 4 and 5.

Table B-7. Indoor/Outdoor Soil Ingestion Rates

		Outdoor Soil & Indoor Dust		Indoor Dust		Weighted Ingestion Rate (mg/day) [a]
Receptor Population	Age	Ingestion Rate (mg/day)	Days	Ingestion Rate (mg/day)	Days	
Resident	Child (1 - 6 years)	150	150	80	200	110
	Adult	50	150	30	200	39

[a]Calculated as the weighted average of ingestion rates for indoor and outdoor days and indoor days only.

Table B-8. Recommended Mean Surface Areas by Body Part for Males and Females Combined

Age	Head	Face [c]	Arms	Forearms [d]	Hands	Legs	Lower Legs [e]	Feet	Face, Hands, Forearms, Lower Legs and Feet	Face, Hands, Forearms, and Lower Legs	Face, Hands and Forearms
1 year [a]	870	287	690	311	300	1,220	488	330	1,716	1,386	898
2 years [a]	510	168	880	396	280	1,540	616	380	1,840	1,460	844
3 years [a]	610	201	1,060	477	370	1,950	780	490	2,318	1,828	1,048
4 years [a]	610	201	1,060	477	370	1,950	780	490	2,318	1,828	1,048
5 years [a]	610	201	1,060	477	370	1,950	780	490	2,318	1,828	1,048
6 years [a]	660	218	1,510	680	510	3,110	1,244	730	3,381	2,651	1,407
Child (1 to 6 years) [b]	645	213	1,043	470	367	1,953	781	485	2,315	1,830	1,049
Adult [a]	1250	413	2,755	1,240	980	6,400	2,560	1,295	6,487	5,192	2,632

Notes: All values are shown in units of cm^2

[a] Mean surface area for males and females combined from USEPA 2011, Table 7-2.

[b] Calculated as average of 1 to 6 year olds.

[c] Values not reported in USEPA 2011. Based on USEPA 2004; assumes 33% of head for face.

[d] Values not reported in USEPA 2011. Based on USEPA 2004; assumes 45% of arms for forearms.

[e] Values not reported in USEPA 2011. Based on USEPA 2004; assumes 40% of legs for lower legs.

Table B-9. Season-Weighted Surface Areas [a]

		Warmer Outdoor Months May - September		Cooler Outdoor Months April and October		
Scenario	Age	Surface Area (cm^2)	Days/year	Surface Area (cm^2)	Days/year	Weighted Surface Area [b] (cm^2)
Resident	Adult	5,192 [c]	107 [d]	2,632 [e]	43 [f]	4,458
Recreator	Child (1 - 6 years)	2,315 [g]	64 [h]	1,049 [e]	26 [i]	1,950
	Adult	5,192 [c]	64 [h]	2,632 [e]	26 [i]	4,453

[a] Receptors and age groups not shown do not have a seasonal weighting component (see Table B-8 for age-weighted surface areas).

[b] Calculated as the weighted average of surface areas for months May-Sept and April and October.

[c] Assumes face, hands, forearms, and lower legs (see Table B-8).

[d] Assumes 5/7 of the total outdoor exposure frequency of 150 days (i.e., 5 of 7 months).

[e] Assumes face, hands, and forearms (see Table B-8).

[f] Assumes 2/7 of the total outdoor exposure frequency of 150 days (i.e., 2 of 7 months).

[g] Assumes face, hands, forearms, lower legs, and feet (see Table B-8).

[h] Assumes 5/7 of total exposure frequency of 90 days/year (i.e., 5 of 7 months).

[i] Assumes 2/7 of total exposure frequency of 90 days/year (i.e., 2 of 7 months).

Table B-10. Recommended Adherence Factors for Skin

	Face	Arms	Hands	Legs	Feet
Children					
Residential (indoors)	0.054 [a]	0.0041	0.011	0.0035	0.010
Daycare (indoors and outdoors)	0.054 [a]	0.024	0.099	0.020	0.071
Activities with soil	0.054	0.046	0.17	0.051	0.20
Adults					
Activities with soil	0.0240	0.0379	0.1595	0.0189	0.1393
Construction activities	0.0982	0.1859	0.2763	0.066	NA

Notes: Values taken from USEPA 2011, Table 7-4.
All values are shown in units of mg/cm^2
NA = Not available

[a] Value recommended for children exposed to outdoor soil. No value for residential (indoors) or daycare (indoors and outdoors) is available.

Table B-11. Age-, Surface-Area-, and Seasonal Weighted Adherence Factors

	SA, Face (cm^2)	AF, Face (mg/cm^2)	SA, Forearms (cm^2)	AF, Forearms (mg/cm^2)	SA, Hands (cm^2)	AF, Hands (mg/cm^2)	SA, Lower Legs (cm^2)	AF, Lower Legs (mg/cm^2)	SA, Feet (cm^2)	AF, Feet (mg/cm^2)	Area Weighted AF (mg/cm^2)	Relative annual frequency (days/year)	Area- and Season-Weighted AF (mg/cm^2)
Resident													
Children, indoor days	213	0.054	470	0.0041	367	0.011	781	0.0035	485	0.010	0.011	200	0.026
Children, indoor+outdoor days	213	0.054	470	0.024	367	0.099	781	0.02	485	0.071	0.047	150	
Adults, outdoors, May-Sept	413	0.024	1,240	0.0379	980	0.1595	2,560	0.0189	-- [a]	-- [a]	0.050	107	0.025
Adults, outdoors, April+Oct	413	0.024	1,240	0.0379	980	0.1595	-- [a]	-- [a]	-- [a]	-- [a]	0.081	43	
Adults, Nov-March	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	0.0	200	
Recreator													
Children, outdoor days, May-Sept	213	0.054	470	0.046	367	0.17	781	0.051	485	0.20	0.100	64	0.098
Children, outdoor days, April + Oct	213	0.054	470	0.046	367	0.17	-- [a]	-- [a]	-- [a]	-- [a]	0.091	26	
Adults, outdoors, May-Sept	413	0.024	1,240	0.0379	980	0.1595	2,560	0.0189	-- [a]	-- [a]	0.050	64	0.059
Adults, outdoors, April+Oct	413	0.024	1,240	0.0379	980	0.1595	-- [a]	-- [a]	-- [a]	-- [a]	0.081	26	
Construction Worker													
Adults, outdoors	413	0.0982	1,240	0.1859	980	0.2763	-- [a]	-- [a]	-- [a]	-- [a]	0.206	-- [b]	-- [b]

Notes: -- = Not applicable
AF = adherence factor (see Table B-10)
SA = surface area (see Table B-8)

[a] Not conceptualized as an exposed body part for receptor scenario.

[b] No difference in exposed body parts throughout the exposure period.

APPENDIX C

PHASE 2 EXPOSURE SCENARIOS AND PARAMETERS FOR HUMAN HEALTH RISK ASSESSMENT

September 2014 – Corrected November 2014

INTRODUCTION

For Phase 2 of the Upper Hudson River (UHR) Floodplain Baseline Human Health Risk Assessment (BHHRA), the current and reasonably anticipated future uses of each exposure area (EA) will be evaluated. For the majority of human exposure scenarios, two separate analyses will be conducted for Phase 2: a Phase 2 Default Analysis and a Phase 2 Site-Specific Analysis. The Phase 2 Default Analysis will be limited to the default scenarios requested by USEPA. These default scenarios will evaluate residential, recreational, commercial, and construction worker exposures and the consumption of garden produce. They will use the RME exposure assumptions provided in USEPA guidance (USEPA 1991, 2002, 2014) and otherwise approved assumptions where no default values are available from USEPA. The Phase 2 Site-Specific Analysis will evaluate a larger set of site-specific exposure scenarios than were evaluated in Phase 1 to reflect more refined usage patterns, including varying types, intensities, and durations of exposure. The employment of this wider array of exposure scenarios allows for the diversity of land uses within the UHR Floodplain to be taken into account in the risk assessment. This analysis will evaluate both reasonable maximum exposure (RME) and central tendency exposure (CTE) risks and hazards.

As discussed in Section 3.7.2, a separate risk assessment will be conducted to evaluate potential exposures to near-shore sediments. For this analysis, a single set of exposure parameters, as provided by USEPA, will be used.

This appendix describes the specific exposure scenarios to be evaluated in Phase 2 of the BHHRA and presents the RME parameters that will be used to evaluate them under the Phase 2 Default Analysis and Phase 2 Site-Specific Analysis. For agricultural use scenarios, parameters have not been provided for either analysis. USEPA guidance does not currently provide default parameters for an agricultural scenario and, because of the variations in agricultural usage of the Floodplain, it will be necessary to develop EA-specific exposure parameters to address these potential exposures under the Phase 2 Site-Specific Analysis. Exposure parameters for the CTE evaluations, which will also be performed for each EA as part of the Phase 2 Site-Specific Analysis of the BHHRA, will be developed and presented as part of the Pathway Analysis Report (PAR) (see Section 3.4 of this Work Plan).

Both the Phase 2 Default Analysis and the Phase 2 Site-Specific Analysis will be presented in the Final BHHRA Report for USEPA's consideration. While the parameters and assumptions to be used in each are presented in the tables of this appendix, it should be noted that USEPA has not currently adopted the use of the non-default parameters proposed for Phase 2. GE can provide the rationale for the use of those parameters in the PAR and USEPA will review the information provided for potential consideration of their use.

EXPOSURE SCENARIOS

The exposure scenarios for the Phase 2 Site-Specific Analysis have been selected to encompass the diversity of land uses that are known to occur in the UHR Floodplain, including residential, agricultural, seasonal residential, school, recreational, and commercial usage. The scenarios to be evaluated are described below. The categories to which each of the Phase 2 site-specific scenarios will be assigned for the Phase 2 Default Analysis are also discussed.

- Residential Use: There are three general types of residential parcels located on the Floodplain. The first type consists of parcels that include a house located within or close to the Floodplain so that there is a potential for individuals to contact Floodplain soils while outdoors and also to track outdoor Floodplain soils into the house. The second type comprises parcels on which the residential home is located at a sufficient distance from the Floodplain boundary that it is unlikely that residents will track Floodplain soils into the house. The third type of residential parcels consists of those with homes and maintained yards that are outside of the Floodplain and on which there are physical constraints, such as steep topography or wet areas, which make it unlikely that the Floodplain area is regularly used. For the Phase 2 Site-Specific Analysis, potential exposures at this third type of residential property will be evaluated using a recreational scenario (i.e., the most appropriate of Recreational 1, 2, and 3, as discussed below). EAs for the first and second types of residential parcels will be defined as the area of the property that residents are likely to use (including both Floodplain and non-Floodplain portions). This may be the entire parcel or a subarea of the parcel. The Phase 2 Site-Specific Analysis residential scenarios are as follows:

- Residential 1 will be a residential scenario in which it is assumed that adults and children may have regular contact with Floodplain soils within the EA and with indoor dust derived from those soils. This scenario will be evaluated assuming that individuals may have direct contact with surface soil (0- to 12-inch depth) outdoors during the warmer months of the year (April through October) and that they may be exposed to indoor dust derived from outdoor surface soil throughout the year. While it is possible that individuals may also occasionally be present in Floodplain areas during the late fall, winter, or early spring, the climatic conditions in northern New York during this period (cold temperatures resulting in the wearing of heavy clothing, frozen ground, and snow cover) will minimize any potential for direct contact exposure during those months. This scenario will be applied to all EAs at which residential homes are located at a distance from the Floodplain at which there is potential for tracking Floodplain soils into the house. It will also be applied as a future use scenario for EAs where it is determined that future residential use is reasonably anticipated and where the physical characteristics of the EA would allow a house to be constructed close to the Floodplain.
- Residential 2 will be similar to Residential 1 with the exception that it will not be assumed that indoor dusts are derived from Floodplain soils. Thus, the only potential for exposure will be through direct contact with outdoor soils in the EA from April through October. On a case-by-case basis, Residential 2 will be applied to properties where a portion of the EA is in the Floodplain, but the home is located a sufficient distance away from the outer Floodplain boundary (or there is some physical barrier) such that residents who may contact outdoor Floodplain soils are unlikely to track such soils into the house. It will also be applied as a future use scenario for EAs where it is determined that future residential use is reasonably anticipated and where the physical characteristics of the EA would preclude construction of a house close to the Floodplain.

For the Phase 2 Default Analysis, EAs in both the Residential 1 and Residential 2 scenarios will be assigned to the default residential scenarios. Residential properties at which it is unlikely that the Floodplain area would be regularly used will be assigned to the default recreational scenario.

- Agricultural Use: There are a number of agricultural fields that are contained at least in part within the Floodplain of the UHR. Most of these are crop fields on which feed crops, such as corn and hay, are grown and there are no homes present. However, in some locations, the farm fields are located adjacent to residential homes and, in at least one case, there is a "backyard" farm on which vegetables are grown and livestock are grazed. Thus, it will be necessary to consider a variety of agricultural exposures and to consider appropriate combinations of those agricultural exposures on an EA-specific basis. Potential exposure pathways that may be considered on agricultural EAs include:

  - Residential exposures – Potential exposure to children and adults through direct contact with surface soil (top foot) under the appropriate residential scenario described above.
  - Worker exposures – Potential exposure to adult workers through direct contact with surface soil.
  - Ingestion of home-grown farm products or livestock – The specific farm products to be considered will vary depending upon the crops grown on the individual parcels and/or the animals being raised there.

  Agricultural EAs will be evaluated in a site-specific manner in the Phase 2 Site-Specific Analysis. In addition, for each agricultural scenario for a given agricultural EA, if default exposure assumptions are available, they will also be applied as part of the Phase 2 Default Analysis.

- Seasonal Residential Use: There are a number of parcels in the UHR Floodplain at which there are camps or seasonal residences. Many of these parcels are owned by the New York State Canal Corporation (NYSCC) or utility companies and are leased/permitted to individuals on an annual basis for limited use. Restrictions included in these leases/permits generally preclude earthwork and the development of these parcels for permanent, year-round residential homes.

  These seasonal residences are generally small and are located very near or within the Floodplain of the river. They are used regularly only during the warmer months (assumed to be June through August for this scenario) and often only on the weekends. Because of their locations, there is potential for direct contact with surface

Floodplain soil (0- to 12-inch depth) at EAs defined at or within these parcels and also potential for indoor dust derived from Floodplain soil. However, the number of days spent in these EAs will be much lower than the number of days spent at an EA that contains a permanent home. Thus, for the Phase 2 Site-Specific Analysis the age groups and exposure pathways evaluated will be similar to those specified for the above-described residential scenarios, but the exposure frequency will be decreased to 90 days per year to reflect seasonal usage. That frequency reflects use during the summer, especially on weekends and during vacations, as well as potential occasional use during the spring and fall.

There currently are other seasonal properties (e.g., RVs, camps) that are privately owned. Some of these are located on islands while others are located on the mainland. Because access to islands is very limited in the winter and utilities are not typically available there, it is unlikely that permanent year-round residences will ever be built on these parcels. Thus, the seasonal use scenario described in the preceding paragraph will be used to evaluate these properties. There are also, however, privately owned seasonal parcels on the mainland that have easier access to roads and utilities and could potentially be converted to permanent homes in the future. Thus, EAs on these parcels will be evaluated assuming seasonal residential use as the current use, but future use will be assumed to be residential if it is reasonably anticipated that permanent homes would be present there in the future. In this case, for the Phase 2 Site-Specific Analysis, the reasonably anticipated future use will be evaluated using the most relevant residential scenario discussed previously.

For the Phase 2 Default Analysis, these EAs will be assigned to the default recreational scenario if construction of a permanent home is not reasonably anticipated. Those EAs at which future construction of a permanent home is reasonably anticipated will be assigned to the default residential scenario.

- <u>School Use</u>: There are currently five designated school properties on which a portion of the property falls within the UHR Floodplain. Some of these parcels have maintained areas or recreational fields in or adjacent to the Floodplain. On other properties, the Floodplain area is largely paved or is confined to a narrow strip along the river that does not appear to have usage during the school day. On those school properties where the Floodplain portion consists of maintained areas or athletic fields, there is potential for students, teachers, and maintenance workers to have regular contact with Floodplain soils during the school day and/or during athletic events. The age groups of the individuals exposed will vary and may include adults, pre-kindergarten, elementary, middle-school, or high-school aged children who attend the school, and different age groups of children and/or adults who may use the athletic fields during the school year or the summer months. On the school properties where the Floodplain is more remote from the maintained area, it is most likely that those areas are used on a less regular, recreational basis, if at all. It will be necessary to consider a variety of direct contact exposures on school properties and to consider the most appropriate combinations of age groups and activity types on an EA-specific basis. Potential exposure pathways that may be considered at these EAs include:

- School exposures – Potential direct contact exposure to surface soil in maintained areas for school-age children (specific to each school) and adults during the school year.
- Worker exposures – Potential direct contact exposure to surface soils in maintained areas for adults who are responsible for maintenance of school property throughout the year.
- Recreational exposures – Potential direct contact exposure to surface soil in maintained areas or athletic fields for adults, adolescents, and/or children who may use those areas for recreational purposes during the school year or the summer months or both. For properties where the Floodplain is more remote from the maintained area, this pathway may include more infrequent direct contact to surface soils for individuals who occasionally use the Floodplain portion of these parcels for other recreational purposes.

For the Phase 2 Site-Specific Analysis, these parcels will be evaluated using site-specific parameters. The appropriate scenarios and age groups to be evaluated for each school property and the exposure assumptions and parameters used to evaluate them will be presented in the PAR. For the Phase 2 Default Analysis, school properties will be assigned to the default residential scenario.

- Recreational Use: There are numerous areas of undeveloped land along the UHR Floodplain and they vary in nature. Some are well developed for recreational usage, such as parks and boat launches, or contain easily accessible river access areas. Others are more remote and have no obvious signs of regular recreational usage, but may have trails indicating that they are intermittently used. Finally, there are areas that are remote from public access areas, are heavily overgrown or wet, and have no signs of recreational use, but where occasional future recreational use is reasonably anticipated. Depending on the area(s) of the parcel at which use is anticipated, EAs may be defined as the entire parcels or subareas within any of these types of recreational land. The three recreational scenarios that will be evaluated in the Phase 2 Site-Specific Analysis are:
  - Recreational 1 (high use recreation) will be evaluated in those EAs where there are obvious signs of public usage (such as parks, marinas, and boat launches) or where public use is likely to occur (e.g., beach areas, docks adjacent to roads). This scenario will assume that children and adults may regularly participate in recreational activities in these areas during the warmer months of the year (April through October) and that they may have contact with Floodplain surface soils (0- to 12-inch depth) during those activities. As discussed under the Residential scenarios, it is possible that individuals may also be present in some of these areas during the late fall, winter, or early spring; however, climatic conditions in northern New York during this period will minimize potential for any direct contact exposure to occur.
  - Recreational 2 (medium use recreation) will be evaluated in those EAs that may be used for recreational purposes, but at which no signs of regular usage are present. These EAs might include undeveloped bank areas near public roads, accessible parcels that do not appear to be regularly used, and remote portions of parcels that are used for other purposes and so not likely used for regular recreation (e.g., large commercially zoned parcels on which the Floodplain is distant from the buildings and there are no obvious signs of Floodplain usage). The soil depth, exposure pathways, and assumptions for children and adults will be the same as those used for Recreational 1, except that the exposure frequency will be lower.

- Recreational 3 (low use recreation) will be evaluated in those undeveloped EAs that are remote and difficult to access, have steep banks leading to the Floodplain, or contain wet areas. It will be assumed that individuals may occasionally be in these EAs for some purpose but because of the potential safety hazards (e.g., steep, rocky banks) and/or difficult access due to lack of established trails, wetlands and/or heavy overgrowth, only older children and adults will be present there. This scenario will use the same assumptions used to evaluate Recreational 1 and 2, except that it will be assumed that young children will not be present in these areas and that the exposure frequency will be lower than that for Recreational 2.

For the Phase 2 Default Analysis, Recreational 1, 2, and 3 EAs will be assigned to the default recreational scenario.

- <u>Outdoor Worker Scenarios</u>: There are two general types of parcels in the UHR Floodplain at which commercial outdoor work occurs. The first type consists of parcels that include the Floodplain in some portion of the area(s) in which individuals would be working; the second type consists of parcels that include Floodplain only on a portion of the property that is remote from areas that are being used by workers (e.g., at the edge of the property by the river) but may be used by other individuals for recreational purposes. Potential exposures on this second type of commercial parcel will be evaluated using a recreational scenario. For the Phase 2 Site-Specific Analysis, the most appropriate of the Recreational 1, 2, or 3 scenarios will be evaluated; for the Phase 2 Default Analysis, the default recreational scenario will be used, as discussed above).

  EAs for the first type of commercial parcels described will be selected as the area where worker exposures are anticipated to occur. For the Phase 2 Site-Specific Analysis, these parcels will be further differentiated based on the types of workers who may be exposed to Floodplain soil: (1) those individuals who work outdoors daily in the same location and so may have regular contact with Floodplain soils; and (2) those who may visit an EA on a less regular basis for the purpose of groundskeeping or other occasional maintenance activities. Thus, both a regular, daily outdoor worker scenario and a more intermittent groundskeeper scenario will be evaluated in the BHHRA. Under the Phase 2 Site-Specific Analysis, the outdoor worker scenarios that will be evaluated are:

- The Outdoor Worker 1 scenario involves an adult who works outdoors daily during the year, engaged in activities such as marina work, lumberyard activities, and park maintenance. This individual may work outdoors in the same EA daily throughout the work week. Therefore, this individual would have potential for direct contact with surface soil during the warmer months of the year. While some individuals may also work outdoors during the late fall, winter, and early spring months, the climatic conditions in the area of the UHR during that time would result in frozen ground, snow cover, and the need to wear heavy clothing for warmth. All of these factors would inhibit potential for any direct contact with soil during that period.
- The Outdoor Worker 2 scenario involves an adult groundskeeper who periodically mows lawns and performs other maintenance activities in an EA. The groundskeeper would have potential for direct contact with surface soil while working on the EA but that potential would be limited to a few hours per week due to the intermittent need for landscaping activity. This scenario will apply to commercial businesses, churches, or public properties that are mostly paved and have limited areas of landscaping that require maintenance, and for which there are no employees that are required to undertake regular outdoor work activities. Direct contact with surface soil by a groundskeeper will be evaluated as a seasonal exposure spanning from the beginning of April through the end of October. Maintenance activities of this type would not be required during the other months of the year when the ground is frozen or snow covered. The key difference between Outdoor Worker 1 and Outdoor Worker 2 is that the exposure frequency for Outdoor Worker 2 is more intermittent than the exposure frequency for Outdoor Worker 1.

For the Phase 2 Default Analysis, EAs to which either of these scenarios applies will be assigned to the default commercial worker scenario.

- Utility Worker Scenario: Utility work may occur in identified utility corridors (e.g., power lines and sewer lines). This work is expected to be intermittent and of a short duration in a single EA but these activities may be repeated on an annual basis. In addition, because this work may involve excavation into deeper soils, it may include exposures to both surface and subsurface soils. Thus, for the Phase 2 Site-Specific

Analysis, direct contact with soils in the upper 4 feet will be evaluated for an adult utility worker in any EAs on which the utility work is likely to involve excavation. Conversely, for those EAs that include utilities that are above ground so that excavation activities are not likely to occur, the 0- to 12-inch soil depth increment will be evaluated. For the Phase 2 Default Analysis, EAs on which utility work is expected to occur will be assigned to the default construction worker scenario (discussed below).

There are three additional scenarios that could occur almost anywhere on the Floodplain parcels and do not depend on the assigned land use categories. These include construction work, residential gardens on residential EAs, and utility work outside of the EAs that are designated as utility corridors. The following scenarios will be applied as future use scenarios at any EAs where such activities are reasonably anticipated.

- Construction Worker: While it is necessary to get permission to undertake new construction in the Floodplain and it is unlikely that new construction will be permitted there, an existing home may require some construction activities if it is remodeled or enlarged. In addition, in some places, roads cross through the UHR Floodplain so that if road repairs are necessary, there may be some potential for exposure to Floodplain soils during that work. Construction often requires excavation. Thus, it is likely that exposures during this activity would be to a combination of surface and deeper subsurface soils (0 to 10 feet). Unlike utility work, construction activities in a single location may continue for an extended period of time but only occur during a single year and are not likely to be repeated yearly. Potential construction worker exposures to surface and subsurface soils will be evaluated for an extended period during a single year at any EAs to which this scenario is applied. Construction workers will be evaluated using both the parameters outlined for the Phase 2 Default Analysis and those specified for the Phase 2 Site-Specific Analysis.
- Residential Garden: Some residential homes may now, or in the future, have home gardens in which they grow produce for home consumption. The Residential Garden scenario will evaluate these potential exposures for any EAs where such use is reasonably anticipated to occur in the Floodplain. This scenario will consider

potential exposures to adults and children who may grow surface and root vegetables in surface soil (0- to 12-inch depth) for their own consumption. These EAs will be evaluated using two sets of exposure parameters – one for the Phase 2 Default Analysis and a second for the Phase 2 Site-Specific Analysis.

- Utility Workers: In addition to the potential exposures in utility corridors described above, utility work may occur on privately owned properties where it is necessary to replace or repair existing underground utilities or run utilities to newly built structures. As described above, these workers would have intermittent, short-term exposures that may include exposures to both surface and subsurface soils. For the Phase 2 Site-Specific Analysis, utility workers will be evaluated using a unique set of parameters that reflect the intermittent and short-term exposures to such soils (to a depth of 4 feet) that are anticipated for this receptor. USEPA does not have default exposure parameters for utility workers. Thus, under the Phase 2 Default Analysis, utility workers will be evaluated using parameters outlined for the construction workers (default analysis).
- Near-Shore Sediment Exposures: In addition to the scenarios described above, the near-shore sediment areas with a reasonable potential for human use, as identified through the process described in Section 2.4, will be evaluated. These near-shore sediment areas are exposed only when river flow is low (typically discrete periods during the late summer and fall), and the exposure during these periods tends to be intermittent and short-term because of variations in daily flow. Thus, a low frequency recreational scenario will be used to evaluate exposures in these areas. This scenario will evaluate potential exposures to young children, adolescents, and adults. Unlike the evaluations for Floodplain soils, the risk evaluation for near-shore sediments will be conducted using a single set of exposure parameters that have been provided by USEPA.

EXPOSURE PARAMETERS

The RME parameters for Phase 2 of the BHHRA have been selected to reflect conservative assumptions that characterize complete exposure pathways for human receptors, including incidental ingestion of, and dermal contact with, Floodplain soil (see Figure 3-1 of this Work

Plan). The exposure parameters for the Phase 2 Site-Specific Analysis consider information outlined in USEPA's 2011 *Exposure Factors Handbook*, where available, as well as certain factors presented in USEPA's 2014 *Update of Standard Default Exposure Factors*, where relevant; and they consider climatic conditions along the UHR Floodplain, which will affect the potential for exposures under the defined scenarios. The exposure parameters selected for the Phase 2 Site-Specific Analysis are more site-specific and refined than those selected for the Phase 1 Adjusted Refined Screening Analysis. Exposure parameters have been selected to characterize the wider array of exposure scenarios described above. In addition, while the Phase 1 exposure parameters were developed for only two age groups (young children and adults), the exposure parameters for the Phase 2 Site-Specific Analysis have been developed for three age groups (young children, older children, and adults). Because different age groupings are anticipated to be exposed under the various exposure scenarios defined for Phase 2, and because the intensity of some contact pathways varies with age, employing parameters for three age groups instead of the two used in the Phase 1 evaluation allows for exposures and risks to be more accurately characterized. Exposure parameters for the Phase 2 Default Analysis are based on the default values provided in USEPA guidance (USEPA 1991, 2002, 2014). Where no default exposure assumptions are available, the exposure parameter values will be proposed to USEPA for review and approval.

Tables C-1 through C-11 (provided in RAGS D Table Series 4 format) outline the exposure parameters that will be used in the Phase 2 Site-Specific Analysis for most of the exposure scenarios described above – namely, residents (Residential 1 and 2 scenarios), seasonal residents, recreators (Recreational 1, 2, and 3 scenarios), outdoor commercial workers (Outdoor Worker 1 and 2 scenarios), utility workers, construction workers, and consumption of home-grown produce. Tables C-12 through C-17 provide additional details on the derivation of specific exposure parameters for the Site-Specific Analysis. Tables C-18 through C-22 outline the exposure parameters that will be used in the Phase 2 Default Analysis for residential, recreational, outdoor commercial worker, construction, and residential garden scenarios. Table C-23 outlines the exposure parameters that will be used to evaluate exposures to near-shore sediments.

Exposure parameters for agricultural scenarios that assume the presence of a home and the raising of crops and/or livestock for human consumption are not presented in this appendix because EA-specific information regarding the agricultural setting and the complete exposure pathways at these agricultural EAs will be gathered in order to develop more specific parameters to be used in characterizing potential exposures there. Such EA-specific information may include the presence or absence of a residence, the specific crops and livestock raised, and the end uses of each. EA-specific parameters for the agricultural areas to be evaluated in Phase 2 will be presented in the PAR.

Similarly, this appendix does not present exposure parameters for the Phase 2 Site-Specific Analysis of school properties that contain portions within the UHR Floodplain, where potential exposures to school children and/or adults will be evaluated. (Under the Phase 2 Default Analysis, these properties will be evaluated under the default residential scenario.) The parameters to be used for these properties will depend on the location of the school yard and associated playing fields (if any) relative to the Floodplain, and the ages of the children who attend the school and/or use the playing fields. The EA-specific parameters to be used for each of these properties will be presented in the PAR.

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TABLES

Table C-1. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Residential 1 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River

REASONABLE MAXIMUM EXPOSURE
UPPER HUDSON RIVER FLOODPLAIN
Exposure Medium: Surface Soil

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Resident 1	Incidental Ingestion	Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	110	mg/day	Age- and frequency-weighted ingestion rates for indoor and outdoor soil (USEPA 2011. Table 5-1). See footnote 1.	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 4.	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	77	mg/day	Age- and frequency-weighted value for indoor and outdoor soil exposure; Table 5-1 (USEPA 2011). See footnote 1.	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 4.	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	39	mg/day	Age- and frequency-weighted ingestion rates for indoor and outdoor soil (USEPA 2011; Table 5-1). See footnote 1.	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 4.	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is 26 years.	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-1. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Residential 1 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River

REASONABLE MAXIMUM EXPOSURE
UPPER HUDSON RIVER FLOODPLAIN
Exposure Medium: Surface Soil

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
		Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	2,315	cm^2/event	Assumes face, hands, forearms, lower legs and feet. Age-weighted mean surface area (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.026	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 4.	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA, 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
	Dermal Contact	Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	3,810	cm^2/event	Assumes face, hands, forearms, lower legs, and feet from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.042	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 4.	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA, 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-1. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Residential 1 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River

REASONABLE MAXIMUM EXPOSURE
UPPER HUDSON RIVER FLOODPLAIN
Exposure Medium: Surface Soil

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	4,458	cm^2/event	Assumes face, hands, forearms and lower legs from May through September. Assumes face, hands and forearms in April and October. Seasonally weighted mean surface areas for adults (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.025	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence. See footnote 4.	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is 26 years.	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA, 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes

TBD = To be determined

[1] See Tables C-12 and C-13 for derivation.

[2] See Table C-14 for derivation of value for young child and Tables C-14 and C-15 for derivation of values for older child and adult.

[3] See Tables C-16 and C-17 for derivation.

[4] Residents are assumed to be exposed to indoor dust derived from outdoor soil for 350 days/year and to outdoor soil for 150 days/year. These exposure frequencies were used to derive weighted soil ingestion rates and soil adherence factors.

Table C-2. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Residential 2 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Resident 2	Incidental Ingestion	Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	125	mg/day	Age- weighted ingestion rate for outdoor soil; (USEPA 2011. Table 5-1). See footnote 1.	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	150	days/yr	Five days per week for seven months per year (April - October)	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	50	mg/day	Age- specific recommended outdoor soil ingestion rate (USEPA 2011. Table 5-1).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	150	days/yr	Five days per week for seven months per year (April - October)	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	20	mg/day	Recommended outdoor soil ingestion rate for adults (USEPA 2011, 5-1).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	150	days/yr	Five days per week for seven months per year (April - October)	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is 26 years.	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-2. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Residential 2 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
	Dermal Contact	Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	1,952	cm^2/event	Assumes face, hands, forearms, lower legs, and feet from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.098	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	150	days/yr	Five days per week for seven months per year (April - October)	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	3,810	cm^2/event	Assumes face, hands, forearms, lower legs, and feet from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.097	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	150	days/yr	Five days per week for seven months per year (April - October)	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-2. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Residential 2 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	4,458	cm^2/event	Assumes face, hands, forearms and lower legs from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.059	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	150	days/yr	Five days per week for seven months per year (April - October)	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes

TBD = To be determined

[1] See Table C-12 for derivation.

[2] See Tables C-14 and C-15 for derivation.

[3] See Tables C-16 and C-17 for derivation.

Table C-3. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Seasonal Residential Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Seasonal Resident	Incidental Ingestion	Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	131	mg/day	Age- and frequency-weighted ingestion rates for indoor and outdoor soil (USEPA 2011. Table 5-1). See footnote 1.	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	90	days/yr	Assumes 7 days per week during the warmest months of the year (June, July and August) - indoor and outdoor exposure. See footnote 2.	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	89	mg/day	Age- and frequency-weighted value for indoor and outdoor soil exposure; Table 5-1 (USEPA 2011). See footnote 1.	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	90	days/yr	Assumes 7 days per week during the warmest months of the year (June, July and August) - indoor and outdoor exposure. See footnote 2.	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 2011)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	44	mg/day	Age- and frequency-weighted value for indoor and outdoor soil exposure; Table 5-1 (USEPA 2011). See footnote 1.	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	90	days/yr	Assumes 7 days per week during the warmest months of the year (June, July and August) - indoor and outdoor exposure. See footnote 2.	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is 26 years.	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 2011)	

Table C-3. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Seasonal Residential Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
		Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	2,315	cm^2/event	Assumes face, hands, forearms, lower legs and feet. Age-weighted mean surface area (USEPA 2011, Table 7-2). See footnote 3.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.047	mg/cm^2	Age-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	90	days/yr	Assumes 7 days per week during the warmest months of the year (June, July and August). See footnote 2.	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA, 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
	Dermal Contact	Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	4,591	cm^2/event	Assumes face, hands, forearms, lower legs and feet. Age-weighted mean surface area (USEPA 2011, Table 7-2). See footnote 3.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.099	mg/cm^2	Age-, and surface area-weighted adherence (USEPA 2011). See footnote 4.	
				EF	Exposure Frequency	90	days/yr	Assumes 7 days per week during the warmest months of the year (June, July and August). See footnote 2.	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA, 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-3. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Seasonal Residential Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
				C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	
				SA	Exposed Skin Surface Area	5,192	cm^2/event	Assumes face, hands, forearms, and lower legs. Age-weighted mean surface area (USEPA 2011, Table 7-2). See footnote 3.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.050	mg/cm^2	Age-, and surface area-weighted adherence (USEPA 2011). See footnote 4.	
		Adult	Surface Soil	EF	Exposure Frequency	65	days/yr	Assumes 5 days per week during the warmest months of the year (June, July and August)	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT $DA_{event} = C_s$ x CF x AF x ABS_d
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is 26 years.	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA, 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes:

TBD = To be determined

[1] See Tables C-12 and C-13 for derivation.

[2] Seasonal residents are assumed to be exposed to indoor dust derived from outdoor soil for 90 days/year and to outdoor soil for 65 days/year. These exposure frequencies were used to derive weighted soil ingestion rates.

[3] See Table C-14 for derivation.

[4] See Tables C-16 and C-17 for derivation.

Table C-4. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Recreator 1 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Recreator 1	Incidental Ingestion	Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	125	mg/day	Age- weighted ingestion rate for outdoor soil; (USEPA 2011. Table 5-1). See footnote 1.	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	50	mg/day	Age- specific recommended outdoor soil ingestion rate (USEPA 2011. Table 5-1).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	20	mg/day	Recommended outdoor soil ingestion rate for adults (USEPA 2011, 5-1).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is residential default of 26 years.	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-4. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Recreator 1 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
		Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	1,950	cm^2/event	Assumes face, hands, forearms, lower legs, and feet from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.098	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
	Dermal Contact	Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	3,804	cm^2/event	Assumes face, hands, forearms, lower legs, and feet from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.097	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-4. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Recreator 1 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	4,452	cm^2/event	Assumes face, hands, forearms and lower legs from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.059	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is residential default of 26 years.	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes
TBD = To be determined
[1] See Table C-12 for derivation.
[2] See Tables C-14 and C-15 for derivation.
[3] See Tables C-16 and C-17 for derivation.

Table C-5. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Recreator 2 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Recreator 2	Incidental Ingestion	Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	125	mg/day	Age- weighted ingestion rate for outdoor soil; (USEPA 2011. Table 5-1). See footnote 1.	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	60	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	50	mg/day	Age- specific recommended outdoor soil ingestion rate (USEPA 2011. Table 5-1).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	60	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	20	mg/day	Recommended outdoor soil ingestion rate for adults (USEPA 2011, 5-1).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	60	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is residential default of 26 years.	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-5. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Recreator 2 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
	Dermal Contact	Young Child (1 - 6 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	1,977	cm^2/event	Assumes face, hands, forearms, lower legs, and feet from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.098	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	60	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	18.8	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	3,865	cm^2/event	Assumes face, hands, forearms, lower legs, and feet from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.097	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	60	days/yr	Assumes 3 days per week during the warmer months of the year	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-5. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Recreator 2 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	4,510	cm^2/event	Assumes face, hands, forearms, and lower legs from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 2.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.059	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 3.	
				EF	Exposure Frequency	60	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is residential default of 26 years.	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes
TBD = To be determined
[1] See Table C-12 for derivation.
[2] See Tables C-14 and C-15 for derivation.
[3] See Tables C-16 and C-17 for derivation.

Table C-6 Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Recreator 3 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Recreator 3	Incidental Ingestion	Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	50	mg/day	Age- specific recommended outdoor soil ingestion rate (USEPA 2011. Table 5-1).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	30	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	20	mg/day	Recommended outdoor soil ingestion rate for adults (USEPA 2011, 5-1).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	30	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	14	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is residential default of 26 years.	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	5,110	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Table C-6 Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Recreator 3 Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
	Dermal Contact	Older Child (7 - 18 years)	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT $DA_{event} = C_s$ x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	3,864	cm^2/event	Assumes face, hands, forearms, lower legs, and feet from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 1.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.097	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 2.	
				EF	Exposure Frequency	30	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	52.2	kg	Age-specific mean body weight (USEPA 2011, Table 8-1)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT $DA_{event} = C_s$ x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	4,510	cm^2/event	Assumes face, hands, forearms, and lower legs from May through September. Assumes face, hands and forearms in April and October. Age- and season weighted mean surface areas (USEPA 2011, Table 7-2). See footnote 1.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.059	mg/cm^2	Age-, season-, and surface area-weighted adherence (USEPA 2011). See footnote 2.	
				EF	Exposure Frequency	30	days/yr	Assumes 3 days per week during the warmer months of the year (April - October)	
				ED	Exposure Duration	14	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is residential default of 26 years.	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	5,110	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes
TBD = To be determined
[1] See Tables C-14 and C-15 for derivation.
[2] See Tables C-16 and C-17 for derivation.

Table C-7 Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Outdoor Worker 1 Exposure to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Outdoor Worker 1	Incidental Ingestion	Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	20	mg/day	Recommended outdoor soil ingestion rate for adults (USEPA 2011, Table 5-1).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	150	days/yr	Assumes 5 days/week for the season from April-October	
				ED	Exposure Duration	25	yrs	Default for outdoor workers (USEPA 2014)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	9,125	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
	Dermal Contact	Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	2,632	cm^2/event	Assumes face, hands, and forearms. Mean surface areas for adults (USEPA 2011, Table 7-2). See footnote 1.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.081	mg/cm^2	Surface area weighted adherence (USEPA 2011). See footnote 2.	
				EF	Exposure Frequency	150	days/yr	Assumes 5 days/week for the season from April-October	
				ED	Exposure Duration	25	yrs	Default for outdoor workers (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	9,125	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes
TBD = To be determined
[1] See Table C-14 for derivation.
[2] See Tables C-16 and C-17 for derivation.

Table C-8. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Outdoor Worker 2 Exposure to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Outdoor Worker 2	Incidental Ingestion	Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	20	mg/day	Recommended outdoor soil ingestion rate for adults (USEPA 2011, Table 5-1)	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	30	days/yr	Assumes 1 day/week for the season from April-October	
				ED	Exposure Duration	25	yrs	Default for outdoor workers (USEPA 2014)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	9,125	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
	Dermal Contact	Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	2,632	cm^2/event	Assumes face, hands, and forearms. Mean surface areas for adults (USEPA 2011, Table 7-2). See footnote 1.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.081	mg/cm^2	Surface area weighted adherence (USEPA 2011). See footnote 2.	
				EF	Exposure Frequency	30	days/yr	Assumes 1 day/week for the season from April-October	
				ED	Exposure Duration	25	yrs	Default for outdoor workers (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	9,125	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes

TBD = To be determined

[1] See Table C-14 for derivation.

[2] See Tables C-16 and C-17 for derivation.

Table C-9. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Utility Worker Exposure to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

Scenario Timeframe: Current/Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Utility Worker	Incidental Ingestion	Adult	Surface and Subsurface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	100	mg/day	Default for outdoor workers (USEPA 2014)	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	30	days/yr	Assumes 30 days per year as requested by USEPA	
				ED	Exposure Duration	25	yrs	Default for outdoor workers (USEPA 2014)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	9,125	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
	Dermal Contact	Adult	Surface and Subsurface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	2,632	cm^2/event	Assumes face, hands, and forearms. Mean surface areas for adults (USEPA 2011, Table 7-2), See footnote 1.	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.206	mg/cm^2	Surface area weighted adherence (USEPA 2011). See footnote 2.	
				EF	Exposure Frequency	30	days/yr	Assumes 30 days per year as requested by USEPA	
				ED	Exposure Duration	25	yrs	Default for outdoor workers (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	9,125	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes
TBD = To be determined
[1] See Table C-14 for derivation.
[2] See Tables C-16 and C-17 for derivation.

Table C-10. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Construction Worker Exposure to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Construction Worker	Incidental Ingestion	Adult	Surface and Subsurface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	100	mg/day	Default for outdoor workers (USEPA 2014)	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	130	days/yr	Assumes 5 days/week during a 6 month construction job	
				ED	Exposure Duration	1	yrs	Assumes 1 year of construction	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	365	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
	Dermal Contact	Adult	Surface and Subsurface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	2,632	cm^2/event	Assumes face, hands, and forearms. Mean surface areas for adults (USEPA 2011, Table 7-2), See footnote 1	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.206	mg/cm^2	Surface area weighted adherence (USEPA 2011). See footnote 2	
				EF	Exposure Frequency	130	days/yr	Assumes 5 days/week during a 6 month construction job	
				ED	Exposure Duration	1	yrs	Assumes 1 year of construction	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	365	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
	Inhalation	Adult	Particulates Derived from Surface and Subsurface Soil	C_A	Chemical Concentration in Air	TBD	mg/m^3	Approach to be used will be presented in PAR	Exposure Concentration (mg/m^3) = CA x ET x EF x ED x CF x 1/AT
				ET	Exposure Time	8	hours/day	Default for outdoor workers (USEPA 2014)	
				EF	Exposure Frequency	130	days/yr	Assumes 5 days/week during a 6 month construction job	
				ED	Exposure Duration	1	yrs	Assumes 1 year of construction	
				CF	Conversion Factor	0.04	day/hours	--	
				AT_{nc}	Averaging Time (non-cancer)	365	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes
TBD = To be determined
[1] See Table C-14 for derivation.
[2] See Tables C-16 and C-17 for derivation.

Table C-11. Values Used for Daily Intake Calculations - Phase 2 Site-Specific Analysis, Residential Gardener Exposure to Homegrown Produce
Reasonable Maximum Exposure - Upper Hudson River Floodplain

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Homegrown Crops

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Residential Gardener	Ingestion of Homegrown Produce	Young Child (1 - 6 years)	Homegrown Produce	$C_{produce}$	Chemical Concentration in Produce	TBD	mg/kg	Approach to be used will be presented in PAR	Intake (mg/kg-day) = $C_{produce}$ x $IgR_{produce}$ x EF x ED x CF x 1/AT
				$IgR_{produce}$	Ingestion Rate (home-grown produce)	1.1	g/kg-day	Age-adjusted, annualized average daily consumption of home-produced vegetables for populations that garden (Table 13-1, USEPA 2011)	
				EF	Exposure Frequency	365	days/yr	Used with an annualized average daily consumption rate	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				CF	Conversion Factor	1.00E-03	kg/g	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Older Child (7 - 18 years)	Homegrown Produce	$C_{produce}$	Chemical Concentration in Produce	TBD	mg/kg	Approach to be used will be presented in PAR	Intake (mg/kg-day) = $C_{produce}$ x $IgR_{produce}$ x EF x ED x CF x 1/AT
				$IgR_{produce}$	Ingestion Rate (home-grown produce)	0.64	g/kg-day	Age-adjusted, annualized average daily consumption of home-produced vegetables for populations that garden (Table 13-1, USEPA 2011)	
				EF	Exposure Frequency	365	days/yr	Used with an annualized average daily consumption rate	
				ED	Exposure Duration	12	yrs	Age-adjusted exposure duration (USEPA 2014)	
				CF	Conversion Factor	1.00E-03	kg/g	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	
		Adult	Homegrown Produce	$C_{produce}$	Chemical Concentration in Produce	TBD	mg/kg	Approach to be used will be presented in PAR	Intake (mg/kg-day) = $C_{produce}$ x $IgR_{produce}$ x EF x ED x CF x 1/AT
				$IgR_{produce}$	Ingestion Rate (home-grown produce)	0.56	g/kg-day	Age-adjusted, annualized average daily consumption of home-produced vegetables for populations that garden (Table 13-1, USEPA 2011)	
				EF	Exposure Frequency	365	days/yr	Used with an annualized average daily consumption rate	
				ED	Exposure Duration	8	yrs	Age-adjusted exposure duration (USEPA 2014); Total exposure duration is 26 years.	
				CF	Conversion Factor	1.00E-03	kg/g	--	
				AT_{nc}	Averaging Time (non-cancer)	2,920	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	28,470	days	365 days x 78 yrs (USEPA 1989, 2011)	

Notes:
TBD = To be determined

Table C-12. Recommended Age-Specific Soil Ingestion Rates

Age	Outdoor Soil Ingestion Rate (mg/day)		Indoor Dust Ingestion Rate (mg/day)		Soil and Dust Ingestion Rate (mg/day)	
	Central Tendency	Upper Percentile	Central Tendency	Upper Percentile	Central Tendency	Upper Percentile
1 to <6 years [a]	50	--	60	--	100	--
3 to <6 years [a]	--	200	--	100	--	200
6 to <21 years [a]	50	--	60	--	100	--
Weighted Ingestion Rate for 1 - 6 year old [b]	125		80		150	
Adult [a]	20	--	30	--	50	--

[a] Soil ingestion rates from USEPA 2011, Table 5-1.

[b] The weighted ingestion rate for 1 - 6 year olds is calculated using the central tendency value for ages 1, 2 and 6, and the upper percentile value for ages 3, 4 and 5.

Table C-13. Indoor/Outdoor Soil Ingestion Rates

		Outdoor Soil & Indoor Dust		Indoor Dust		Weighted
Receptor Population	Age	Ingestion Rate (mg/day)	Days	Ingestion Rate (mg/day)	Days	Ingestion Rate (mg/day) [b]
Resident 1	Young Child (1 - 6 years)	150	150	80	200	110
	Older Child (7 - 18 years) [a]	100	150	60	200	77
	Adult	50	150	30	200	39
Seasonal Resident	Young Child (1 - 6 years)	150	65	80	25	131
	Older Child (7 - 18 years) [a]	100	65	60	25	89
	Adult	50	65	30	25	44

[a] Relies on ingestion rates for 6 to < 21 years shown in Table C-12.
[b] Calculated as the weighted average of ingestion rates for indoor and outdoor days and indoor days only.

Table C-14. Recommended Mean Surface Areas by Body Part for Males and Females Combined

Age	Head	Face [d]	Arms	Forearms [e]	Hands	Legs	Lower Legs [f]	Feet	Face, Hands, Forearms, Lower Legs and Feet	Face, Hands, Forearms, and Lower Legs	Face, Hands and Forearms
1 year [a]	870	287	690	311	300	1,220	488	330	1,716	1,386	898
2 years [a]	510	168	880	396	280	1,540	616	380	1,840	1,460	844
3 years [a]	610	201	1,060	477	370	1,950	780	490	2,318	1,828	1,048
4 years [a]	610	201	1,060	477	370	1,950	780	490	2,318	1,828	1,048
5 years [a]	610	201	1,060	477	370	1,950	780	490	2,318	1,828	1,048
6 years [a]	660	218	1,510	680	510	3,110	1,244	730	3,381	2,651	1,407
Young Child (1 to 6 years) [b]	645	213	1,043	470	367	1,953	781	485	2,315	1,830	1,049
7 years	660	218	1,510	680	510	3,110	1,244	730	3,381	2,651	1,407
8 years	660	218	1,510	680	510	3,110	1,244	730	3,381	2,651	1,407
9 years	660	218	1,510	680	510	3,110	1,244	730	3,381	2,651	1,407
10 years	660	218	1,510	680	510	3,110	1,244	730	3,381	2,651	1,407
11 years	730	241	2,270	1,022	720	4,830	1,932	1,050	4,964	3,914	1,982
12 years	730	241	2,270	1,022	720	4,830	1,932	1,050	4,964	3,914	1,982
13 years	730	241	2,270	1,022	720	4,830	1,932	1,050	4,964	3,914	1,982
14 years	730	241	2,270	1,022	720	4,830	1,932	1,050	4,964	3,914	1,982
15 years	730	241	2,270	1,022	720	4,830	1,932	1,050	4,964	3,914	1,982
16 years	750	248	2,690	1,211	830	5,430	2,172	1,120	5,580	4,460	2,288
17 years	750	248	2,690	1,211	830	5,430	2,172	1,120	5,580	4,460	2,288
18 years	750	248	2,690	1,211	830	5,430	2,172	1,120	5,580	4,460	2,288
Older Child (7 to 18 years) [c]	712	235	2,122	955	678	4,407	1,763	961	4,591	3,630	1,867
Adult [a]	1250	413	2,755	1,240	980	6,400	2,560	1,295	6,487	5,192	2,632

Notes: All values are shown in units of cm^2

[a] Mean surface area for males and females combined from USEPA 2011, Table 7-2.

[b] Calculated as average of 1- 6 year olds.

[c] Calculated as average of 7-18 year olds.

[d] Values not reported in USEPA 2011. Based on USEPA 2004 assumes 33% of head for face.

[e] Values not reported in USEPA 2011. Based on USEPA 2004 assumes 45% of arms for forearms.

[f] Values not reported in USEPA 2011. Based on USEPA 2004 assumes 40% of legs for lower legs.

Table C-15. Season-Weighted Surface Areas [a]

		Warmer Outdoor Months May - September		Cooler Outdoor Months April and October		
Scenario	Age	Surface Area (cm^2)	Days/year	Surface Area (cm^2)	Days/year	Weighted Surface Area (cm^2)
Resident 1	Older Child (7 - 18 years)	4,591 [b]	107	1,867 [e]	43	3,810
	Adult	5,192 [c]	107	2,632 [e]	43	4,458
Resident 2	Young Child (1 - 6 years)	2,315 [b]	107	1,049 [e]	43	1,952
	Older Child (7 - 18 years)	4,591 [b]	107	1,867 [e]	43	3,810
	Adult	5,192 [c]	107	2,632 [e]	43	4,458
Recreator 1	Young Child (1 - 6 years)	2,315 [b]	64 [d]	1,049 [e]	26 [d]	1,950
	Older Child (7 - 18 years)	4,591 [b]	64 [d]	1,867 [e]	26 [d]	3,804
	Adult	5,192 [c]	64 [d]	2,632 [e]	26 [d]	4,453
Recreator 2	Young Child (1 - 6 years)	2,315 [b]	44 [f]	1,049 [e]	16 [f]	1,978
	Older Child (7 - 18 years)	4,591 [b]	44 [f]	1,867 [e]	16 [f]	3,864
	Adult	5,192 [c]	44 [f]	2,632 [e]	16 [f]	4,510
Recreator 3	Older Child (7 - 18 years)	4,591 [b]	22 [h]	1,867 [e]	8 [h]	3,864
	Adult	5,192 [c]	22 [h]	2,632 [e]	8 [h]	4,510

[a] Receptors and age groups not shown do not have a seasonal weighting component (see Table C-14 for age-weighted surface areas).
[b] Assumes face, hands, forearms, lower legs, and feet (see Table C-14).
[c] Assumes face, hands, forearms, and lower legs (see Table C-14).
[d] Assumes 3 days per week during these months.
[e] Assumes face, hands, and forearms (see Table C-14).
[f] Assumes 2 days per week during these months.
[g] Assumes face, hands, forearms, lower legs, and feet (see Table C-14).
[h] Assumes 1 day per week during these months.

Table C-16. Recommended Adherence Factors for Skin

	Face	Arms	Hands	Legs	Feet
Children					
Residential (indoors)	0.054 [a]	0.0041	0.011	0.0035	0.010
Daycare (indoors and outdoors)	0.054 [a]	0.024	0.099	0.020	0.071
Activities with soil	0.054	0.046	0.17	0.051	0.20
Adults					
Activities with soil	0.0240	0.0379	0.1595	0.0189	0.1393
Construction activities	0.0982	0.1859	0.2763	0.0660	NA

Notes: Values taken from USEPA 2011, Table 7-4.

All values are shown in units of mg/cm^2

NA = Not available

[a] Value recommended for children exposed to outdoor soil. No value for residential (indoors) or daycare (indoors and outdoors) is available.

Table C-17. Age-, Surface-Area-, and Seasonal Weighted Adherence Factors

	SA, Face (cm^2)	AF, Face (mg/cm^2)	SA, Forearms (cm^2)	AF, Forearms (mg/cm^2)	SA, Hands (cm^2)	AF, Hands (mg/cm^2)	SA, Lower Legs (cm^2)	AF, Lower Legs (mg/cm^2)	SA, Feet (cm^2)	AF, Feet (mg/cm^2)	Area Weighted AF (mg/cm^2)	Relative annual frequency (days/year)	Area- and Season-Weighted AF (mg/cm^2)
Resident 1													
Young Children, indoor days	213	0.054	470	0.0041	367	0.011	781	0.0035	485	0.010	0.011	200	0.026
Young Children, indoor+outdoor days	213	0.054	470	0.024	367	0.099	781	0.02	485	0.071	0.047	150	
Older Children, outdoors, May-Sept	235	0.054	955	0.046	678	0.17	1,763	0.051	961	0.20	0.099	107	0.042
Older Children, outdoors, April+Oct	235	0.054	955	0.046	678	0.17	-- [a]	-- [a]	-- [a]	-- [a]	0.092	43	
Older Children, Nov-March	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	0.0	200	
Adults, outdoors, May-Sept	413	0.024	1,240	0.0379	980	0.1595	2,560	0.0189	-- [a]	-- [a]	0.050	107	0.025
Adults, outdoors, April+Oct	413	0.024	1,240	0.0379	980	0.1595	-- [a]	-- [a]	-- [a]	-- [a]	0.081	43	
Adults, Nov-March	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	-- [a]	0.0	200	
Resident 2													
Young Children, outdoors, May-Sept	213	0.054	470	0.046	367	0.17	781	0.051	485	0.20	0.100	107	0.098
Young Children, outdoors, April + Oct	213	0.054	470	0.046	367	0.17	-- [a]	-- [a]	-- [a]	-- [a]	0.091	43	
Older Children, outdoors, May-Sept	235	0.054	955	0.046	678	0.17	1,763	0.051	961	0.20	0.099	107	0.097
Older Children, outdoors, April + Oct	235	0.054	955	0.046	678	0.17	-- [a]	-- [a]	-- [a]	-- [a]	0.092	43	
Adults, outdoors, May-Sept	413	0.024	1,240	0.0379	980	0.1595	2,560	0.0189	-- [a]	-- [a]	0.050	107	0.059
Adults, outdoors, April+Oct	413	0.024	1,240	0.0379	980	0.1595	-- [a]	-- [a]	-- [a]	-- [a]	0.081	43	
Seasonal Resident													
Young Children, indoor+outdoor days	213	0.054	470	0.024	367	0.099	781	0.02	485	0.071	0.047	-- [b]	-- [b]
Older Children, outdoors, June-August	235	0.054	955	0.046	678	0.17	1,763	0.051	961	0.20	0.099	-- [b]	-- [b]
Adults, outdoors, June-August	413	0.024	1,240	0.0379	980	0.1595	2,560	0.0189	-- [a]	-- [a]	0.050	-- [b]	-- [b]
Recreator 1													
Young Children, outdoor days, May-Sept	213	0.054	470	0.046	367	0.17	781	0.051	485	0.20	0.100	64	0.098
Young Children, outdoor days, April + Oct	213	0.054	470	0.046	367	0.17	-- [a]	-- [a]	-- [a]	-- [a]	0.091	26	
Older Children, outdoor days, May-Sept	235	0.054	955	0.046	678	0.17	1,763	0.051	961	0.20	0.099	64	0.097
Older Children, outdoor days, April + Oct	235	0.054	955	0.046	678	0.17	-- [a]	-- [a]	-- [a]	-- [a]	0.092	26	
Adults, outdoors, May-Sept	413	0.024	1,240	0.0379	980	0.1595	2,560	0.0189	-- [a]	-- [a]	0.050	64	0.059
Adults, outdoors, April+Oct	413	0.024	1,240	0.0379	980	0.1595	-- [a]	-- [a]	-- [a]	-- [a]	0.081	26	
Recreator 2													
Young Children, outdoor days, May-Sept	213	0.054	470	0.046	367	0.17	781	0.051	485	0.20	0.100	44	0.098
Young Children, outdoor days, April + Oct	213	0.054	470	0.046	367	0.17	-- [a]	-- [a]	-- [a]	-- [a]	0.091	16	
Older Children, outdoor days, May-Sept	235	0.054	955	0.046	678	0.17	1,763	0.051	961	0.20	0.099	44	0.097
Older Children, outdoor days, April + Oct	235	0.054	955	0.046	678	0.17	-- [a]	-- [a]	-- [a]	-- [a]	0.092	16	
Adults, outdoors, May-Sept	413	0.024	1,240	0.0379	980	0.1595	2,560	0.0189	-- [a]	-- [a]	0.050	44	0.059
Adults, outdoors, April + Oct	413	0.024	1,240	0.0379	980	0.1595	-- [a]	-- [a]	-- [a]	-- [a]	0.081	16	

Table C-17. Age-, Surface-Area-, and Seasonal Weighted Adherence Factors

	SA, Face (cm^2)	AF, Face (mg/cm^2)	SA, Forearms (cm^2)	AF, Forearms (mg/cm^2)	SA, Hands (cm^2)	AF, Hands (mg/cm^2)	SA, Lower Legs (cm^2)	AF, Lower Legs (mg/cm^2)	SA, Feet (cm^2)	AF, Feet (mg/cm^2)	Area Weighted AF (mg/cm^2)	Relative annual frequency (days/year)	Area- and Season-Weighted AF (mg/cm^2)
Recreator 3													
Older Children, outdoor days, May-Sept	235	0.054	955	0.046	678	0.17	1,763	0.051	961	0.20	0.099	22	0.097
Older Children, outdoor days, April + Oct	235	0.054	955	0.046	678	0.17	-- [a]	-- [a]	-- [a]	-- [a]	0.092	8	
Adults, outdoors, May-Sept	413	0.024	1,240	0.0379	980	0.1595	2,560	0.0189	-- [a]	-- [a]	0.050	22	0.059
Adults, outdoors, April + Oct	413	0.024	1,240	0.0379	980	0.1595	-- [a]	-- [a]	-- [a]	-- [a]	0.081	8	
Outdoor Worker (1&2)													
Adults, outdoors	413	0.024	1,240	0.0379	980	0.1595	-- [a]	-- [a]	-- [a]	-- [a]	0.081	-- [b]	-- [b]
Utility Worker													
Adults, outdoors	413	0.0982	1,240	0.1859	980	0.2763	-- [a]	-- [a]	-- [a]	-- [a]	0.206	-- [b]	-- [b]
Construction Worker													
Adults, outdoors	413	0.0982	1,240	0.1859	980	0.2763	-- [a]	-- [a]	-- [a]	-- [a]	0.206	-- [b]	-- [b]

Notes: -- = Not applicable
AF = adherence factor (see Table C-16)
SA = surface area (see Table C-15)

[a] Not conceptualized as an exposed body part for receptor scenario.

[b] No difference in exposed body parts throughout the exposure period.

Table C-18. Values Used for Daily Intake Calculations - Phase 2 Default Analysis, Residential Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

		Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Resident	Incidental Ingestion	Child	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	200	mg/day	Default for children (USEPA 2014)	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence.	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				BW	Body Weight	15	kg	Default for children (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	100	mg/day	Default for adults (USEPA 2014)	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence.	
				ED	Exposure Duration	20	yrs	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	7,300	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Table C-18. Values Used for Daily Intake Calculations - Phase 2 Default Analysis, Residential Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

		Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
	Dermal Contact	Child	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	2,690	cm^2/event	Default for child residents (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.2	mg/cm^2	Default for child residents (USEPA 2014)	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence.	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	15	kg	Default for children (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	6,032	cm^2/event	Default for adult residents (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.07	mg/cm^2	Default for adult residents (USEPA 2014)	
				EF	Exposure Frequency	350	days/yr	Default for residents (USEPA 2014); Assumes 2 weeks away from residence.	
				ED	Exposure Duration	20	yrs	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	7,300	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined

Table C-19. Values Used for Daily Intake Calculations - Phase 2 Default Analysis, Recreational Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Recreator	Incidental Ingestion	Child	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	200	mg/day	Default for children (USEPA 2014)	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week for the season from April - October	
				ED	Exposure Duration	6	yrs	Default exposure duration for children (USEPA 2014)	
				BW	Body Weight	15	kg	Default for children (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	100	mg/day	Default for adults (USEPA 2014)	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week for the season from April - October	
				ED	Exposure Duration	20	yrs	Age-adjusted exposure duration (USEPA 2014)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	7,300	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Table C-19. Values Used for Daily Intake Calculations - Phase 2 Default Analysis, Recreational Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
	Dermal Contact	Child	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	2,690	cm^2/event	Default for child residents (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.2	mg/cm^2	Default for child residents (USEPA 2014)	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week for the season from April - October	
				ED	Exposure Duration	6	yrs	Default exposure duration for children (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	15	kg	Default for children (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	6,032	cm^2/event	Default for adult residents (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.07	mg/cm^2	Default for adult residents (USEPA 2014)	
				EF	Exposure Frequency	90	days/yr	Assumes 3 days per week for the season from April - October	
				ED	Exposure Duration	20	yrs	Age-adjusted exposure duration (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	7,300	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined

Table C-20. Values Used for Daily Intake Calculations -Phase 2 Default Analysis, Outdoor Worker Exposures to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

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

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Outdoor Worker	Incidental Ingestion	Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	100	mg/day	Default for outdoor workers (USEPA 2014)	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	225	days/yr	Default for outdoor workers (USEPA 2014)	
				ED	Exposure Duration	25	yrs	Default for outdoor workers (USEPA 2014)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	9,125	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
	Dermal Contact	Adult	Surface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	3,470	cm^2/event	Default for outdoor workers (USEPA 2014)	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.12	mg/cm^2	Default for outdoor workers (USEPA 2014)	
				EF	Exposure Frequency	225	days/yr	Default for outdoor workers (USEPA 2014)	
				ED	Exposure Duration	25	yrs	Default for outdoor workers (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	9,125	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined

Table C-21. Values Used for Daily Intake Calculations - Phase 2 Default Analysis, Construction Worker Exposure to Soil
Reasonable Maximum Exposure - Upper Hudson River Floodplain

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Construction Worker	Incidental Ingestion	Adult	Surface and Subsurface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{soil}	Ingestion Rate	330	mg/day	Default for construction workers (USEPA 2002)	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	250	days/yr	Default for construction workers (USEPA 2002)	
				ED	Exposure Duration	1	yrs	Assumes 1 year of construction	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	365	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
	Dermal Contact	Adult	Surface and Subsurface Soil	C_s	Chemical Concentration in Soil	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	3,300	cm^2/event	Default for construction workers (USEPA 2002)	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.3	mg/cm^2	Default for construction workers (USEPA 2002)	
				EF	Exposure Frequency	250	days/yr	Default for construction workers (USEPA 2002)	
				ED	Exposure Duration	1	yrs	Assumes 1 year of construction	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	80	kg	Default for adults (USEPA 2014)	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	365	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
	Inhalation	Adult	Particulates Derived from Surface and Subsurface Soil	C_A	Chemical Concentration in Air	TBD	mg/m^3	Approach to be used will be presented in PAR	Exposure Concentration (mg/m^3) = CA x ET x EF x ED x CF x 1/AT
				ET	Exposure Time	8	hours/day	Default for outdoor workers (USEPA 2014)	
				EF	Exposure Frequency	250	days/yr	Default for construction workers (USEPA 2002)	
				ED	Exposure Duration	1	yrs	Assumes 1 year of construction	
				CF	Conversion Factor	0.04	day/hours	--	
				AT_{nc}	Averaging Time (non-cancer)	365	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined

Table C-22. Values Used for Daily Intake Calculations - Phase 2 Default Analysis, Residential Gardener Exposure to Homegrown Produce
Reasonable Maximum Exposure - Upper Hudson River Floodplain

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Homegrown Crops

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Residential Gardener	Ingestion of Homegrown Produce	Child	Homegrown Produce	$C_{produce}$	Chemical Concentration in Produce	TBD	mg/kg	Approach to be used will be presented in PAR	Intake (mg/kg-day) = $C_{produce}$ x $IgR_{produce}$ x EF x ED x CF x 1/BW x 1/AT
				$IgR_{produce}$	Ingestion Rate (home-grown produce)	80	g/day	Default for home-grown vegetables (USEPA 1991). See footnote 1.	
				BW	Body weight	15	kg	Default for children (USEPA 2014)	
				EF	Exposure Frequency	365	days/yr	Used with an annualized average daily consumption rate	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				CF	Conversion Factor	1.00E-03	kg/g	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Homegrown Produce	$C_{produce}$	Chemical Concentration in Produce	TBD	mg/kg	Approach to be used will be presented in PAR	Intake (mg/kg-day) = $C_{produce}$ x $IgR_{produce}$ x EF x ED x CF x 1/BW x 1/AT
				$IgR_{produce}$	Ingestion Rate (home-grown produce)	80	g/day	Default for home-grown vegetables (USEPA 1991)	
				BW	Body weight	80	kg	Default for adults (USEPA 2014)	
				EF	Exposure Frequency	365	days/yr	Used with an annualized average daily consumption rate	
				ED	Exposure Duration	20	yrs	Age-adjusted exposure duration (USEPA 2014)	
				CF	Conversion Factor	1.00E-03	kg/g	--	
				AT_{nc}	Averaging Time (non-cancer)	7,300	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Notes

TBD = To be determined

[1] USEPA does not provide age-specific default consumption rates for produce. In the absense of age-specific rates, the available default form USEPA will be applied to both children and adults.

Table C-23. Values Used for Daily Intake Calculations - Recreator Exposures to Near-Shore Sediment
Reasonable Maximum Exposure - Upper Hudson River Floodplain

Scenario Timeframe: Current/Future
Medium: Surface Sediment
Exposure Medium: Surface Sediment

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Recreator for Near-Shore Sediment	Incidental Ingestion	Young Child	Surface Sediment	C_{sed}	Chemical Concentration in Sediment	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{sed}	Ingestion Rate	100	mg/day	Sediment ingestion rate (USEPA 2000a).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	13	days/yr	Assumes 1 day per week during the summer months (USEPA 2000a)	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				BW	Body Weight	15	kg	Parameter provided by USEPA, September 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
		Adolescents	Surface Sediment	C_{sed}	Chemical Concentration in Sediment	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{sed}	Ingestion Rate	50	mg/day	Sediment ingestion rate (USEPA 2000a).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	39	days/yr	Assumes 3 days per week during the summer months USEPA 2000a)	
				ED	Exposure Duration	12	yrs	Parameter provided by USEPA, September 2014	
				BW	Body Weight	43	kg	Parameter provided by USEPA, September 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
		Adult	Surface Sediment	C_{sed}	Chemical Concentration in Sediment	TBD	mg/kg	To be determined	Intake (mg/kg-day) = C_s x IgR_{soil} x EF x ED x ABS_o x CF x 1/BW x 1/AT
				IgR_{sed}	Ingestion Rate	50	mg/day	Sediment ingestion rate (USEPA 2000a).	
				ABS_o	Oral Absorption Factor	1	unitless	Conservative default	
				EF	Exposure Frequency	13	days/yr	Assumes 1 day per week during the summer months (USEPA 2000a)	
				ED	Exposure Duration	12	yrs	Parameter provided by USEPA, September 2014	
				BW	Body Weight	70	kg	Parameter provided by USEPA, September 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Table C-23. Values Used for Daily Intake Calculations - Recreator Exposures to Near-Shore Sediment
Reasonable Maximum Exposure - Upper Hudson River Floodplain

Scenario Timeframe: Current/Future
Medium: Surface Sediment
Exposure Medium: Surface Sediment

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
	Dermal Contact	Young Child	Surface Sediment	C_{sed}	Chemical Concentration in Sediment	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	2,792	cm^2/event	Parameter provided by USEPA, September 2014	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.2	mg/cm^2	Parameter provided by USEPA, September 2014	
				EF	Exposure Frequency	13	days/yr	Assumes 1 day per week during the summer months (USEPA 2000a)	
				ED	Exposure Duration	6	yrs	Default for children (USEPA 2014)	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	15	kg	Parameter provided by USEPA, September 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	
		Adolescents	Surface Sediment	C_{sed}	Chemical Concentration in Sediment	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	4,263	cm^2/event	Parameter provided by USEPA, September 2014	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.25	mg/cm^2	Parameter provided by USEPA, September 2014	
				EF	Exposure Frequency	39	days/yr	Assumes 3 days per week during the summer months USEPA 2000a)	
				ED	Exposure Duration	12	yrs	Parameter provided by USEPA, September 2014	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	43	kg	Parameter provided by USEPA, September 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Table C-23. Values Used for Daily Intake Calculations - Recreator Exposures to Near-Shore Sediment
Reasonable Maximum Exposure - Upper Hudson River Floodplain

Scenario Timeframe: Current/Future
Medium: Surface Sediment
Exposure Medium: Surface Sediment

Receptor Population	Exposure Route	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
		Adult	Surface Sediment	C_{sed}	Chemical Concentration in Sediment	TBD	mg/kg	To be determined	Intake (mg/kg-day) = DA_{event} x EF x ED x EV x SA x 1/BW x 1/AT DA_{event} = C_s x CF x AF x ABS_d
				SA	Exposed Skin Surface Area	6,073	cm^2/event	Parameter provided by USEPA, September 2014	
				ABS_d	Dermal Absorption Factor	0.14	unitless	USEPA 2004 based on Wester et al. 1993	
				AF	Adherence Factor	0.25	mg/cm^2	Parameter provided by USEPA, September 2014	
				EF	Exposure Frequency	13	days/yr	Assumes 1 day per week during the summer months (USEPA 2000a)	
				ED	Exposure Duration	12	yrs	Parameter provided by USEPA, September 2014	
				EV	Event Frequency	1	events/day	Assumed default (USEPA 2004, Exhibit 3-5)	
				BW	Body Weight	70	kg	Parameter provided by USEPA, September 2014	
				CF	Conversion Factor	1.00E-06	kg/mg	--	
				AT_{nc}	Averaging Time (non-cancer)	4,380	days	ED x 365 days/yr (USEPA 1989)	
				AT_c	Averaging Time (cancer)	25,550	days	365 days x 70 yrs (USEPA 1989, 2014)	

Notes
TBD = To be determined

APPENDIX D

PROCESS FOR SELECTING TOXICITY REFERENCE VALUES FOR ECOLOGICAL RISK ASSESSMENT

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INTRODUCTION

This appendix describes the process that will be followed to select toxicity reference values (TRVs) for the ecological risk assessment (ERA) of the Upper Hudson River (UHR) Floodplain. It first provides a brief introduction to TRVs. It then describes the general criteria for selection of TRVs. Finally, it discusses specifically the selection of TRVs for use in the Screening-Level Ecological Risk Assessment (SLERA) and those for use in the more refined Baseline Ecological Risk Assessment (BERA).

A TRV is the exposure concentration or dose of a chemical of interest (in this case Total PCBs) associated with a defined level of effect or lack of effect. Comparisons of TRVs with site-specific exposure estimates (referred to as hazard quotients or HQs) will be an important line of evidence for the UHR Floodplain ERA.[1] TRVs will be identified from information available from the scientific literature, as well as site-specific effects studies, if available.

Depending on the receptor species and the availability of exposure and effects data, TRVs may take a variety of forms. TRVs may be developed based on PCB concentrations in abiotic media, diet, or tissue (including eggs), or they may be expressed as a dose (i.e., in milligrams PCB per kilogram body weight per day; mg/kg-day). TRVs may be identified as single values, ranges, or distributions. They may represent no observed adverse effect levels (NOAELs), lowest observed adverse effect levels (LOAELs), or dose-response relationships. The use of NOAELs and LOAELs to define effect thresholds is a simplistic, though practical, approach. Dose-response relationships provide more information about the nature and severity of effect associated with exposures in the underlying toxicity study or studies. Dose-response relationships can include concentrations associated with a specific degree of effect, such as 20% effect concentrations (EC20s) or other effect levels found to be protective, or they can be represented by mathematical functions to predict effect levels associated with particular exposure levels.

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[1] For purposes of this Appendix, TRVs are distinct from ecologically based screening benchmarks, which are PCB concentrations in Floodplain soil, sediment, or surface water identified from regulatory guidance (if applicable and appropriate) and/or the peer-reviewed literature for use in screening-level evaluations of certain receptors, as discussed in Section 4.3.3 of the RI/FS Work Plan.

TOXICITY REFERENCE VALUES SELECTION CRITERIA

TRVs will be developed both for the SLERA and for the BERA. This section describes the general criteria for the selection of TRVs, while differences between the selection of TRVs for the SLERA and the selection of TRVs for the BERA are discussed at the end of this appendix.

In general, TRVs will be selected with the objective of supporting a protective and robust interpretation of site-specific PCB exposures. The TRV selection process will begin with the compilation of all potentially relevant toxicity studies, including both laboratory and field studies. Each study will be critically reviewed, considering both the minimum requirements for selection of a study to provide a TRV and certain balancing considerations for preferring one study over another (consistent with the approach outlined by Mayfield et al. 2013). These minimum requirements and balancing considerations are listed in Table D-1. Appropriate TRV(s) will be selected for each receptor species, based on thorough consideration of the strengths and uncertainties of each candidate toxicity study and considering the phase of the ERA in which the TRVs will be used.

Table D-1
Toxicity Reference Values Selection Requirements and Balancing Considerations

Attribute	Minimum Requirement to Consider a Study	Balancing Consideration Preference
Test Species	Test species is a representative species as defined for a receptor of interest	Receptor species or similar species
Specificity	Effects attributable to PCBs in a controlled experiment or field study	Definitive causal link to PCBs
PCBs Tested	Environmentally relevant PCB mixture	PCB mixture composition known and similar to site, or able to account for differences in bioaccumulation and potency
Endpoint	Reproduction (including survival of offspring)[a]	Overall production of offspring
Test Duration	Chronic[b]	Lengthy or multi-generation study
Exposure Measures	Identifiable exposure concentrations in relevant media	Diet or tissue preferred for higher trophic level organisms
Test Conditions	Environmentally relevant conditions	Real (field) or realistic (lab) conditions
Data Quality	Adequate documentation and data quality to support a TRV	Effects threshold well defined (NOAEL and LOAEL or EC_X provided) or able to evaluate unbounded results relative to other studies
Representativeness	NA	Protective, considering consistency among studies (avoid outliers)

Notes:

a. TRV derivation will focus on reproductive endpoints, including survival of offspring, because they are generally more sensitive than survival or growth. However, if survival (for all receptors) or growth (for fish, amphibians, or reptiles) is shown to be more sensitive than reproduction for a receptor, then the more sensitive endpoint will be considered. Additionally, survival and/or growth studies (as appropriate to the receptor) will be considered if insufficient reproductive studies are available for the receptor.

b. If sufficient chronic toxicity studies are unavailable for a receptor of interest, then studies involving short-term or subchronic duration will be evaluated.

Each attribute identified in Table D-1 is further discussed below, including the minimum requirements for considering a toxicity study and the balancing considerations.

Test Species

Consideration of toxicity data for multiple species is often necessary in TRV derivation, because toxicity data are typically limited or unavailable for many of the species for which quantitative ecological risk analysis is performed. It is recognized that extrapolation of TRVs between taxonomic classes or even higher levels of taxonomic organization is uncertain. For the UHR Floodplain ERA, the types of test species that will be considered in the TRV selection process for each receptor of interest are specified in Table D-2. Depending on the outcome of the SLERA, however, some of the species listed in Table D-2 may be eliminated from consideration in the BERA.

Table D-2
Toxicity Study Species that Are Representative of Ecological Receptors for TRV Derivation Purposes

Receptor Species Subject to Evaluation	Representative Study Species[a]
Mink	Mink
Short-tailed shrew, deer mouse, meadow vole, muskrat, little brown bat	Small mammals
Gray catbird	High-sensitivity bird species[b]
American robin, wren, sparrow, woodcock, sandpiper, marsh wren	Mid-sensitivity bird species[b]
Red-tailed hawk, great blue heron, Canada goose, mallard, wood duck, kingfisher	Low-sensitivity bird species[b]
Wood frog	Amphibians
Snapping turtle	Reptiles
Fish	Fish

Notes:
a. If data for representative study species are not available, toxicity data for the next most closely related taxa will be considered and uncertainties will be addressed in the weight-of-evidence evaluation.
b. Based on genetic sequence of aryl hydrocarbon receptor (Farmahin et al. 2013)

Mink are more sensitive to PCBs than are other mammals such as rodents and rabbits, and the sensitivity of mink to PCBs has been extensively studied. Therefore, mink toxicity data will be segregated from that of other mammals. Further, small mammal receptor species (e.g., short-tailed shrew) will be represented by small mammal toxicity study species. This approach reduces uncertainty associated with extrapolating toxicity data among species of very different body sizes, as body size can affect both food (and contaminant) intake and elimination rates. The extrapolation of dietary doses among species inherently assumes that differences in contaminant intake, but not elimination, may be sufficient to account for differences in exposure-response relationships among species. Body weight scaling may be proposed to USEPA as a possible method to account for this source of uncertainty for mammalian receptors (USEPA 2011).

Bird species also exhibit wide variation in sensitivity to PCBs, and recent genetic sequencing research on dioxin-like compounds helps explain observed differences in sensitivity. Farmahin et al. (2013) compiled genetic sequencing data for 86 species and grouped the species into high, moderate, and low sensitivity categories based on specific differences in the aryl hydrocarbon receptor genome (see also Karchner et al. 2006, Head et al. 2008, Manning et al. 2012). Only 5% of the 86 species were categorized as highly sensitive species, including the chicken, gray catbird, ruby-throated hummingbird, and European starling. Fifty-five percent of the species were classified as moderately sensitive, including many passerines. Forty-one percent of the species were categorized as having low sensitivity; this group was dominated by raptors, piscivores (e.g., wading birds, gulls, kingfishers), and waterfowl. Toxicity study species will be considered representative of the receptor species listed in Table D-2 if they share the same sensitivity classification. In cases where the aryl hydrocarbon receptor gene sequence is not available for a bird species of interest, a proposed approach to assigning the species to a group will be provided in the BERA Work Plan.

Insufficient information is available for classes other than birds and mammals to segregate toxicity study species based on sensitivity categories. Thus, for example, all amphibian toxicity data will be considered in the TRV selection process for the wood frog.

All relevant studies will be considered provided that the species studied is potentially representative of the receptor and the data are potentially applicable to that receptor. As a balancing consideration, close similarity between a toxicity study species and a receptor species will be preferred. Similarity between species will be judged based on taxonomy, body size, and feeding guild.

Specificity

Laboratory studies confounded by the presence of other chemicals will not be considered. Field studies may be considered if it is clear that PCBs are the predominant environmental contaminant at the study site. As a balancing consideration, studies establishing a definitive causal link between PCB exposures and effects (or lack of effects) will be preferred over those in which PCB causation is only considered likely.

Types of PCBs Tested

The PCBs tested in the toxicity study must be an environmentally relevant PCB mixture. Studies testing the toxicity of individual PCB congeners will not be used as the basis for TRVs, because such studies do not account for potentially important toxicological interactions among PCB congeners in environmental mixtures (Safe 1994).

TRVs will generally be based on total PCB concentrations rather than congener-specific exposure estimates. However, as a balancing consideration, the particular PCB mixture will be reviewed to assess the comparability of the types of PCBs at study sites to the PCBs in the UHR Floodplain, with close comparability to the UHR Floodplain being preferred. The Total PCB approach will maximize comparability of TRVs to existing site characterization data, and it will allow incorporation of an extensive body of toxicity studies. However, alternative approaches may be considered if necessary to incorporate the highest quality and most relevant toxicity data.

Toxicity Endpoints

Toxicity endpoints considered as the basis for TRV derivation must relate directly to the assessment endpoint for the receptor of interest. Thus, TRV derivation for avian and mammalian receptors will address reproduction and survival endpoints, while TRVs for fish, reptiles, and amphibians will address reproduction, survival, and growth. Reproduction is generally a more sensitive endpoint than survival or growth and will thus be the focus of scientific literature review. However, if survival (for all receptors) or growth (for fish, amphibians, or reptiles) is shown to be more sensitive than reproduction for a given receptor, then the more sensitive endpoint will be considered. Toxicity endpoints other than other than those specified in applicable assessment endpoints (e.g., behavior, physiology, biochemistry, avian or mammalian growth) will only be used if: (1) they are clearly linked to reproduction and survival (or growth if applicable); and (2) data directly measuring reproduction and survival (or growth if applicable) are insufficient to support robust TRVs.

"Reproduction" can include multiple measures of reproductive success. While evaluating endpoints separately can be informative and cannot be ruled out at this time, it is anticipated that, as a balancing consideration, the preferred reproductive endpoint may be overall production of offspring (e.g., the net effect of egg production, hatching success, and offspring survival). In cases where a TRV is developed based on a specific magnitude of effect, the selected magnitude of effect will be protective considering population-level effects on the receptor species of interest.

Test Duration

Toxicity studies considered for TRV derivation will be limited to those with chronic exposure durations, unless insufficient chronic studies are available for the receptor of interest to support a robust TRV. It should be noted that reproductive studies that are only for several days during gestation will be viewed as equivalent to chronic exposures. As a balancing consideration, longer exposures are preferred. Field studies will be assumed to represent multi-generation exposures unless study-specific information indicates otherwise.

Exposure Measures

To be considered as the basis for a TRV, a study must provide sufficient information to determine a useable measure of PCB exposure. Depending on the receptor, this may include dietary doses or PCB concentrations in soil, water (for aquatic organisms), diet, or tissue. As a balancing consideration, dietary or tissue exposure measures will be preferred for higher trophic level receptors. Measures such as the amount of PCBs injected into an adult organism would not be acceptable. Egg injection data will be considered only if the injection method employed in a particular study can accurately and reliably reproduce dose-response relationships observed based on maternal transfer, and if the egg injection study meets all of the above-listed criteria for selecting studies for TRV derivation.

Test Conditions

Test conditions should be as real (field studies) or realistic (laboratory studies) and environmentally relevant as possible. Potential laboratory artifacts, where identifiable, will be assessed as a balancing consideration. Studies with severe laboratory artifacts will be rejected as providing unacceptable data quality.

Data Quality

For a study to be considered as a basis for TRV derivation, the study documentation must be sufficient to allow evaluation of data quality, and the data quality must be sufficient to support the intended data use. Data quality will be judged based on factors such as sample size, performance of controls, and robustness of statistical analyses, as well as the adequacy of the study design and test conditions.

An aspect of data quality that will be considered as a balancing factor is the extent to which the study results clearly define an effect threshold or dose-response relationship. Ideally, the study results would span a gradient of effects, from no effect to severe effect, with sufficient data to define the desired effect threshold with a high degree of confidence. It can also be sufficient, although not preferable, to bracket an effect threshold with a NOAEL and a LOAEL, particularly when there is a relatively small difference in exposure between the two. Unbounded NOAELs and LOAELs can also provide valuable information if they can be compared to other studies' results for the same or similar species.

Representativeness

At the end of the TRV selection process, studies will be examined for outliers with the goal of being protective, yet considering consistency among the studies. If a study is deemed an outlier that is not representative of the overall body of knowledge, given a sufficient number of studies for comparison, it may be eliminated from consideration and a rationale provided.

SELECTION OF TOXICITY REFERENCE VALUES FOR SLERA AND BERA

In the SLERA, screening-level TRVs will be developed for avian and mammalian receptors, as well as for aquatic reptiles if suitable toxicity studies are available. Screening-level TRVs may also be derived for fish or amphibians as appropriate (e.g., if appropriate screening benchmarks are not available or are not sufficient to address relevant exposure pathways). Screening-level TRVs will not be developed for plants or invertebrates (which will be evaluated through use of screening benchmarks) or for terrestrial reptiles (for which insufficient data are available). Screening-level TRVs will represent exposure levels below which there is high confidence that an adverse effect will not occur. Such TRVs for use in the SLERA will be identified from all studies that meet the minimum requirements for consideration (as listed above), but without evaluating the additional balancing considerations. At a minimum, screening-level TRVs will include values representing NOAELs to the extent that such values are available. However, they may also include values based on other measures of effects, such as LOAELs, and a range of TRVs may be considered based on the data available.

For the BERA, refined TRVs will be identified in the BERA Work Plan for each receptor species identified in the SLERA Report as warranting further evaluation in Phase 1 of the BERA. These TRVs may be updated in the BERA if additional relevant toxicity information (such as the publication of new studies) becomes available. Selection of TRVs for the BERA will include evaluation of the balancing considerations identified above, in addition to the evaluation of the minimum requirements for consideration of a toxicity study. TRVs may represent NOAELs, LOAELs, or specific effect concentrations, or they may reflect dose-response relationships to provide additional information on the magnitude of effects associated with different exposure levels. Multiple TRVs may be selected and applied for a given receptor. Specifically, TRVs may consist of ranges, and may be developed for multiple measures of exposure (e.g., dietary dose and tissue). Additionally, the results of site-specific effects studies may be considered. The resulting information will be evaluated in the BERA, considering the strengths, uncertainties, and interactions of the available lines of evidence.

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