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March 6, 2009

Ms. Susan Svirsky
U.S. Environmental Protection Agency
c/o Weston Solutions, Inc.
10 Lyman Street
Pittsfield, MA 01201

Re: GE-Pittsfield/Housatonic River Site
Rest of River (GECD850)
Response to EPA's Interim Comments on Corrective Measures Study Report

Dear Ms. Svirsky:

Enclosed for the General Electric Company (GE) is a response to EPA's September 9, 2008 comments on the Corrective Measures Study (CMS) Report for the Rest of River. As you know, EPA has agreed that an ecologically sensitive alternative to the sediment and floodplain soil removal alternatives discussed in the CMS Report "should be further developed and analyzed and compared to the existing suite of alternatives on an equal footing under the CMS process provided for by the Consent Decree" in a revised CMS Report (February 5, 2009 Letter from Acting Regional Administrator Ira W. Leighton to Ann R. Klee, GE). Accordingly, as noted in Ms. Klee's February 25, 2009 response to Acting Regional Administrator Leighton, this response does not include responses to some comments or portions of comments that will be affected by the further development of remedial alternatives, including the ecologically sensitive alternative, or that require additional time to complete. GE will provide those responses, along with GE's evaluation of the ecologically sensitive alternative and any revisions to these interim responses in light of that evaluation, in the revised CMS Report anticipated in EPA's February 5, 2009 letter.

Please call me if you have any questions.

Very truly yours,

Andy Silfer

Andrew T. Silfer, P.E.
GE Project Coordinator

Enclosure

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General Electric Company
Pittsfield, Massachusetts

Response to EPA's Interim Comments on CMS Report Housatonic River – Rest of River

Volume 1 – Text, Tables, and Figures

March 2009

Acknowledgments

Several individuals and organizations contributed to the preparation of this Response to EPA's Interim Comments on the CMS Report. Principal authors included ARCADIS and Anchor QEA, LLC. The evaluations presented herein of the ecological impacts of the remedial alternatives included in the CMS Report were performed by AECOM Environment and Robert P. Brooks, Ph.D., Brooks Consulting, Professor of Geography and Ecology, Pennsylvania State University and Director of the Penn State Cooperative Wetlands Center.

Volume 1

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Introduction

The CMS

On March 21, 2008, the General Electric Company (GE) submitted to the U.S. Environmental Protection Agency (EPA) a Corrective Measures Study (CMS) Report evaluating potential corrective measures (remedial actions) to address polychlorinated biphenyls (PCBs) in the Rest of River portion of the GE-Pittsfield/Housatonic River Site (the Site) (ARCADIS and QEA, 2008). The Rest of River is the portion of the Housatonic River and its floodplain located downstream of the confluence of the East and West Branches of the Housatonic River (the Confluence) to which releases of hazardous constituents from the GE facility in Pittsfield, Massachusetts have migrated.

The CMS Report was submitted pursuant to Special Condition II.G of a permit issued by EPA to GE under the corrective action provisions of the Resource Conservation and Recovery Act (RCRA) on July 18, 2000, and reissued on December 5, 2007 to extend its expiration date (the Permit) – which Permit is part of the comprehensive settlement embodied in the Consent Decree (CD) for the Site. The CMS Report evaluated a number of remedial alternatives for the Rest of River, including eight alternatives for addressing sediments, seven alternatives for addressing floodplain soil, and five alternatives for treatment and/or disposition of sediments and soils that may be removed from the River and floodplain. These alternatives were evaluated under nine criteria specified in the Permit, consisting of three General Standards and six Selection Decision Factors. These evaluations utilized a PCB fate, transport, and bioaccumulation model developed by EPA; a set of Interim Media Protection Goals (IMPGs) required by EPA based on human health and ecological risk assessments conducted by EPA; and various other inputs and procedures that EPA directed GE to use in the CMS.

The CMS Report noted that GE disagrees with, and reserves its right to challenge, many of the assumptions, input values, interpretations, and conclusions in EPA's risk assessments and thus underlying the IMPGs, as well as several of the other inputs and procedures that EPA directed GE to use in the CMS. As a result, GE made clear that the CMS Report should not be regarded as GE's endorsement of the evaluations and conclusions set forth therein.

Nevertheless, based on the inputs and procedures required by EPA, the CMS Report concluded that the sediment and floodplain remedial alternatives known as SED 3 and FP 3 would best meet EPA's remedy selection criteria under the Permit. This combined remedial alternative would involve the removal of 227,000 cubic yards (cy) of sediment and soil from 177 acres and 14.2 linear miles of riverbank in the Primary Study Area (PSA), located between the Confluence and Woods Pond Dam. This affected area includes 103 acres of

Priority Habitat for state-listed threatened, endangered, or special concern species (jointly referred to as rare species) that would be severely impacted, much of it permanently.

Widespread Criticism of the CMS Report

The public and the Commonwealth of Massachusetts (the Commonwealth) criticized the CMS Report's conclusion. *The Berkshire Eagle* concluded in a September 10, 2008 editorial that "[a] cleanup along the lines of the one in Pittsfield carried through Lenox and South County would devastate the river and its banks, creating an aesthetic disaster that would also affect wildlife . . . ." The Commonwealth's Secretary of Energy and Environmental Affairs, Ian Bowles, wrote to EPA, on June 16, 2008, that "there are fundamental inadequacies in the draft study. . . . In addition, there is also a need for extensive discussion with GE and other stakeholders. Ultimately, the discussions must consider options that do not lie within the four corners of the CMS, and that are likely to achieve a consensus allowing a cleanup to go forward." A broad-based group of non-governmental organizations and individuals nominated the Upper Housatonic River, which includes the PSA, as an Area of Critical Environmental Concern (ACEC) with the intention of "increasing community and state agency participation in the current examination of alternatives and long-term solutions needed to address the clean-up of the current levels of PCB contamination in and along the river" (Save the Housatonic, 2008)

EPA's Initial Comments

On September 9, 2008, EPA responded to the criticism of the CMS Report and provided 166 comments on that report. In its letter transmitting these comments, EPA wrote:

> "An overriding concern with the CMS is that it failed to recognize the unique character of the Housatonic River below the confluence of the East and West Branches. . . . The analysis of alternatives in the CMS must provide a detailed discussion of how each alternative will provide species habitat protection through avoidance of negative impacts where possible or restoration where impacts are unavoidable, and if necessary, mitigation. . . . Until the CMS has been supplemented to satisfactorily address the concerns presented here, EPA believes it is premature to opine on which alternative or combination of alternatives best satisfy the permit criteria."

EPA's September 9, 2008 correspondence did not constitute any of the actions specified in the Permit (Special Condition II.H) for EPA's actions on the CMS Report (i.e., approval, conditional approval, or disapproval). Rather, it requested that GE provide substantial additional information and analyses before EPA could take such action. The September 9, 2008 correspondence also indicated EPA's willingness to "consider the development and detailed analysis of additional remedial alternatives" beyond those evaluated in the CMS and outlined a process for doing so.

Development of Ecologically Sensitive Alternative

Immediately upon receiving EPA's September 9, 2008 correspondence, GE began additional evaluations of the ecological impacts of the alternatives evaluated in the CMS. These additional evaluations required thousands of hours of effort by GE and its consultants, including a team of ecological experts added in response to the public's and the Commonwealth's criticism of the CMS. Based on these additional evaluations, GE agrees with those who had concluded that any combination of the sediment and floodplain soil removal alternatives evaluated in the CMS, including SED 3 and FP 3, would be inappropriate. Based on that conclusion, GE began work on the development of a more ecologically sensitive alternative.

Any alternative, including the ecologically sensitive alternative, must be protective of human health and the environment. However, in evaluating the overall protectiveness of the environment of any remedy, including the ecologically sensitive alternative, GE will, as required by the Permit, balance the goal of achieving the IMPGs (based on the inputs required by EPA) against the permanent adverse ecological effects of the remedial actions that would be necessary to achieve those IMPGs. Through such balancing, the development of the ecologically sensitive alternative will respond to the concerns of the public, the Commonwealth, and EPA about the irreparable harm that the sediment and soil removal alternatives evaluated in the CMS would cause to the PSA and its diverse and abundant wildlife, including a great number of state-listed rare species. Accordingly, the following principles consistent with those concerns will govern the development of the ecologically sensitive alternative:

- The PSA contains a wide distribution of habitats for faunal and floral species of concern (including rare species) that would be adversely affected by remediation activities. These habitats include significant habitats of species with strong site fidelities – such as vernal pools (relied upon by various amphibian species such as the wood frog, spotted salamander, and Jefferson salamander), vertical riverbanks (relied upon by species such as the belted kingfisher, bank swallow, and wood turtle), and marshes (relied upon by avian species such as bitterns and the common moorhen – where the remediation would disrupt those animals' ability to continue to return to and use these habitats.

- The forested riparian corridor in the PSA is relatively well preserved. Most of the sediment and soil removal alternatives evaluated in the CMS would materially impact the spatial integrity of the forested riparian corridor and adversely affect the wide-ranging species (e.g., top carnivores and migratory and resident birds) dependent on that corridor.

- The natural hydrologic processes that are active in the upper reaches of the PSA are responsible for creating the abundance and diversity of stream, floodplain, and wetland features that are so important to faunal and floral species of concern. The remediation and stabilization of riverbanks (even with bioengineering) would end these critical processes.

- Replacement of the vernal pools, riverbanks, groundwater-supported wetlands, and mature forested wetlands that would be severely impacted by most of the sediment and soil removal alternatives evaluated in the CMS is not practicable.

Through the application of these principles, GE is developing an ecologically sensitive alternative that would protect the unique character of the PSA, including a substantial amount of the Priority Habitat for rare species that would be severely impacted by implementation of the SED 3/FP 3 removal alternatives and more extensive alternatives, and thereby protect ecological receptors to the greatest extent possible without devastating the habitats critical to those ecological receptors.

By way of comparison, the SED 3/FP 3 removal alternatives would result in a "take" of at least 12 state-listed rare animal species (including American bittern, arrow clubtail, bald eagle, brook snaketail, common moorehen, Jefferson salamander, mustard white butterfly, riffle snaketail, triangle floater, water shrew, wood turtle, and zebra clubtail) and at least 9 state-listed rare plant species (including bristly buttercup, bur oak, crooked-stem aster, foxtail sedge, Gray's sedge, hairy wild rye, intermediate spike-rush, narrow-leaved spring beauty, and wapato). The "takes" of at least 13 of these state-listed rare species would be of a significant percentage of the local population of those species such that the work would be absolutely prohibited by the Massachusetts Endangered Species Act (MESA). Even more "takes" are possible under this combined alternative. Other remedial alternatives (SED 4 through SED 8 and FP 4 through FP 7) would result in at least as many, and in some cases even more, "takes," and takes of even greater severity.

In the interest of maximizing ecological benefit while minimizing damage to the unique ecology of the PSA, the ecologically sensitive alternative will identify the locations at which sediment or soil should be removed, as well as the locations of related access roads and staging areas, based on the following criteria:

- Concentration of PCBs present in sediment or soil;
- Avoidance of areas with a high density of faunal and floral species of concern;
- Avoiding or minimizing the disturbance of remaining vertical riverbanks and the application of stabilization techniques to riverbanks;
- Maintenance of a forested riparian corridor width of at least 1,000 feet, to the maximum extent practicable;
- Avoidance of habitat fragmentation by soil removal, access roads, or staging areas in currently intact areas, to the maximum extent practicable; and
- Otherwise minimizing and mitigating the effect of removal-related activities.

EPA's Response Regarding Ecologically Sensitive Alternative

GE discussed the development of this ecologically sensitive alternative with EPA and the Commonwealth on December 19, 2008. At that time, EPA, the Commonwealth, and GE agreed that the appropriate next step was the preparation of a work plan for the development of that alternative and that a meeting should be promptly scheduled to that end. However, on February 5, 2009, Ira Leighton, the Acting Regional Administrator for EPA Region 1 sent a letter to Ann R. Klee, GE's Vice President, Corporate Environmental Programs, in which EPA indicated that GE should, by March 9, 2009, attempt to respond to EPA's September 9 comments respecting the remedial alternatives evaluated in the CMS, and that later this year the ecologically sensitive alternative "should be further developed and analyzed and compared to the existing suite of alternatives on an equal footing under the CMS process provided for by the Consent Decree." Ultimately, EPA now anticipates that GE will submit a revised CMS Report integrating the ecologically sensitive alternative and "other necessary revisions to the draft CMS, e.g., revised comparative analysis, final ACEC decision implications, and other changes that flow from discussion of GE's March 9th response."

As stated in a January 16, 2009 letter from Ms. Klee to then EPA Regional Administrator Robert Varney, GE believed, and still believes, that "a comprehensive response that includes both the supplemental information relating to the previously analyzed alternatives [requested by EPA on September 9] and . . . analysis of the [ecologically sensitive alternative would] facilitate a meaningful evaluation of all alternatives . . . ."

This Interim Response

Notwithstanding GE's disagreement with EPA over the best way to proceed to complete the CMS, GE has endeavored to respond to EPA's comments related to the remedial alternatives evaluated in the CMS by March 9.[1] GE is unable at this time respond to a few of those comments or portions of comments (e.g., those relating to the identification of potential locations for an Upland Disposal Facility, those requesting an in-depth evaluation of potential impact avoidance, minimization, or mitigation actions for six example areas), because GE has not completed its evaluations and because those evaluations would be affected by further definition of the sediment and floodplain removal alternatives, including the ecologically sensitive alternative. In addition, GE's ecological experts have had insufficient time to complete all aspects of their painstaking work.[2] Finally, as EPA's February 5 correspondence recognizes, GE's comparisons among remedial alternatives will all change, perhaps materially, based on GE's continuing evaluations of the ecologically sensitive alternative.

For these reasons, among others, GE reserves the right to contest EPA's September 9 comments on the CMS Report as well as the subsequent correspondence from EPA. Nevertheless, GE has prepared this response to EPA's interim comments on the CMS Report (Interim Response). The format of this response consists of reiteration of each of EPA's comments (in italics) followed by GE's response to that comment. There are separate sections for responses to EPA's General Comments and its Specific Comments.[3] Supporting materials are provided in tables, figures, and appendices to this document.

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[1] We note that the CMS process has not yet reached the point under the Permit where deadlines for submittals would be established, because, as noted above, EPA has not yet taken any of the steps specified in the Permit for action on the CMS Report.

[2] For comparison, in response to EPA's Specific Comment 21, detailed evaluations have been prepared for each of 28 state-listed rare species, assessing the impacts of all the sediment and floodplain remedial alternatives on each of those species and the consequent implications for compliance with the substantive requirements of MESA and its implementing regulations. The level of effort and complexity involved in such an assessment is exceptional in the Commonwealth. The assessment of 28 rare species over a large area (>1,000 acres) of diverse habitats, with evaluations required of 12 alternatives, would typically justify a multi-year effort, but in this case has been compressed into several months. As a result, there has not been sufficient time to complete other parts of the analyses requested by EPA, such as the detailed evaluations of the six example areas identified by EPA.

[3] EPA's Specific Comments include a number of comments on the *Initial Phase IA Cultural Resources Assessment for the Housatonic River – Rest of River Project*, dated March 13, 2008, which GE submitted in conjunction with the CMS Report. These are Specific Comments 131 through 137. GE is submitting a separate document addressing those comments.

As with the CMS Report, the responses in this Interim Response are based on EPA's model, the IMPGs that EPA required GE to use, and the other assumptions, procedures, and inputs that EPA directed GE to use in the CMS. In consequence, this Interim Response is subject to the same qualifications and reservations presented in the CMS Report. That is, GE preserves its positions on these issues; and it reserves its right, pursuant to Special Condition II.N.5 of the Permit, to raise any objections on these or other issues in a challenge to EPA's modification of the Permit to select corrective measures for the Rest of River, as well as any other rights that GE has under the Permit, the CD, or applicable law.

Responses to General Comments

General Comment 1 (Page 1): *GE shall submit potential locations for the siting of an upland disposal facility with an evaluation of the suitability of each location with regard to PCB landfill siting criteria and compliance with ARARs. In addition, GE shall perform an analysis of ARARs, as specified in EPA's comments relating to ARARs in this letter, for each such upland disposal location(s).*

GE's analysis of ARARs for the Upland Disposal Facility location(s) shall include, but not be limited to, the following:

- *a discussion for each location of the attainment of ARARs, any potential application of the EPA Area of Contamination Policy, and the ability of the alternative to attain ARARs in the event the Area of Contamination Policy does not apply; and*

- *the ability of an Upland Disposal Facility to be constructed with a double-liner system.*

GE Response: GE is continuing to evaluate potential locations for an Upland Disposal Facility that are near the River, sufficient in size, and potentially available and suitable for use for such a facility. In particular, GE is considering locations outside the 100- and 500-year floodplains, outside any wetlands or other areas that would constitute resource areas under the Massachusetts Wetlands Protection Act, and outside areas designated by the Natural Heritage and Endangered Species Program (NHESP) of the Massachusetts Division of Fisheries and Wildlife (MDFW) as Priority Habitat or Estimated Habitat of threatened or endangered species or species of special concern. To date, GE has not completed its evaluation of such potential locations. Under the approach outlined by EPA in its February 5, 2009 letter, this Interim Response is an interim submittal and will be followed by further discussions of a new remedial alternative, evaluation of that alternative "on an equal footing" with the previously evaluated alternatives, and development and submission of a revised CMS Report that incorporates that new alternative as well as other revisions stemming from this Interim Response and other new information (e.g., the potential designation of the Upper Housatonic River as an ACEC). Given this revised approach, GE will complete its evaluation of potential locations for an Upland Disposal Facility during this same period. In the revised CMS Report, GE will identify those potential locations, and will provide a detailed analysis of applicable or relevant and appropriate requirements (ARARs) for each such location, including PCB landfill siting criteria and the other information requested by EPA in this comment.

<u>General Comment 2 (Page 1):</u> *GE shall submit information on potential locations for the disposal of materials offsite, including but not limited to the following:*

- *the location(s) for disposal of material that, if subject to thermal desorption or chemical extraction, is not suitable for reuse.*
- *additional discussion of the potential for beneficial reuse of material post-processing, if subjected to thermal desorption.*
- *the location(s) for disposal of material not subject to thermal desorption or chemical extraction.*

GE Response: Information on potential locations for disposal of materials off-site and the potential for beneficial reuse is provided below in the same order as the bullet points in EPA's comment. It should be noted that although particular off-site disposal facilities have been identified below as potential candidates, if disposal at an off-site facility is selected as part of the remedial action, further evaluation would be required to identify the specific facility(ies) to be used.

- The disposal location(s) for treated materials from the chemical extraction or thermal desorption process that are not suitable for reuse following treatment would depend on a number of factors. As noted in the CMS Report, for such materials that contained PCBs at or above 50 milligrams per kilogram (mg/kg) prior to treatment, the ability to dispose of such materials in a solid waste disposal facility that is not permitted under the Toxic Substances Control Act (TSCA), even if the materials contain less than 50 mg/kg after treatment, would require an EPA determination that such disposal would satisfy the substantive requirements of EPA's TSCA regulations for a risk-based approval (40 CFR § 761.61(c)). If such a determination is obtained, and assuming that the materials would not constitute hazardous waste under RCRA, the treated materials could be transported to a permitted solid waste disposal facility. One possible location for disposal of such chemically or thermally treated material from the Site could be Waste Management LLC's High Acres Landfill located in Fairport, New York. Possible locations for disposal in Massachusetts, which would require prior approval by the Massachusetts Department of Environmental Protection (MDEP) and the disposal facility, could include the Fitchburg-Westminster, Southbridge, and Bourne Landfills. (Treated materials containing PCBs less than 2 mg/kg could be reused at these Massachusetts landfills per MDEP COMM-94-007 and COMM-97-001.) Other potential locations would be evaluated during design. Treated material for which such a risk-based determination is not obtained from EPA would be required to be disposed of at a TSCA-permitted landfill. One possible location for disposal of TSCA-regulated material could be Waste Management LLC's Model City Landfill located in Youngstown, New York. Other potential locations would be evaluated during design.

- As assumed in the CMS Report, some material subjected to thermal desorption could potentially be reused on-site in a beneficial manner as floodplain backfill. Because the thermal treatment process would greatly reduce the organic content present in the treated materials, reuse would require that the materials first be amended by importing and mixing in an organic material source. Specifically, for purposes of the CMS, it was assumed that approximately 50% of the treated floodplain soils would be mixed/amended with topsoil (at an approximate 1:1 ratio) and reused on-site as backfill in the floodplain as part of the selected floodplain soil remedial alternative. That would provide all of the necessary backfill for floodplain areas. The remaining approximately 50% of the treated soils would require management/disposal through some other means (off-site disposal was assumed in the CMS Report). While the leachability of certain metals that may be present in the soils could be altered by thermal desorption treatment (for example, thermal desorption can oxidize lead, increasing toxicity and mobility [ITRC, 1998]) and thereby affect the ultimate end use and/or disposal costs of the treated material, it was assumed, for purposes of the CMS, that metals leachability would not affect this end use and/or disposal costs.

  Regarding potential use of treated sediments (and remaining soils) as backfill in the River itself, GE is unaware of any precedent for the use of thermally treated materials as backfill in a riverine environment. Use of such materials as substrate in the River would involve a number of problems. For example, the thermally treated sediments would be different from the current in-river sediments in that pre-treatment screening would remove rocks and debris present in the sediment which may otherwise provide habitat for aquatic organisms and substrate for aquatic vegetation, and the thermal treatment process would lower the organic content and alter the physical characteristics (e.g., cohesiveness) of the sediments. While amendment of the treated material would be required to replace the organic carbon content, it is uncertain whether the physical properties of the mixed materials (e.g., cohesiveness, plasticity, stability) would be sufficiently stable for use as riverbed material. To help stabilize the bed and improve habitat value, rocks would need to be added back to the treated materials, further complicating the post-treatment process. Further, while the CMS Report assumed that PCB concentrations would be reduced to below 1 mg/kg in the treated material, it is not clear that adding material containing PCBs, even at these low levels, to an aquatic environment would be considered acceptable by EPA. Finally, while amendment of the treated material with an organic carbon source should help bind some of the metals present in the treated materials, the thermal treatment has been shown to increase metals mobility, a concern that would be heightened if the material were placed back in the River. For the reasons noted above, it has been assumed that none of the treated materials would be used as backfill or capping material in the River.

Other potential beneficial reuses of material subject to thermal desorption could include use as landfill cover material or incorporation into asphalt (EPA, 2004a). The ability to implement either of these two options would be dependent on whether there is a need for such material at the time the remedial action is carried out. If thermal desorption was chosen as part of the selected remedy, further evaluation of beneficial reuse could be performed to determine if there are viable opportunities available. The evaluation would include, but not be limited to, determining if there is a need for treated material, the proximity of where the treated material would be used to the site, and what cost, if any, would be associated with reusing the treated material.

- Materials not subject to thermal desorption or chemical extraction that contain PCBs at or above 50 mg/kg and thus are regulated under TSCA would be disposed of at a TSCA-permitted landfill. Materials not subject to thermal desorption or chemical extraction that contain PCBs below 50 mg/kg (i.e., non-TSCA material) could be disposed of at an authorized off-site solid waste landfill, assuming that the materials would not constitute hazardous waste under RCRA. As previously noted, one TSCA-permitted landfill that could be considered as a disposal location for TSCA materials is Waste Management LLC's Model City Landfill. Possible locations for disposal of materials identified as non-TSCA could include Waste Management LLC's High Acres Landfill in New York and the Fitchburg-Westminster, Southbridge, and Bourne Landfills in Massachusetts, subject to the necessary approvals. However, if alternative TD 1 were selected, a detailed sourcing effort would be performed during design to identify appropriate off-site disposal facilities for both TSCA and non-TSCA materials.

General Comment 3 (Page 2): *GE shall submit potential locations for a chemical oxidation/thermal desorption unit(s) and an analysis of how such locations comply with ARARs, in accordance with the ARARs evaluation requirements in this letter.*

GE Response: GE has identified a potential location for a chemical extraction or thermal desorption unit. That location would be on GE-owned property along New Lenox Road (known as the former DeVos property). For purposes of this response, it has been assumed that either a chemical extraction or a thermal desorption unit with support areas (staging areas and access roads) would require approximately 5 acres. A potential 5-acre area within the above-referenced GE property is shown on Figure GC3-1. While this area would be located within the 100-year floodplain and, in part, within 200 feet of the River, it would be located outside the 1 mg/kg PCB isopleth and outside any area that contains wetlands. In addition, this area would be located outside the 20-acre area on this property that is currently subject to an Agricultural Preservation Restriction. However, as also shown on Figure GC3-1, this area, like virtually all the floodplain within the PSA between the Confluence and Woods Pond Dam, is located within areas that have been designated by the NHESP of the MDFW as Priority Habitats and Estimated Habitats of state-listed rare species.

As discussed in the Response to General Comment 1, GE has not completed its evaluation of potential locations for an Upland Disposal Facility under alternative TD 3, and will complete that evaluation during the forthcoming period while discussions and evaluations are ongoing relating to a new remedial alternative for sediments and floodplain soil. In this situation, GE has deferred completion of the analyses of ARARs for all treatment/disposition alternatives until such analyses can be prepared for all those alternatives, including the potential locations for an Upland Disposal Facility, so that the alternatives can be compared in terms of their compliance with ARARs. Accordingly, GE will include in the revised CMS Report a full analysis of how the above-identified location for a chemical extraction or thermal desorption facility complies with ARARs, including those relating activities within floodplains, within 200 feet of a river, and within rare species habitats, as well as those applicable to treatment facilities. This analysis will be provided in the form of detailed ARARs tables as described in General Comment 23.

General Comment 4 (Page 2): *GE shall develop and submit the carbon footprint for each alternative being evaluated, including associated transportation, as a measure of short term effectiveness.*

GE Response: As requested, GE has developed an estimate for the carbon footprint of each alternative evaluated in the CMS. Appendix A to this Interim Response contains a greenhouse gas (GHG) inventory/carbon footprint analysis that estimates emissions associated with each of the different sediment, floodplain soil, and treatment/disposition alternatives. This carbon footprint was based on carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions anticipated to result from activities supporting each remediation alternative described in the CMS Report. This analysis was conducted in accordance with the Climate Leaders Greenhouse Gas Inventory Protocol, titled *Design Principles*, published by EPA (2005a). In accordance with that guidance, overall emissions for each alternative have been reported as metric tons (tonnes) of carbon dioxide equivalents (CO_2-eq).

The inventory presented in Appendix A provides information on the anticipated activities from each alternative that are expected to result in emissions, as well as the methods used to make the calculations, as recommended by EPA (2005a*)*. The following sources of emissions are among those included in this analysis:

- ***Direct Emissions***: Emissions resulting from activities such as transportation of materials/equipment to/from the site, construction activities (e.g., tree clearing/site preparation, access road/staging area construction, installation of steel sheeting, bank stabilization, installing riprap, placement of isolation layer/armor stone, sediment and floodplain soil removal, sediment dewatering/stockpiling/ stabilization), decay of chipped trees, and final treatment (if applicable) and disposition of materials in a regulated landfill.

- ***Indirect Emissions***: Emissions resulting from the generation of purchased electricity used for water treatment, chemical extraction (TD 4), and thermal desorption (TD 5).

- ***"Off-Site" Emissions***: Emissions resulting from off-site activities such as production of steel sheetpiling, quarrying of riprap (armor stone), refining of diesel fuel, excavation of gravel/backfill from borrow pits, and cement/concrete manufacture.

The inventory presented in Appendix A includes estimates of anticipated GHG emissions expected to occur during the timeframe over which each project alternative is anticipated to be implemented, as they would be associated with activities such as sediment removal, floodplain soil removal, and ancillary activities such as construction of staging areas and access roads.[4]

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[4] For certain activities, direct emissions are expected to extend beyond the project timeframe. These consist of the emissions relating to changes in forest carbon stocks – specifically those relating to the removal and chipping of trees (to facilitate access road/staging area construction and floodplain soil removal) and those relating to the replanting of trees as part of site restoration. CO_2 emissions resulting from the decay of chipped trees and from changes in carbon sequestration rates due to removal of mature trees and replanting with seedlings will last longer than the project duration, and an equilibrium in net emissions can eventually be expected over a longer timeframe (i.e., zero overall net emissions eventually resulting 100 years or more after project initiation). However, to provide comparability with the other CO_2 emissions estimated for the remedial alternatives and given the fluctuations in these forest-related emission rates over time, only the net direct emissions resulting from these components over the project timeframe have been included in this analysis.

Summary tables that present estimated emissions for each alternative, reported by the above emission categories and sub-categories (e.g., transportation vs. construction), are provided within the text of Appendix A (Tables 1, 2, and 3). Detailed calculations are presented separately in Tables A-1 through A-31 for each sediment (A-1 through A-13), floodplain (A-14 through A-26), and treatment/disposition (A-27 through A-31) alternative. Tables A-13 and A-26 specifically present direct emissions expected to result due to tree removal activities (e.g., fossil-fuel-related emissions due to the use of chainsaws, wood chippers, stump grinders, etc.) for the sediment and floodplain alternatives, respectively. Figures GC4-1 through GC4-3 provide a graphical depiction of the estimated GHG emissions for the sediment, floodplain, and treatment/disposition alternatives, respectively.

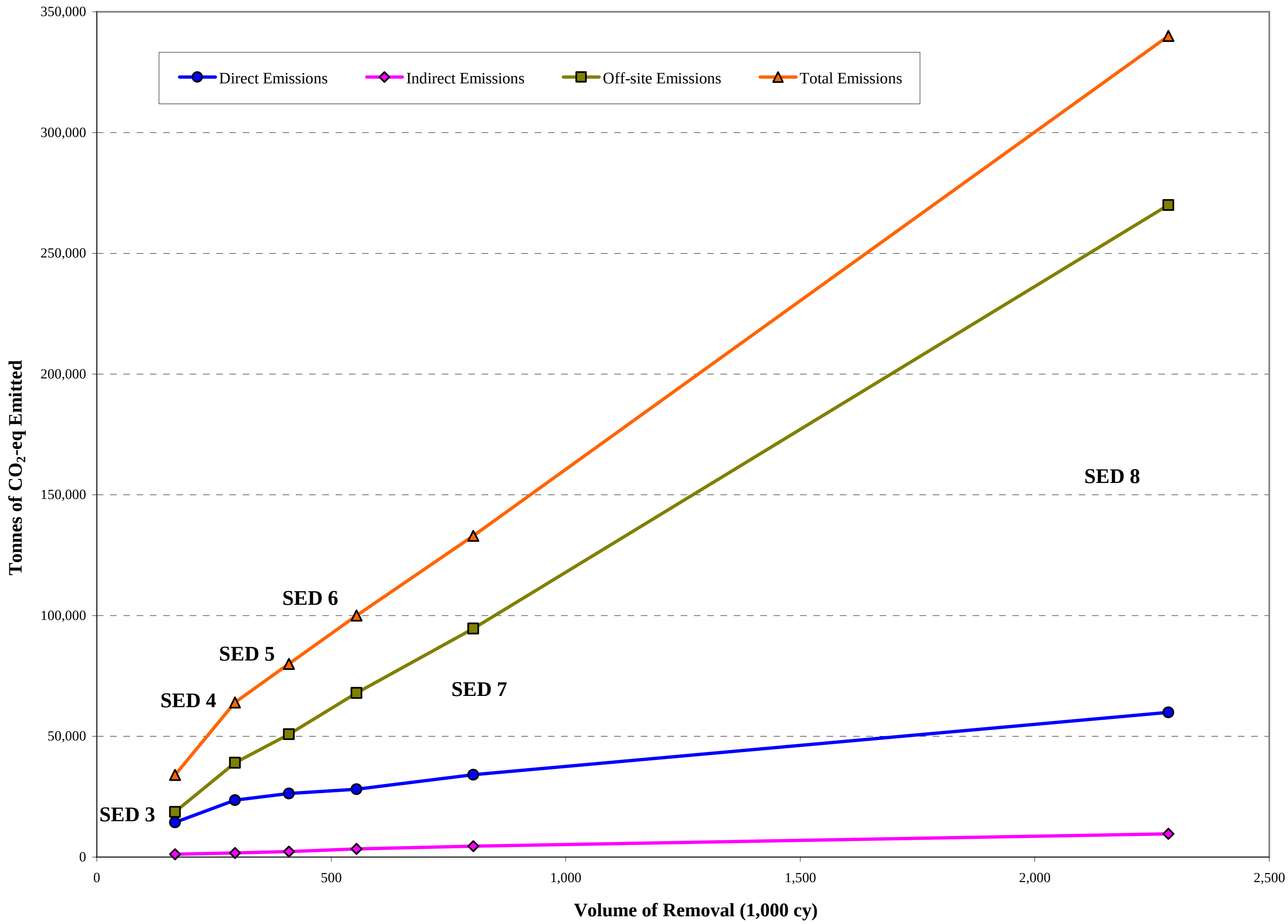

Figure GC4-1. Sediment alternatives, tonnes CO_2-eq emitted vs. volume of sediments removed.

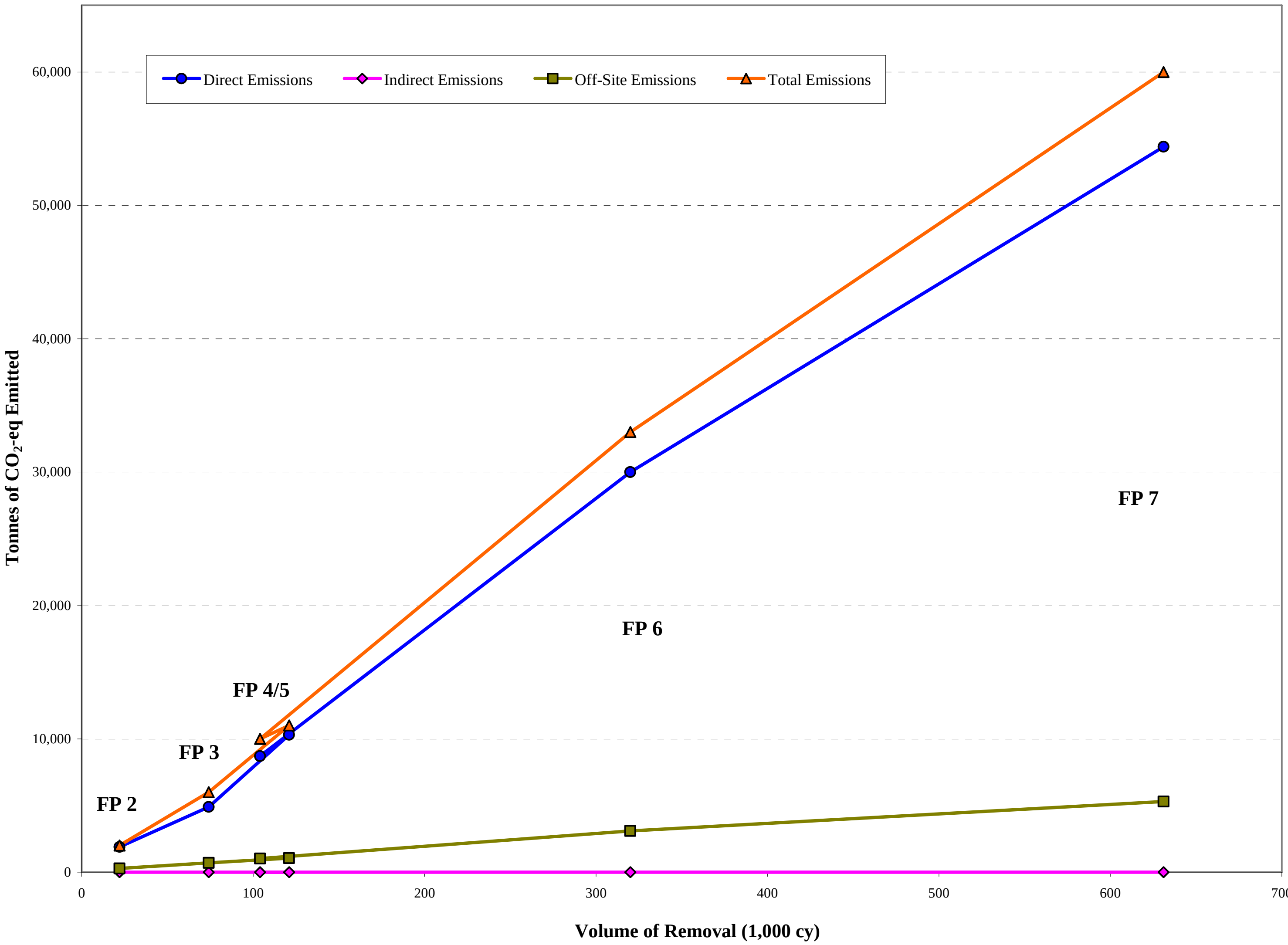

Figure GC4-2. Floodplain alternatives, tonnes CO_2-eq emitted vs. volume of removal.

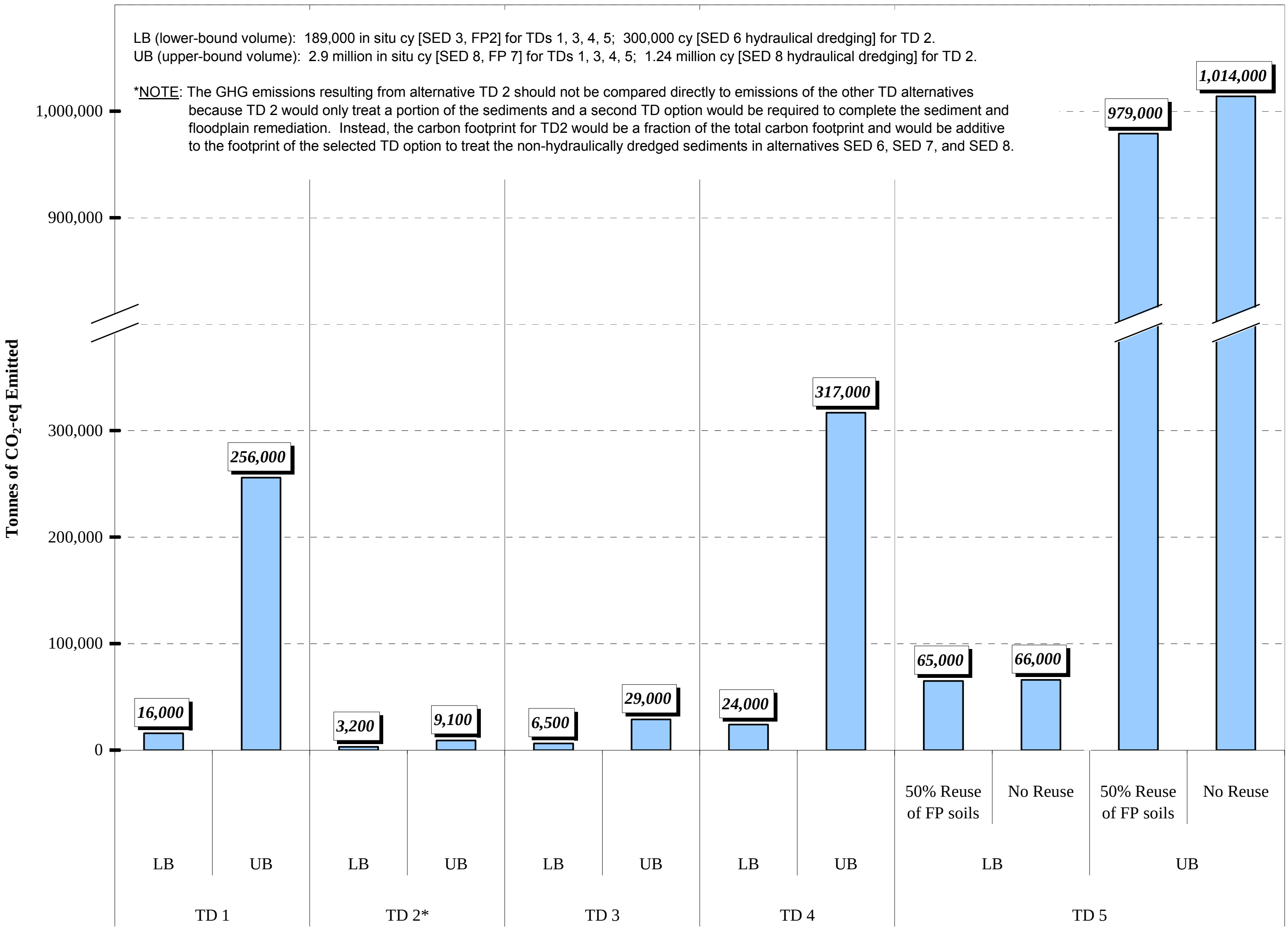

Figure GC4-3. Treatment/Disposition alternatives, tonnes CO_2-eq emitted.

In general, as expected, tonnes of CO_2-eq emissions were found to increase with the quantities of removed sediments and floodplain soils, due to the associated increase in energy expenditures. Calculated emissions for the alternatives involving removal range from approximately 34,000 tonnes (SED 3) to 340,000 tonnes (SED 8) for the sediment alternatives, and 2,000 tonnes (FP 2) to 60,000 tonnes (FP 7) for the floodplain soil alternatives (with FP 4 and FP 5 being relatively equal due to their equal volumes). Comparison among the three emission categories indicates that off-site emissions account for approximately 55-70% of the total emissions for each sediment alternative, and that direct emissions account for approximately 80-95% of the total emissions for each floodplain alternative. Emissions due to disruptions in forest carbon stocks (all or nearly all of which result from the decay of chipped trees[5]) account for approximately 20-45% of the total emissions for each floodplain alternative, while comprising a much smaller component (approximately 1-10%) of the total emissions for the sediment alternatives. The most significant off-site sources are associated with steel sheeting manufacture and production of cement to be used for stabilization. For the direct emissions, those associated with construction activities are approximately ten times greater than those associated with transportation activities.

For the treatment/disposition alternatives, evaluations were conducted for a range of removal scenarios, with the lower bound based on a combination of SED 3 and FP 2 and the upper bound based on a combination of SED 8 and FP 7. In general, emissions were lowest in TD 2 (disposition in a local in-water Confined Disposal Facility [CDF]), followed by TD 3 (disposition in a local Upland Disposal Facility), TD 1 (disposal in an off-site permitted landfill or landfills), TD 4 (chemical extraction), and TD 5 (thermal desorption). However, it should be noted that TD 2 would only handle a portion of the sediments and that thus a second TD option would be required to complete the sediment and floodplain remediation. Excluding TD 2, lower-bound emissions range from 6,500 tonnes to 66,000 tonnes and upper-bound emissions range from 29,000 tonnes to 1,014,000 tonnes. For both the lower and upper bounds, this range reflects a range from TD 3 to TD 5 (assuming no re-use of floodplain soils post-treatment for TD 5). Direct emissions from transportation of materials for off-site disposal account for the majority of emissions in TD 1 and TD 4, with a somewhat lesser contribution in TD 4 from operation of the chemical extraction facility. For TD 2 and TD 3, emissions from construction activities account for the majority of emissions, with a somewhat lesser contribution from transportation of materials. For TD 5, the majority of emissions results from natural gas usage in the thermal desorber, direct conversion to CO_2 of the total organic carbon component of the sediments and floodplain soils, and transportation of treated materials for disposal. Most of the remaining TD emissions are due

[5] Emissions from the decay of chipped trees represent 100% of the emissions due to disruptions in forest carbon stocks in the SED alternatives and 94% and greater of those emissions in the FP alternatives.

to diesel fuel refining (off-site emissions) in all TD alternatives, natural gas production/ distribution in TD 5, and purchased electricity (indirect emissions) for running the chemical extraction and thermal desorption apparatus (in TD 4 and TD 5, respectively).

In order to put the estimated emissions for the sediment, floodplain, and treatment/disposition alternatives into perspective, a table summarizing several comparison equivalencies is also presented in Appendix A. This table provides some context regarding the emissions reported therein by illustrating the size/quantity of other GHG-emitting activities that would be equivalent to the estimated SED, FP, and TD emissions. Specifically, the number of passenger vehicles that would emit an equivalent quantity of CO_2-eq in 1 year, the number of barrels of oil consumed that would emit an equivalent amount of CO_2, and the number of homes from which the energy used in 1 year would emit an equivalent amount of CO_2, are presented. For example, the emissions estimated to result from the implementation of SED 6 – approximately 100,000 tonnes of CO_2-eq – correspond to the annual output of approximately 18,300 passenger vehicles, consumption of 232,600 barrels of oil, or the annual output of 9,100 homes.

General Comment 5 (Page 2): *GE shall submit an evaluation of the use of rail as a transportation option for potential offsite disposal.*

GE Response: To assist in responding to this comment, GE retained the services of R.L. Banks and Associates, Inc. (RLBA), of Arlington, Virginia, a rail consulting firm, to evaluate the feasibility of transporting excavated materials from the Housatonic River and floodplain by rail to an appropriate off-site disposal facility or facilities. RLBA's evaluation was limited to the physical/technical feasibility of rail transportation of these materials. Based on its evaluation, RLBA concluded that rail transport of the excavated materials would be technically feasible. The bases for that conclusion are provided below.

The initial question in this evaluation related to the availability of suitable rail service in the Rest of River area. It was found that the Housatonic RailRoad Company (HRRC) operates regularly scheduled freight train operations over its tracks in close proximity to the Housatonic River in the area between Pittsfield and Housatonic, Massachusetts. In preliminary discussions, HRRC has indicated that it has adequate rail infrastructure and locomotive power to handle the anticipated volumes of materials at the anticipated production rates under the CMS alternatives. HRRC's main line is capable of handling cars of 286,000 pounds (lbs) gross loading, the *de facto* industry standard. The trackage that would support project shipments is maintained to a mixture of Federal Railway Administration (FRA) Class 1 and Class 2 standards, permitting freight operations at 10 and 25 miles per hour (mph), respectively. Based on RLBA's spot checks and conversations with HRRC, this trackage is actively maintained and would appear to be adequate to handle rail cars containing project materials, although this would need to be confirmed by an on-track inspection.

While the HRRC maintains tracks in relatively close proximity to the River in some sections, it is important to note that it is impractical to load railroad cars when they are located on an active railroad line because it would interfere too much with existing operations. Therefore, another important factor is the availability of loading areas that either exist or could be constructed to facilitate the staging of empty railcars, the loading of railcars, and the switching/movement of loaded cars into the traffic flow of the rail line. A preliminary review indicated that potential loading sites exist adjacent to or in very close proximity to the HRRC tracks, some of which already feature at least some rail infrastructure. If one of these potential sites were viable, it would limit the need to construct entirely new staging/loading tracks, although some new tracks would likely need to be constructed. At this time, it is anticipated that a single rail loading site would be selected and then configured appropriately to allow the loading of railcars. RLBA estimates that about 3.5 acres would be needed for the construction of the loading areas, with an additional four acres in an elongated shape to support the construction of new tracks.

Once dewatered (as necessary) at the temporary staging areas near the River, the excavated materials would be transported by trucks to the rail loading site, using trucks similar to those considered for transport to off-site landfills. Materials subject to TSCA regulation and non-TSCA materials would be segregated in separate storage and loading areas. The TSCA and non-TSCA materials would then be loaded into conventional open-top, low-side gondola railcars, again keeping those materials segregated. It is anticipated that the cars would be lined with a "Super Sack" or similar plastic disposable liner, which would be closed over the top to form a watertight wrapping. It is unlikely that railcars would be provided by the railroads; therefore GE would need to procure the cars elsewhere through either purchase or lease.

Rail service to and from the loading site would be provided by HRRC. After loading, the outbound loaded railcars would need to be moved by HRRC to an interchange with a longer-haul railroad. HHRC has an existing interchange with CSX Transportation, Inc. (CSX) in Pittsfield, to which HHRC currently sends (and receives) a train every day (averaging about 30 to 35 cars per day). The additional railcars holding project materials could be added to that train. That interchange track can hold over 200 cars, which should be sufficient to handle the movement of project materials as well as the existing freight volume. From that interchange, the loaded cars would be moved by CSX, and perhaps subsequently other railroads, to an appropriate off-site landfill or landfills, as discussed below.

In assessing the feasibility of rail transport as described above, RLBA considered a range of removal volumes and project durations, based on the alternatives previously evaluated in the CMS Report. The minimum volume and schedule were based on a combination of alternatives SED 3 and FP 2 (i.e., 187,000 cy of removal), and an overall project duration of 9.6 years, during which excavated materials would be generated for rail transport for approximately 9 years. The maximum volume and duration was based on a combination of SED 8 and FP 7 (i.e., 2,915,000 cy of removal), with an overall project duration of approximately 52 years during which excavated materials would be generated for rail transport for approximately 37 years. An assumed split between TSCA and non-TSCA materials was also considered based on information provided by ARCADIS. It was estimated that the minimum material volume generated by the project would result in about 660 carloads of TSCA material (about one-half carload per day during periods of active excavation) and about 2,996 carloads of non-TSCA material (about two carloads per day during periods of active excavation, peaking at three carloads per day). RLBA concluded that these are acceptable volumes for rail transport. Under the maximum removal scenario, it was estimated that the project would result in about 9,900 carloads of TSCA material (ranging from about one to four carloads per day during periods of active excavation) and about 37,000 carloads of non-TSCA material (ranging from three to eight carloads per day during periods of active excavation in the first 40 years of the project to 12 carloads per day late in the project). It was concluded that these volumes could be handled by the railroads and would not overwhelm their capacities. It was further concluded that rail service would likely be available for the duration of the project, even up to the maximum duration of over 50 years, although projections that far into the future are necessarily uncertain.

The estimated volumes for this project would not be sufficient to warrant the use of unit trains (in which all cars in a train are dedicated to carrying project materials). Instead, at the HRRC/CSX interchange, project cars would be included on trains in general freight service and would be forwarded as part of general freight trains along the various routes of CSX and potentially other long-haul Class 1 railroads (with additional interchanges as necessary) until the selected landfill location(s) were reached.

Finally, the evaluation of rail feasibility included an assessment of the availability of rail-served landfills with the physical capability and regulatory approvals to unload, handle, and dispose of TSCA and non-TSCA materials. RLBA confirmed the availability of numerous such landfills at the present time, including both TSCA and non-TSCA landfills, located in a number of states outside of Massachusetts. Upon arrival of the loaded railcars at the selected landfill(s), the contained materials would be unloaded and disposed of by the landfill operator. The empty railcars would then be returned to the loading facility via the reverse route. However, the potential availability of off-site landfills served by rail over project durations as long as 50 years is necessarily uncertain.

Based on the foregoing considerations, RLBA concluded that rail transport of the excavated Rest of River sediments and soils to off-site landfill(s) appears to be a technically feasible option.

General Comment 6 (Page 2): *GE shall provide an analysis of an alternative(s) for bank stabilization that allows for greater use of bioengineering methods rather than armor stone/revetment for areas where adjacent floodplain land use, topography, and hydrodynamics allow. Such methods provide greater opportunities for more rapid and beneficial revegetation during the restoration process. This analysis shall include an evaluation of the reduction in bank slope to maximize the use of bioengineering/ revegetation. GE shall also provide the assumptions used in estimating the remedial component for erodable banks (e.g. areas, slopes, bank height) both in the previous CMS submittal and in the reevaluation.*

GE Response: All of the sediment alternatives evaluated in the CMS Report, except for SED 1 and SED 2, include bank excavation and stabilization in Reaches 5A and 5B to limit releases of PCB-containing bank soil due to erosion of the banks. At the outset, it is important to recognize that excavation and stabilization of riverbanks will cause serious and irreversible ecological harm in the PSA regardless of whether "armor stone/revetment" or "bioengineering methods" are used to stabilize the excavated banks. GE thus disagrees that bioengineering methods would constitute an acceptable restoration technique by providing "greater opportunities for more rapid beneficial revegetation." "Revegetation" will not mitigate the serious and irreversible ecological harm caused by any excavation and stabilization of the riverbanks so it is not "beneficial" in terms of addressing that ecological harm.

In Reaches 5A and 5B of the PSA, natural geomorphic processes contribute to the formation of natural river and floodplain features, including meanders. The presence of riverbanks with exposed soil is essential to those natural geomorphic processes, which are a major influence on the nature of the river's bottom and substrate, as well as the channel itself and downstream banks. These natural geomorphic processes form meanders by higher hydraulic energy eroding the riverbank on the outer curve of the meander, creating overhanging vertical, or near-vertical, riverbanks, while lower hydraulic energy on the inner curve of the meander results in sediment deposition forming new, more gently sloping riverbanks, sand bars, or mudflats. As the river channel continues to migrate, the new riverbank on the inner curve of the meander proceeds through a series of successional stages, which in the upper reaches of the PSA culminates in mature riparian forest consisting of trees, including silver maple, box elder, and eastern cottonwood. Meanwhile, the vegetation on the top edge of the outer curve of the meander falls into the river channel as the riverbank erodes, with the woody debris providing in-stream habitat structures.

Many of the species inhabiting the PSA, including at least six state-listed rare species, require habitat types that are unsustainable in the absence of these natural geomorphic processes and their effects described above. The six state-listed species are the wood turtle, water shrew, arrow clubtail, brook snaketail, riffle snaketail, and zebra clubtail. Other species also rely on this type of habitat. Belted kingfishers and bank swallows require nest burrows in the overhanging vertical, or near-vertical, riverbanks primarily found on the outer curves of the river. These species demonstrate high site fidelity, returning to the same nest burrows year after year. Wood turtles and the northern water snake use these overhanging banks for shelter. Most riparian mammals in the PSA use bank burrows or den sites in riverbanks for shelter and breeding. The mature riparian forest on the tops of the riverbanks provides shade to the river and its bank that is essential to the creation of microclimates on which specific species in the PSA, including dragonflies, wood turtle, and four-toed salamander, rely. The mature riparian forest also provides hard and soft mast (food) and nesting cavities for several species, including wood duck and flying squirrel. The root masses of the forest naturally stabilize the riverbanks. Also, a variety of vertebrate and invertebrate species depend on an appropriate mix of herbaceous, living woody, and dead woody vegetation in the river channel itself for breeding, foraging, and basking sites. That appropriate mix of herbaceous, living woody, and dead woody vegetation is also dependent on the natural geomorphic processes described above.

By definition, any stabilization method, whether it is "armor stone/revetment" or "bioengineering," will halt these natural geomorphic processes essential to the creation and sustainability of the unique habitats described above and will eliminate the vertical, or near-vertical, riverbank habitat on which these species rely.

For this reason, ecological experts have concluded that the excavation and stabilization of riverbanks associated with remedial alternatives SED 3 through SED 8 will cause serious and irreversible ecological harm to the PSA. These effects are further discussed in Section III.A.2 of the Response to General Comment 10 below. In addition, the impacts on state-listed threatened, endangered, or special concern species that use the riverbanks are discussed in a document entitled "Assessment of MESA Issues for Rare Species Under Remedial Alternatives," which has been prepared in response to EPA's Specific Comment 21, based on information provided by NHESP, and is provided as Appendix B to this Interim Response. In fact, excavating and stabilizing more than 10% of the riverbanks in the PSA will materially impair the habitats discussed above, and will materially interfere with the species habitat, as well as the migratory and dispersal functions of the forested riparian corridor.

Further, given the unavoidable destruction of the forested riparian corridor inherent in the implementation of remedial alternatives SED 3 through SED 8, any improvement in the pace of the "beneficial revegetation" of that forested riparian corridor associated with bioengineering of the banks is not expected to be material. First, because, as suggested by federal guidance (Federal Interagency Stream Restoration Working Group [FISRWG], 1998), bioengineering techniques are applicable for bank slopes of 2:1 or less steep, implementation of this stabilization method will result in a wider and shallower river channel exposed to more sunlight. That change, together with the necessary removal of the forest canopy required in connection with riverbank remediation, will produce warmer water temperatures in the river and result in a loss of the source of woody debris that is critical to the aquatic habitat. These factors will adversely affect certain habitats in the river channel and its vicinity, and the species that rely on them. Second, "revegetated" plant species on remediated and stabilized river banks will be forced to compete with invasive plant species already present in the PSA, which would jeopardize the success of any "beneficial revegetation."

With respect to specific bank stabilization techniques, it was assumed in the CMS Report that SED 3 through SED 8 would involve a combination of armoring, revetment mats, and bioengineering techniques to stabilize the banks in Reaches 5A and 5B. Specifically, the CMS Report assumed that revetment mats would be used for restored bank slopes of 1½:1 or steeper (assumed to constitute about 20% of the area), armor stone would be used for restored bank slopes between 1½:1 and 3:1 (assumed to constitute about 60% of the area), and bioengineering would be used for restored bank slopes of 3:1 or less (assumed to constitute about 20% of the area). This 20:60:20 split was based on a qualitative, screening-level assessment of current bank conditions. A detailed analysis of the applicability of these techniques was not performed. Further, because GE did not yet have the benefit of the detailed analyses evaluating the ecological impacts of bank stabilization, as reflected in the Response to General Comment 10 and in Appendix B, the harm that would be caused by bank stabilization methods was not fully considered in the CMS Report.

Nevertheless, in order to evaluate alternative techniques for bank stabilization using bioengineering, as requested by EPA in this comment, additional evaluation of site-specific factors has been conducted. The initial step in this analysis was an evaluation of bank erosion, as the overall goal of stabilizing banks in the sediment alternatives was to limit erosion of PCB-containing bank soil. However, it should be noted that the extent to which bank stabilization would be part of the remedy would be determined after a more detailed analysis is completed during design.

Determination of whether or not a bank will erode is typically made using one of two approaches: (1) predicting erosion primarily due to the action of water on the streambank surface; or (2) focusing on subsurface geotechnical characteristics (FISRWG, 1998). The approach used in this response is based on the former because subsurface geotechnical characteristics have not been mapped in the PSA.

Approaches for characterizing erosion potential due to the action of water are based on either the maximum permissible velocity or the tractive force (e.g., critical shear stress). The shear stress approach is generally considered a better measure of the fluid force than the maximum permissible velocity approach (Fischenich, 2001). The shear stress approach was used for this analysis using the existing EPA Housatonic River hydrodynamic model to calculate shear stresses in the River.

Using shear stresses calculated by the EPA model and other relevant data, GE performed an analysis to identify those areas in Reaches 5A and 5B (i.e., the portion of the river where bank erosion has been observed) where application of bioengineering treatments for bank stabilization would be inappropriate due to physical conditions of the riverbank. This analysis was based on the following information:

- Areas of observed bank erosion;
- In-stream shear stresses;
- Existing bank slope related to the width of the riparian area (defined as the distance from top of bank to the 10-year floodplain boundary);
- Adjacent land use of riparian areas (i.e., areas of the floodplain that may warrant protection from erosion); and
- Current status of the banks (e.g., areas with existing riprap along portions of the banks).

Existing data were compiled and utilized in conjunction with outputs from EPA's hydrodynamic (EFDC) model of the PSA for this evaluation. Table GC6-1 below summarizes the data sets and model outputs used in this analysis.

Table GC6-1. Data Sets and Model Results Compiled for Riverbank Alternatives Analysis.

Data	Description
Shear stress	Shear stresses corresponding to an approximate bank-full flow condition were output from the EPA model. Since the EPA model is based on dynamic simulations (i.e., non-steady-state flows), shear stresses were output for every grid cell in Reaches 5A and 5B at several discrete times in the model corresponding to an approximate bank-full condition. The maximum flow rates from these events range from approximately 1,600 cfs to 2,600 cfs at Pomeroy Avenue. These results were aggregated and used to estimate maximum shear stress within each grid cell. Maximum shear stresses by grid cell are shown on Figures GC6-1a to GC6-1d.
Bank slope	Existing slopes of riverbanks were calculated from the 1998 EPA survey transect data. At each of the 152 transects in Reaches 5A and 5B, bank slopes were calculated for both sides of the river as the slope of a regression line extending from the edge-of water (under ordinary [low flow] conditions) to the top-of-bank. The low flow water surface elevation at each EPA transect location was estimated using EPA's hydrodynamic (EFDC) model by averaging water surface elevations for several discrete times in the model corresponding to low flow conditions. The median and mean flow rates at Pomeroy Avenue associated with these events are approximately 40 cfs and 60 cfs, respectively. Figures GC6-2a to GC6-2d show the EPA transect locations; Figure GC6-2e illustrates the method used to calculate bank slopes for a subset of EPA transect locations in Reach 5A. Calculated bank slopes for all transects in Reaches 5A and 5B are also shown on Figures GC6-3a to GC6-3d.
Riparian areas	Horizontal distance from the top-of-bank to the 10-year floodplain boundary was calculated throughout Reaches 5A and 5B
Existing riprap and stabilization	Areas of existing riprap included in the 2001 EPA-observed bank erosion GIS files were used to identify areas that would not require additional stabilization. In addition, other stabilized areas (i.e., to protect infrastructure such as bridge crossings) were identified based on visual surveys. These areas have also been included on Figures GC6-1a to GC6-1d.
Erosion/accretion areas	GIS files produced by EPA during its 2001 survey of existing bank erosion/accretion areas were used to map areas of observed erosion. Erosional areas are shown on Figures GC6-1a to GC6-1d.

As described in the above table, the data sets and model outputs used in this riverbank analysis are shown together on Figures GC6-1a to GC6-1d, and the EPA cross-section data and process used to determine bank slopes are shown in Figures GC6-2a to GC6-2e. The calculated bank slopes are shown on Figure GC6-3a to GC6-3d. These data were used to identify areas within Reaches 5A and 5B where bank stabilization using bioengineering techniques would likely not be appropriate based solely on physical reasons, without taking into account the associated ecological harm described above.

As described above, shear stresses associated with an approximate bank-full flow condition were determined using EPA's model to represent the erosive forces acting on the banks. The highest model shear stresses were compared to physical river features, which indicated that the highest shear stresses occur in areas where the river changes from high gradient to low gradient and at the outer bank of river meanders. The shear stresses at these locations, estimated at greater than 200 dynes/cm^2 were used as threshold values above which bioengineering would be inappropriate for physical reasons in the Housatonic River. This threshold value is conservatively low compared to the shear stress thresholds for the use of bioengineering treatments summarized by Fischenich (2001), but was considered appropriate for this analysis due the uncertainty of applying the model-predicted, cross-sectionally averaged shear stresses to the banks. The limited areas of the Housatonic River where predicted shear stresses would make bioengineering inappropriate are shown in Figures GC6-4a to GC6-4d.

For those areas where shear stresses do not appear to be limiting, the existing bank slope and width of the adjacent riparian area were evaluated to further determine if conditions in those areas are conducive to bioengineering. Federal guidance on stream restoration suggests that 2:1 to 10:1 slopes (i.e., slopes of 0.1 to 0.5) provide the optimal range of bank slopes for the application of bioengineering treatments (FISRWG, 1998). However, areas having slopes between 2:1 and 10:1 that are currently eroding (as documented by EPA) were identified as areas where bioengineering may not be feasible; in these areas where erosion is currently occurring despite the presence of relatively shallow slopes (i.e., within the recommended range for bioengineering), bank erosion may be occurring due to the nature of the bank material (e.g., undercutting and/or slumping of noncohesive sediments/soils) rather than the forces acting on the banks themselves. The ability to use bioengineering treatments in areas such as these would need to be further evaluated during design.

Based on the shear stress analysis, bioengineering treatments would not be applicable for approximately 10% of the riverbanks in Reaches 5A and 5B. Bioengineering treatments may also not be applicable for another 30% of the riverbanks in Reaches 5A and 5B with slopes between 2:1 and 10:1 that are currently eroding, depending on the results of further evaluation during design. These areas are shown on Figures GC6-4a to GC6-4d.

For the other 60% of the riverbanks, only a relatively small portion of them – representing about 20% of the overall riverbanks in Reaches 5A and 5B – have bank slopes between 2:1 and 10:1 and are not currently eroding. Applying bioengineering techniques in these areas may prevent the banks from eroding in the future due to remedial activities or stabilization of the banks in other areas, although remediation of these non-eroding banks may ultimately not be necessary and would need to be evaluated further during design.

The other remaining 40% of the riverbanks in Reaches 5A and 5B have slopes that are steeper than the maximum recommended slope for bioengineering (i.e., steeper than 2:1). These riverbanks were evaluated to see whether there is sufficient riparian area to cut back the bank slopes and thus make them physically amenable to bioengineering techniques. Reducing slopes would not be feasible in areas where (1) bank armoring (riprap) is currently present, (2) there is insufficient riparian area or conflicting land uses, or (3) there are relatively "tight" meanders. Evaluation of the riverbanks in Reaches 5A and 5B did not indicate any areas where the first and third of these factors would preclude reducing the bank slopes to 2:1 or less. However, this analysis did show that such a reduction would be precluded by existing land use in a small portion of this remaining area (largely in the vicinity of the EPRI facility, totaling 2% of the riverbanks in these reaches). In any event, as discussed above, such reductions in the bank slopes throughout this area would cause serious and irreversible ecological harm to the river and its banks and the species that use them.

In summary, the screening-level analysis described above indicates that just the physical factors evaluated (without considering the ecological harm that would be caused by any stabilization method) would potentially preclude use of bioengineering techniques in approximately 42% of the banks in Reaches 5A and 5B – i.e., 10% of banks in areas having relatively high shear stresses, 2% of banks in areas where bank slopes could not be reduced due to existing adjacent land use, and potentially another 30% of banks that have bank slopes that are within the optimal range for bioengineering yet are currently eroding. (For the purpose of this screening-level analysis, all of these areas are shown as "bioengineering not applicable" on Figures GC6-5a through GC6-5d.) This leaves approximately 58% where these factors would not preclude such treatment – i.e., 20% of the banks under existing bank slope conditions (to the extent necessary) and 38% more if the bank slopes are reduced. These areas are shown on Figures GC6-5a through GC6-5d.

Because this analysis is preliminary and does not consider the serious and irreversible ecological harm that would be caused by any stabilization method, as discussed above and in other portions of this response, it is of little practical value. The appropriateness of bioengineering techniques requires not only a more detailed engineering analysis of a number of critical design criteria, such as the frequency and duration of peak flows, sediment transport, and bank soil properties, but also a full consideration of the ecological harm that would be caused by this or any stabilization method. In addition, the results of this analysis are shown at the scale of the EPA model grid (i.e., the scale at which the shear stresses were generated). However, the relatively fine scale of the model grid is likely not the most appropriate spatial scale at which various bioengineering techniques could be applied. Rather, bioengineering techniques would likely be applied at a scale consistent with the anticipated erosional forces and ecological considerations, which are typically at a scale larger than a model grid cell. Further analysis would be required during design to evaluate additional data and determine the appropriate spatial scale.

General Comment 7 (Page 2): *GE shall provide a conceptual approach for an institutional control pertaining to the monitoring, management and or disposal of sediment and/or bank soil containing PCBs associated with the maintenance, new construction, or removal of structures that are performed by another party, including but not limited to dams and bridges in the Rest of River. GE shall also discuss the assumptions made in the CMS regarding the status of the dams for each alternative and the effect of these assumptions on long-term effectiveness.*

GE Response: The two principal dams in the Massachusetts portion of the River, Woods Pond Dam and Rising Pond Dam, are owned by GE and subject to the CD. GE monitors and maintains these dams through frequent visual inspections, more detailed inspections of the dams' structural integrity on a periodic basis (with reports to EPA and the Natural Resource Trustees), and the performance of maintenance and repairs as needed. Given GE's liability under the CD in the event of a failure of these dams, including liability for natural resource damages (see CD ¶ 176), GE will continue this monitoring and maintenance program indefinitely. This program ensures that these dams will continue to operate properly and will prevent any major release of the PCBs in the sediments contained in the impoundments behind these dams, and that any sediment or soil handled or removed during repair or maintenance activities will be properly managed by GE. In these circumstances, there is no need for an institutional control, as part of the Rest of River remedy, to address these dams.

There are three other dams on the River in Massachusetts, which impound sediments containing considerably lower PCB concentrations and sediment volumes. These are the Columbia Mill Dam, the Willow Mill Dam, and the Glendale Dam. The Columbia Mill and Willow Mill Dams have a Significant Hazard classification, and the Glendale Dam has a Low Hazard classification. In addition, there are six dams on the Connecticut portion of the River – Falls Village, Bulls Bridge, Rocky River, Shepaug, Stevenson, and Derby. The Falls Village Dam has a Significant Hazard classification, the Bulls Bridge Dam has a Low Hazard classification, and the remaining four dams have a High Hazard classification. All nine of these dams are hydroelectric projects licensed and regulated by the Federal Energy Regulatory Commission (FERC) pursuant to the Federal Power Act and FERC's regulations thereunder (18 CFR Subchapter B). This regulatory scheme requires maintenance and inspections of regulated dams, as appropriate, and FERC approval of the plans and specifications for any substantial alterations or modification to these dams.

As the Supreme Court has held,[6] FERC regulation under the Federal Power Act preempts state and local permitting requirements and similar regulation of these FERC-regulated dams, including application of the Massachusetts Dam Safety Standards and the Connecticut dam safety statutes and associated regulations. Indeed, the Massachusetts Dam Safety Standards explicitly exclude FERC-regulated dams (302 CMR 10.04). However, by virtue of other federal statutes, any new construction, repair, modification, or removal of any of these dams would require review and approval by other agencies in addition to FERC. For example, under Section 401(a)(1) of the federal Clean Water Act, FERC may not issue a license unless the state in which the dam is located has issued a water quality certification for the project. This allows the state environmental authority – in this case, MDEP for the dams in Massachusetts and the Connecticut Department of Environmental Protection (CDEP) for the dams in Connecticut – to consider the impacts of the project on the aquatic environment and to impose conditions on the project to protect the environment. In addition, it appears that any such project would require a dredge and fill permit from the U.S. Army Corps of Engineers (USACE) under Section 404 of the federal Clean Water Act, particularly if it would involve a release of a substantial quantity of sediments from the impoundment behind the dam.[7]

Through these regulatory requirements, the agencies can ensure that any contaminated sediment or bank soil that would be contacted, removed, or released during a dam construction, repair, modification, or removal project would be properly characterized, managed, and/or disposed of, and that any other potential adverse impacts from the work would be fully addressed.

The bridges across the River that are part of the state highway systems are maintained by the Massachusetts Highway Department in Massachusetts and the Connecticut Department of Transportation in Connecticut, and any construction, repair, or removal of such bridges would be conducted by those agencies. Moreover, any bridge construction, repair, modification, replacement, or removal projects that would involve work in or adjacent to the River would require an extensive array of regulatory reviews and approvals. These would include, in Massachusetts, a Section 404 permit from USACE, a Section 401 water quality certification from MDEP, review by the Secretary of Environment and Energy Affairs (EEA) under the Massachusetts Environmental Protection Act (MEPA) and potentially preparation

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[6] *First Iowa Hydro-Electric Cooperative v. Federal Power Comm'n*, 328 U.S. 152 (1946); *California v. Federal Energy Regulatory Comm'n*, 495 U.S. 490 (1990).

[7] While Section 404(f)(1)(B) of the Clean Water Act provides an exemption from this permitting requirement "for the purpose of maintenance [of dams], including emergency reconstruction of recently damaged parts," the USACE has explained in guidance that this exemption applies only where the release of sediments is *necessary* for maintaining the *dam* (as opposed to the impoundment), which will rarely occur, and that thus the exemption will generally not apply to the discharge of any significant quantities of sediment (USACE, 2005).

of an Environmental Impact Report, review and issuance of an Order of Conditions by the local conservation commission under the Massachusetts Wetlands Protection Act, potentially a Chapter 91 waterways license from MDEP, and, depending on the location and extent of the work, review by the NHESP of the MDFW under MESA. In Connecticut, the necessary reviews would likely include a Section 404 permit from USACE, a Section 401 water quality certification from CDEP, and a permit from CDEP or the local municipal wetland agency under the Connecticut Inland Wetlands and Watercourses Act. In both States, these existing regulatory requirements applicable to such bridge work would ensure the proper characterization, management, and/or disposition of any contaminated sediment or bank soil that would be contacted or removed during such an activity.

In these circumstances, GE would rely on the existing institutional controls applicable to the monitoring, maintenance, construction, modification, replacement, or removal of dams and bridges on the Housatonic River. As discussed above, the owners of the non-GE-owned dams in both Massachusetts and Connecticut are subject to detailed regulation by FERC, and the bridges are maintained by the states. Further, the owners/operators of these structures are responsible for the activities that would be necessary to allow construction, repair, modification, replacement, or removal of the structures, including the management and disposition of any contaminated sediment or bank soil that would be affected; and the extensive regulatory requirements that would apply to such activities would allow the relevant agencies to ensure that these activities are carried out properly and in compliance with applicable laws and regulations.

GE should not be responsible for monitoring, management, or disposition of contaminated sediments or bank soils in conjunction with the construction, maintenance, repair, alteration, or removal of these non-GE-owned structures on the River, because those sediments and/or bank soils may contain a variety of chemical constituents which are not attributable to releases from the GE facility. To the extent that the handling or disposition of these materials would involve the incurrence of additional costs attributable to PCBs (i.e., costs that would not have been incurred in the absence of PCBs), the owners would have a claim against GE for those additional costs. In such a situation, GE would consider reimbursing the owner for any incremental costs that can be shown to be attributable solely to the presence of PCBs in the sediments and/or bank soils at concentrations that require special handling procedures or a different disposition approach or location from those that would otherwise be allowed.

With respect to the last sentence in EPA's comment, the CMS Report noted, for each of the sediment alternatives evaluated, that the existing dams along the River would continue to limit the movement of PCB-containing sediments in the impoundments behind the dams, thus further reducing the potential for downstream transport of these sediments, and that the dam inspection, monitoring, and maintenance programs under other authorities would prevent or minimize the potential for failure of those dams. For the two principal dams in Massachusetts, Woods Pond and Rising Pond Dams, GE will ensure that those dams remain in place and do not fail. For the other three dams in Massachusetts, GE anticipates that, as long as those dams remain, the owners will continue their inspection and maintenance programs to prevent dam failure. For the dams on the Connecticut portion of the River, the existing FERC licenses for five of those dams run until May 2044 and the license for the remaining dam (Derby) runs until February 2026; and GE expects that these dam owners will likewise continue their inspection and maintenance programs to prevent dam failure. Further, even if the owner of one of the non-GE-owned dams in Massachusetts or Connecticut did decide to remove the dam, the regulatory requirements discussed above would ensure that any contaminated sediments are properly addressed. Finally, in the unlikely event that one of these dams did fail, the lower PCB concentrations and sediment volumes in the impoundments behind the three non-GE dams in Massachusetts and the very low PCB concentrations in the sediments in the Connecticut impoundments would reduce any resulting impacts from the PCBs in the sediments. These assumptions and considerations contribute to the long-term effectiveness of each the sediment alternatives.

General Comment 8 (Page 2): *With respect to the May 2007 review of innovative technologies performed by GE in the CMS Proposal Supplement, GE shall provide a similarly detailed update to the discussion that reflects the current state of the science, including information on performance, removal efficiencies, applicability, relative costs, operations and maintenance, and implementability.*

GE Response: As requested, GE has conducted a review of current innovative *in situ* treatment technologies for PCBs in sediment and soil to update the discussion included in Section 3 of the CMS Proposal Supplement (ARCADIS BBL and QEA, 2007b). Consistent with the CMS Proposal, potential *in situ* treatment options were evaluated using available information from several EPA websites (including EPA's Superfund Innovative Technology Evaluation [SITE] Program, Clu-in, and the Federal Remediation Technology Roundtable) and various other project and vendor websites. The information summarized below includes data and/or updates from projects that have become available since development of the CMS Proposal Supplement, and should be considered along with the information provided in the CMS Proposal Supplement.

Sediment

In situ treatment technologies (biological, physical, and chemical) for sediment sites continue to be under development, but none has been implemented full-scale at PCB sites. Research on *in situ* biological treatment is continuing, but at this point in time there are no indications that the limitations of this technology (as described in the CMS Proposal Supplement) will be overcome in the near future. The same is true for *in situ* chemical treatment technologies. However, since submittal of the CMS Proposal Supplement in May 2007, several efforts have been made to evaluate the effect of application of activated carbon (AC) on bioavailability of contaminants in sediment. Recent laboratory studies by Sun and Ghosh (2008) have focused on the effects of AC amendment on biouptake reduction in PCB-containing sediment at four sites in the Great Lakes Area of Concern – Niagara River (NY), Grasse River (NY), and Milwaukee River (WI; two locations). Results from these studies indicate that application of activated carbon can reduce the aqueous dissolved PCB concentrations and bioavailable PCBs, resulting in reductions of PCB bioaccumulation by benthic organisms. Specifically, results from these studies showed that "[a]ddition of activated carbon at a dose of 0.5-fold native organic carbon reduced PCB bioaccumulation by 42% for Niagara River sediment, 74% for Milwaukee River sediment 1, and 70% for Milwaukee River sediment 2" (Sun and Ghosh, 2008). Sun and Ghosh (2008) concluded: "Although engineering challenges for amendment delivery remain to be addressed, these laboratory results indicate that AC application can be a potential *in situ* technology to reduce ecosystem exposure to PCBs." Field pilot studies of activated carbon have been performed at the Grasse River (NY) and Hunters Point (CA) (EPA, 2008a; Sun and Ghosh, 2007; Cho et al., 2007). These field studies included the placement and/or mixing of AC in the field over a relatively small treatment area. Initial field testing has indicated a reduction of PCB bioavailability as a result of AC placement. For example, at Hunter's Point (CA), 24% less PCB uptake was observed in field-deployed clams after 1 month and 53% less after 7 months (Cho et al., 2007). Additional monitoring has been performed at the sites in an effort to continue to evaluate the applicability of AC placement to reduce PCB bioavailability.

Another new technique uses AC impregnated with reactive iron/palladium bimetallic nanoparticles (reactive activated carbon [RAC]) (Choi et al., 2008). The use of metals in a zero-valent state has been documented to efficiently dechlorinate PCBs. This treatment includes use of AC to physically sequester the PCBs and metals to treat the PCBs. This process is currently in the research stage and will require field testing to determine its effectiveness.

In August 2008, the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP) conducted a workshop focused on research and development needs related to the bioavailability of contaminants in soils and sediments. As a result of this workshop (SERDP and ESTCP, 2008), critical priorities were placed on researching *in situ* remedies to reduce bioavailability of contaminants in sediments, with a high priority placed on better understanding the effect of black carbon on the bioavailability of contaminants in sediments. Long-term performance measures to evaluate the success of field placed amendments in reducing bioavailability were also identified as a critical demonstration need.

Soil

As with sediment sites, *in situ* treatment technologies (biological, physical, and chemical) for soil sites continue to be under development. No new *in situ* treatment technologies have been implemented full-scale at PCB sites since GE conducted a review in the CMS Proposal Supplement of current innovative *in situ* treatment technologies for soil. GE's recent re-evaluation of such potential technologies indicated that, as previously stated in the CMS Proposal Supplement, many studies are underway within university laboratories to understand the applicability of these treatment technologies to soil sites. In particular, studies of *in situ* biological and zero-valent reduction treatment technology have continued. This continued research has resulted in small incremental increases in the understanding of the processes associated with PCB degradation/destruction. However, these studies remain in the research stage and there are no indications that the limitations of these technologies will be overcome in the near future.

A potential *in situ* treatment technology that is currently in the bench-scale and pilot-scale stages and that was not previously identified in the CMS Proposal Supplement is mineral amendment for remediation of contaminated soils. Emerald Bay Environmental Services has reportedly identified a natural oxidation technology that may offer an approach for *in situ* remediation of soils. The mineral amendment is Simtec Triad Ionate (STI), which is composed of igneous rock containing calcium hydroxide and calcified granite sodium pyrite. Emerald Bay Environmental Services provided limited data from bench-scale studies that they conducted on samples for several sites (Emerald Bay Environmental Services, 2009), as well as from a pilot study conducted by the USACE on sediments from the Gowanus Canal, Brooklyn Borough, NY (Myers, undated). Data from both the bench-scale and pilot studies indicated that the STI amendments resulted in a decrease in the concentrations of polycyclic aromatic hydrocarbons (PAHs) in the soils. Emerald Bay Environmental Services has indicated in conversations that efforts are underway to investigate the effectiveness of STI on decreasing PCB concentrations in soil.

Summary

Although several *in situ* treatment technologies have been, in part, demonstrated at a bench- or pilot-scale level, it remains true, as stated in the CMS Proposal Supplement, that no such technologies have been successfully demonstrated full-scale with PCBs in sediment or soil. As noted by SERDP and ESTCP as recently as November 2008 with regard to sediments: "Although several technologies for … in situ treatment have been developed, there remains a need for demonstration and validation of the effectiveness and permanence of these remedies" (SERDP and ESTCP, 2008). The same need for more successful bench/pilot-scale testing before full-scale implementation is considered exists for technologies for PCB-contaminated soil as well.

General Comment 9 (Page 2): *GE shall provide a more thorough analysis of the chemical extraction pilot study data and the efficacy of the technology, including a detailed analysis of the applicability of reuse and utilization of the processed material in river bottom, bank, or floodplain restoration.*

GE Response: At the request of EPA, a bench-scale study was performed to more fully evaluate the chemical extraction alternative (TD 4) in the CMS. The BioGenesis^{SM} Soil and Sediment Washing Process (BioGenesis process) was selected as the representative chemical extraction treatment technology, and a bench-scale study of this process was conducted in October and November 2007 in accordance with a work plan developed by BioGenesis and approved by EPA on July 31, 2007. A detailed description of this study and its findings was provided in the Bench-Scale Treatability Study Report, authored by BioGenesis and provided as Appendix A to the CMS Report; and a detailed evaluation of chemical extraction, based on the BioGenesis bench-scale study, was included in the main text of the CMS Report. In response to EPA's above-quoted comment, an additional analysis of the data from this study, including a more detailed analysis of the potential for reuse of material treated by this process as backfill in the River or floodplain, has been conducted and is presented in Appendix C hereto. A brief summary of that analysis follows.

As noted in the CMS Report, while the data indicate that the BioGenesis process would reduce PCB concentrations in the treated material by varying amounts, depending on the type of material and the number of treatment cycles, the process does not show effectiveness in treating Rest of River materials to concentrations that would allow on-site reuse of the treated material. To allow treated materials to be reused as backfill, it is expected that the treatment process would have to reliably and consistently achieve PCB levels below 1 or 2 mg/kg in the materials, and even these concentrations may not be low enough to allow reuse in some areas, notably in the river bed. Indeed, to the best of our knowledge, EPA has not permitted the use of PCB-containing treated material as replacement fill for river sediments. Data from the bench-scale study show that the BioGenesis process will only treat material to certain plateau levels and that these plateau levels do not approach 2 mg/kg.

More specifically, the bench-scale study included testing three different types of site materials (two types of sediment and one type of soil), each containing a different mixture of silts, clays, sands and gravels, with varying PCB concentrations. Each material was tested three times and each test consisted of treating the material through three cycles. This testing generated data for a total of 69 different treated material outputs originating from different initial material, multiple runs, and multiple treatment cycles. With the exception of the largest size material (i.e., cobbles > 0.25 inch in size, which are present in only some sediments), none of these outputs achieved concentrations less than 2 mg/kg. For example, the individual results for the remaining outputs from the coarse-grained sediments ranged from 2.7 to 143 mg/kg after one treatment cycle and up to 92 mg/kg after three treatment cycles. Outputs from the fine-grained sediments ranged from 8.6 to 60 mg/kg after one treatment cycle and 8.6 to 23 mg/kg after three treatment cycles. For the floodplain soil, the PCB concentrations ranged from 4.8 to 44 mg/kg after one treatment cycle and 2.6 to 24 mg/kg after three treatment cycles. Mass-weighted PCB averages of the treated materials, considering all three types of materials together, ranged from 7 to 48 mg/kg following one treatment cycle and from 4 to 22 mg/kg following three treatment cycles. The data further indicate that, apart from the largest size fraction that is present only in the coarse-grained sediments, the treated outputs with the lowest PCB concentrations, which were the hydrocyclone outputs, did not show a significant reduction in PCB concentrations between the second and third treatment cycles, indicating that additional treatment would not reduce concentrations further.

An evaluation of the effectiveness of the BioGenesis process, and especially of multiple treatment cycles using that process, is complicated by the loss of solids observed during the bench-scale testing, which resulted in a failure to complete a mass balance. A total of 11% to 40% of the initial mass was unaccounted for following the first treatment cycle and 23 %to 60% of the solids were unaccounted for after three treatment cycles. The inability to achieve closure to the mass balance makes it difficult to fully understand the mechanism for treatment and, therefore, to evaluate effectiveness. The limitations of the bench-scale equipment with regard to completing mass balance are one of the concerns raised in available literature for bench-scale studies performed by BioGenesis at other sites (see Appendix C, Section 4).

Examination of the data suggests that the effectiveness of the process is largely a function of the removal of solids – specifically, how much of the higher-concentration, finer-grained material is removed from the material during successive treatment cycles – rather than dissolution-based removal of PCBs. If this is the case, additional treatment cycles would simply continue to remove more solids (which would be transferred to the wastewater), rather than reduce the PCB concentrations of the remaining solids. This possibility is consistent with the observation that the treated materials with the lowest concentrations (apart from the largest size fraction) did not show significant reductions in PCB concentrations between the second and third treatment cycles, indicating that additional treatment would not reduce concentrations further.

In summary, for the above reasons, the BioGenesis process has not been shown to be able to achieve PCB concentrations that would allow on-site reuse of the treated materials.

General Comment 10 (Page 2): *EPA believes that the CMS does not address General Condition 4 of the April 13, 2007 Conditional Approval of the CMS-P, which directed GE as follows: "For each alternative being considered in the CMS evaluation, GE shall include restoration requirements commensurate with the alternative being considered." GE shall provide a detailed description of the restoration process and methods that may be used to restore habitats affected by removal and other construction activities, including steps that include avoidance, minimization, and mitigation and control of invasive species. This discussion will follow the principles outlined by EPA at http://www.epa.gov/owow/wetlands/restore/principles.html, the Massachusetts Wildlife Habitat Protection Guidelines for Inland Wetlands (2006), and the Society for Ecological Restoration International Guidelines for Developing and Managing Ecological Restoration Projects, 2nd Edition (2005). GE shall use the area(s) identified in Specific Comment 42 to illustrate this process.*

This discussion at a minimum shall include:

- *the process that will be used to identify and document ecological functions, services, and existing conditions in the river (bank and bottom), floodplain, and special habitats prior to implementation of an alternative. For example, as mentioned in the CMS, vernal pools have special hydrologic features. To increase the likelihood of successfully restoring these pools following removal, detailed topographic survey and information on hydrology would be required. The discussion shall describe how existing conditions for river bathymetry may be established and then replaced following potential corrective actions to achieve the pre-existing hydrologic conditions in the river.*

- *The methods that will be used to evaluate options for an alternative to avoid, minimize, or mitigate the impacts of the alternative, including a description of the decision-making process, taking into account the need to avoid and minimize impacts to wetlands and biota, including but not limited to Massachusetts Endangered Species Act (MESA) species to the maximum extent practicable. These methods shall include but not be limited to the following to avoid or minimize impacts from construction: the ability to iteratively evaluate contaminant concentrations and risk, the sequencing and timing of construction activities, and emphasis on timely restoration of impacted habitats following remediation.*

- *The methods that can be used to restore or replicate the ecological functions and services of habitat (including short-term measures such as boulder clusters in channel, placement of woody debris on the floodplain) that are affected by implementation of an alternative.*

- *The process by which performance standards shall be established with stakeholder input to assess the success of the restoration, including the need for specific measures to evaluate the effectiveness and control of invasive species, and the success of bank stabilization (including consideration of the ecological functions and services).*

GE Response: This response addresses only the ecological harm that would be caused by the sediment and floodplain soil removal alternatives that were described in the CMS Report. There is no way to avoid many of the adverse impacts of those alternatives on the habitats in the PSA and the rare species and other species that rely on those habitats. Many of these unavoidable adverse impacts would be so significant that they would render any avoidance of other impacts inconsequential. For example, the unavoidable ecological harm to vernal pools that would be caused by alternatives FP 3 through FP 7 would be of such an unprecedented magnitude that it is likely that many of the adversely affected areas would never return to their current level of function. Likewise, the unavoidable adverse impacts of alternatives SED 3 through SED 8 would result in post-remediation conditions in the riverine habitat that would be permanently degraded in both appearance and function. These adverse impacts, and others, are discussed in greater detail below.

As is discussed in the Introduction to this Interim Response, for these reasons and others, GE is currently discussing with EPA and the Commonwealth the development of an ecologically sensitive alternative that avoids or minimizes the adverse ecological impacts that would result from the implementation of the previously identified removal alternatives. As EPA recognized in its February 5, 2009 letter to GE, it is critical that the ecologically sensitive alternative be developed and evaluated together with the previously identified alternatives, including with respect to the important issues raised by this comment. Accordingly, the discussions in this response are necessarily incomplete and will need to be revised in the revised CMS Report when the ecologically sensitive alternative is also evaluated. In addition, this Interim Response does not include an in-depth discussion of how the process described herein would apply to six example areas identified by EPA on October 30, 2008 (per Specific Comment 42), because GE believes that it is critical that those in-depth area-specific evaluations consider the ecologically sensitive alternative under development and because GE has not had sufficient time to complete those area-specific evaluations. GE will provide such in-depth illustrative evaluations of those six example areas in the revised CMS Report that includes the ecologically sensitive alternative.

GE's response to this comment is divided into four parts. Section I identifies the process that would be used to identify the existing ecological functions, services, and conditions of the habitats that may be affected by the selected remedial alternative(s). Section II addresses the process and methods for evaluating options to avoid or minimize adverse impacts of the remedial alternatives and includes a discussion of whether measures undertaken to avoid or minimize such adverse impacts would in fact do so. Section III provides a detailed discussion and evaluation of potential restoration methods for the various types of habitats that would be negatively impacted by the remedial alternatives. To provide the necessary background information for this evaluation, Section III includes a description of each such habitat type and the adverse impacts that would be caused to that habitat by implementation of the sediment and floodplain remedial alternatives included in the CMS Report. It also describes the key constraints on restoration of each of those habitat types, the restoration methods that could be used, and the likelihood of success of restoration for each of those types. Finally, Section IV describes a process for determining performance standards to assess the success of any restoration measures that may be implemented.

I. Process to Identify Existing Functions

EPA's comment states that GE should describe "the process that will be used to identify and document ecological functions, services, and existing conditions in the river (bank and bottom), floodplain, and special habitats prior to implementation of an alternative." As requested by EPA, GE has drawn from several guidance documents to develop a framework for a process that would be followed to identify and document existing ecological conditions. The guidance documents include EPA's *Principles for the Ecological Restoration of Aquatic Resources* (EPA, 2002); the Society for Ecological Restoration International (SERI) *Guidelines for Developing and Managing Ecological Restoration Projects* (SERI, 2005); the Massachusetts Aquatic Habitat Restoration Task Force's *Blueprint for the Future of Aquatic Habitat Restoration in Massachusetts* (Mass. Aquatic Habitat Restoration Task Force, 2008); and the *Massachusetts Wildlife Habitat Protection Guidelines for Inland Wetlands* (MDEP, 2006). Other guidance documents incorporated into the process are described below.

A. Review of Existing Information

The initial step in the process of identifying and documenting existing conditions would be to review and compile existing information. A considerable amount of work has already been performed that has documented the unique ecological resources of the Housatonic River and its floodplain and in particular those of the PSA between the Confluence and Woods Pond Dam. These include the following:

- The *Ecological Characterization of the Housatonic River*, prepared by Woodlot Alternatives, Inc. (2002) for EPA. This document summarizes detailed field investigations performed over a 3-year period (1998-2000) and associated research compiling the results of previous investigations of the ecological resources of the PSA. Previous investigations that are referenced in this document include wetland characterization/function-value assessments and preliminary ecological characterizations by TechLaw, Inc. (1998, 1999), as well as ecological investigations conducted as part of fate and transport studies (Roy F. Weston, Inc., 2000). The 2002 Ecological Characterization report by Woodlot Alternatives is a compilation of landscape/biophysical settings, natural community types, and biota (including macroinvertebrates, fish, amphibians, reptiles, birds, and mammals), including rare species information.

- The Nomination of the Upper Housatonic River as an ACEC, prepared by the Upper Housatonic River ACEC Steering Committee (Save the Housatonic, 2008). While this document pertains to a broader area than just the PSA, encompassing 12,280 acres (versus the roughly 1,100 acres of the PSA), it summarizes ecological conditions within the Housatonic River and floodplain from the Confluence to Woods Pond Dam.

- Data, mapping, and reports from the NHESP of the MDFW depicting Priority Habitats of Rare Species and Estimated Habitats of Rare Wildlife, as well as Biomap Core Habitat and Supporting Natural Landscape within the PSA. These sources describe habitat conditions of state-wide significance and detail the state-listed rare species that have been documented within the Priority Habitat limits delineated.

- NHESP is currently conducting a comprehensive survey of subpopulations of state-listed rare species within the Upper Housatonic River Valley. One hundred three state-listed rare species have been identified within the potential survey footprint. To date, this research has confirmed the presence of at least 28 endangered, threatened, or special concern species listed under MESA within the stretch between the Confluence and Woods Pond Dam, and has resulted in the preparation of updated Priority Habitat mapping for each of these species. NHESP is also using a model developed by NHESP and Kevin McGarigal and others at the University of Massachusetts to delineate Critical Supporting Watersheds for the Housatonic River. Ultimately NHESP will develop a conservation plan for the Upper Housatonic River Valley. It is anticipated that all of the information being developed by NHESP will be available by the time that this initial step in the restoration design process would be implemented.

- GE's ecological consultants have conducted assessments of the state-listed rare species documented to occur within the PSA. These assessments are presented in a document entitled "Assessment of MESA Issues for Rare Species Under Remedial Alternatives," which is provided as Appendix B hereto. These assessments summarize the life cycles and habitat requirements of these species, indicate the presence of these species in the PSA and adjacent areas, evaluate the adverse impacts to these species that would result from implementation of the remedial alternatives, and assess those impacts as required by MESA and its implementing regulations.[8]

The collective information existing for the PSA specifically, and for the Upper Housatonic River and floodplain in general, clearly documents the unique and extraordinary ecological resources that occur there. These exceptional ecological resources are a product of numerous biophysical factors (geology, hydrogeology, surface water hydrology), land use, and biological factors that function in concert. A brief overview of how these factors contribute to the ecological diversity of the PSA follows:

- <u>Regional landscape context and connectivity:</u> The Housatonic River and its floodplain communities between the Confluence and Woods Pond provide a contiguous riparian corridor along an extensive stretch (about 10 miles) of diverse riverine and wetland/floodplain habitats. The Housatonic River Valley includes undeveloped highlands to the east and west, making it an important regional migratory and dispersal corridor, as well as making the valley an essential element of the ecological complex that includes those flanking highlands.

- <u>Geologic and hydrogeologic setting:</u> Both bedrock and surficial geologic conditions of the region have a significant influence on the ecological resources of the PSA. The calcareous bedrock formation (marble of the Stockbridge Formation) that underlies the valley is bordered by metamorphic rock (slates, schists and gneisses) of the adjacent highlands. Surficial geologic deposits from glaciation have filled the valley with variable material, including calcareous (i.e., alkaline) cobbles derived from the underlying marble. This condition produces a unique hydrogeologic environment of groundwater flow through these deposits and discharges to the surface. These interactions between groundwater and surface waters significantly affect the character of the natural communities in the area.

- <u>Hydrologic characteristics:</u> Surface water and groundwater hydrology, including floodwater dynamics and riverine flow, give rise to a wide array of wetland hydrologic regimes, remnant channel segments, complex and diverse soil profiles (including river sediment differences), riverbank variability, significant microtopographic relief, and diverse vegetative community types.

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[8] With respect to such impacts MESA requires an assessment of: (a) whether the alternative would result in a "take" of the species under the MESA regulations: (b) whether a take could be avoided; (c) whether the take would affect a significant portion of the local population of the species within the PSA; and (d) for those species where the alternative would not be expected to affect a significant portion of the local population, whether a long-term Net Benefit plan could feasibly be developed.

- Habitat functions: Exceptional habitat features have developed due to the cumulative effect of the factors discussed above. A high diversity of contiguous natural riparian community types juxtaposed with complementary adjacent landscapes has given rise to an extensive, relatively unfragmented ecological resource. A distinguishing feature of this resource area is that it supports numerous state-listed endangered, threatened, or special concern species, including the 28 for which Priority Habitat has been mapped by the NHESP in the PSA and others that were identified by Woodlot Alternatives (2002).

B. Obtaining Additional Information

The next step in the process of identifying and documenting existing conditions and functions of the habitats affected by the selected remedial alternative(s) would be to collect additional, focused information, as necessary, to supplement the existing information. Several methods are available to collect such additional information, as described below.

One approach that is based on accepted processes and methodologies is to use a standardized form to record site characteristics, using existing information supplemented with additional field measurements. Numerous sources describing recognized habitat assessment procedures are available for the development of such a form, including:

- *Massachusetts Wildlife Habitat Protection Guidance for Inland Wetlands* (MDEP, 2006);
- *Rosgen Stream Classification System* (Rosgen and Silvey, 1996);
- *Nutrient Criteria Technical Guidance Manual: Wetlands* (EPA, 2008b);
- *The Highway Methodology Workbook Supplement* (USACE, 1995);
- *Estimating Wildlife Habitat Variables* (Hays et al., 1981);
- *Ecological Census Techniques: A Handbook* (Sutherland [ed.], 1996);
- *Wildlife-Habitat Relationships: Concepts and Applications* (Morrision et al., 1998);
- *Research & Management Techniques for Wildlife and Habitats* (The Wildlife Society, 1996); and
- *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* (Barbour et al., 1999).

Based on the criteria outlined in these documents, the standardized form would call for information on a number of parameters in the area subject to assessment. Examples of these parameters are set forth in Table GC10-1.

In addition, specific inventories and measurements may be appropriate for specific habitats. For example, within aquatic riverine habitats, baseline inventories may include: mesohabitat assessment, which involves the dimensions and location of pools, riffles and runs; substrate evaluation, which includes the types and positions of major sediment types (silt, coarse and fine sand, coarse and fine gravel, cobble, ledge or boulder); and a woody debris survey. A baseline bathymetric/topographic survey could be used to assess the amount of sediment to be removed and its current location. Use of the Rosgen Stream Classification System may be appropriate to further document river characteristics based on river geomorphology principles.

As another example, data collected to document existing conditions and functions of vernal pools could include the size and geographical extent of the pool(s), resident plant and animal species, source of hydrology, typical annual water levels and duration of wetness, basic water chemistry data, soil conditions (including potential permeability tests), in-pool physical features, relationship (or networking) to other vernal pools in the area, usage of adjacent habitats by vernal pool animals, and composition of the predator community. In addition, as micro-topography and elevations within a given depression can be an important factor influencing requisite vernal pool water levels, a detailed pre-construction topographic survey is typically performed in efforts to restore a vernal pool. As discussed below, despite these measures, it is likely that many of the vernal pools that would be adversely affected by the remedial alternatives would not return to their current level of function for decades or more, if at all.

Additional field investigations or data collection may be conducted to address specific requirements of procedures referenced above. For example, the USACE Highway Methodology (USACE 1995) lists a series of criteria or conditions to address for each evaluation area that describe the prevailing conditions of the area, which ultimately affect functional capacity.

Another available approach to documenting existing conditions is to use an established model or models designed for the type of habitat in question. A good example of this approach is the hydrogeomorphic (HGM) approach. The HGM approach is the primary method for the intensive assessment of the function of wetlands (Clairain et al., 2002; EPA, 2006a). It is based on the development of a suite of mathematical models for a specific wetland subclass (Smith et al. 1995). These models are simplified representations of ecosystem functions that the wetland may perform and provide a means of comparison to other wetlands in the same regional subclass (Smith and Wakeley, 2001). Each mathematical model is made up of variables that represent characteristics that affect how the wetland performs a specific function. Each variable is represented by a variable subindex score ranging from 0 to 1, with 1 representing the best performance of that particular function and 0 representing the absence of that particular function. Model variables are created from indicators that are either qualitatively or quantitatively measured at the site using standardized assessment protocols (Smith and Wakeley, 2001). These models specify field measurements needed to conduct the assessment.[9]

Similarly, Habitat Suitability Indices (HSIs) could be used to characterize the *potential* suitability of particular habitats for particular fish and wildlife species. HSIs are based upon specific habitat measurements for the targeted species. HSIs typically apply a similar approach to HGM, with 0 representing the absence of useable habitat and 1 corresponding to complete utility of an area as habitat for the target species. Should any of the targeted species that have available HSIs be a focus of the restoration efforts, the use of HSIs may be an appropriate approach for habitat measurements to supplement other information.

These and other available methods will be evaluated to determine the most appropriate one(s) to use in assessing and documenting existing conditions.

C. Approach to Evaluation of Existing Functions

It is anticipated that whatever specific method or methods are used to assess existing conditions will based upon the collection of data on measurable and observable structural parameters that are known to give rise to the functions of the relevant habitats. This approach recognizes that identifiable geographical, physical, biological and chemical characteristics of wetland/floodplain, riparian, and riverine communities perform specific processes which result in various ecological functions. Environmental classifications are often based on measurable attributes of physical structure or pattern. Structure, in turn, is usually the result of physical processes, and thus structurally based classification categories are often related to natural processes or functions. Structural parameters are less variable and more reliably measured than most functions themselves and are more amenable to being designed, controlled, and managed as part of a restoration program (although in some instances even these parameters cannot actually be controlled or managed).

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[9] As discussed further in Section IV.A of this Response, one of the challenges in using such models is that it is necessary to compare measured parameters to a reference condition. The reference condition could include similar unaffected areas in the same region (reference areas) or the pre-remediation conditions of the affected areas themselves. Either of these could be problematic because (a) it may be difficult or impossible to find suitably similar unaffected resource areas to serve as reference areas; and (b) comparisons to pre-remediation conditions would not take account of regional watershed changes that may result in differences between pre- and post-remediation conditions that have nothing to do with the remediation or restoration.

Table GC10-2 lists a few examples of existing functions in the PSA that could be assessed, along with parameters that influence those functions and that could be considered, as necessary, for the collection of data.

Table GC10-2: Examples of Existing Functions in PSA and Associated Structural Parameters.

Function	Associated Parameters
Fish habitat	▪ Water permanence; ▪ Stream physical conditions (width/depth, sinuosity); ▪ Stream flow conditions (velocity, pool-riffle ratio); ▪ Substrate composition; ▪ Sediment load; ▪ Structural features (woody debris, boulders); ▪ Streambank conditions; and ▪ Riparian vegetation.
Wildlife and plant habitat	▪ Diversity and interspersion of vegetative cover types; ▪ Landscape setting and juxtaposition with other habitats; ▪ Presence, persistence and quality of surface waters; ▪ Degree of disturbance; ▪ Plant community vertical profile diversity and density; and ▪ Specific wildlife habitat features (e.g., bank habitats, mature trees, standing dead trees with cavities, woody debris, wildlife food plants; vernal pools).
Groundwater recharge/discharge (i.e., relationship between groundwater and surface water)	▪ Surficial geologic deposits; ▪ Physiographic setting; ▪ Soil types; ▪ Specific conductivity and pH of water; ▪ Evidence of springs or seeps; ▪ Water regime (permanence of surface water bodies, including base flow); and ▪ Water temperature.
Flood flow alteration (effectiveness in storing floodwaters and reducing flood damage	▪ Position in watershed; ▪ Size of floodplain relative to contributing watershed; ▪ Extent of development in watershed; ▪ Surface topography and microtopography; ▪ Storage volume; ▪ Constricted outlets or dam controls; ▪ Surface flow characteristics (e.g., sinuous versus channelized); ▪ Vegetative cover type; ▪ Surficial deposits; and ▪ Bank full and streambank characteristics.

It is worth noting in this regard that habitat is the culmination of interactions among physical, chemical, biological, and land use history characteristics, and is perhaps the function that best reflects the ecological integrity of an ecosystem. Accordingly, while habitat restoration is considered a primary goal, it is derived from numerous factors or variables that operate collectively in a complex manner. Certain "pieces" of the habitat system could not be reconstructed. Other "pieces" of the habitat system may be designed and reconstructed, but achieving full restoration of the current functioning ecological system would still be subject to many uncontrollable factors. Invasive species, damage from major flood events, disruption of predator-prey relationships, and loss of certain species with limited or no ability to re-establish local populations are among these factors.

II. Methods to Evaluate Options to Avoid or Minimize Adverse Effects

EPA's comment next asks for a description of the methods that would be used to evaluate options for a remedial alternative to avoid or minimize adverse impacts from the remediation work to the existing ecological conditions and functions, including impacts to state-listed rare species. (Mitigation options are discussed in the next section of this response as part of restoration methods.) For a given remedial alternative, the methods to be used to evaluate such options fall into three categories: (a) methods relating to siting options; (b) methods relating to timing and sequencing options; and (c) methods relating to the use of best management practices (BMPs). In the event that these options would not avoid or minimize the adverse impacts, an additional option is to adopt a different remedial alternative.

A. Siting Options

For a given remedial alternative involving sediment or soil removal and/or capping or backfilling, the locations of that remediation are fixed by the alternative. As a result, there are no available siting options that would avoid or minimize the effects of the remediation.

However, consideration would be given to adjusting the locations of access roads and staging areas to avoid or minimize adverse impacts where feasible. To the extent practicable, existing infrastructure would be used to gain access to remediation areas, although impacts to current users of such infrastructure need to be assessed. Existing utility line easements may afford access that limits impacts to disturbed plant community types. For much of the PSA, however, existing infrastructure is very limited; access for most sediment, riverbank, and floodplain remedial alternatives would therefore require significant spans of temporary access roads that would unavoidably have to be sited in wetlands and floodplains simply to get to the targeted remediation areas. The process for determining practical access through an area that is currently devoid of existing access infrastructure would involve evaluation of the shortest available routes, a road configuration that could avoid mature trees in non-target areas to the extent practical, and measures to avoid inundated or saturated soils in non-target areas where feasible. Similarly, while an evaluation would be made of the possibility of siting temporary staging areas away from sensitive habitats where feasible, the need for those areas to be relatively close to the removal locations would require siting many of those areas in or near wetlands, since most of the floodplain in the PSA (approximately 85%) consists of wetland community types.

Particular consideration would be given to the design and alignment of access roads and staging areas within the floodplain in order to avoid and minimize impacts to rare species habitat to the extent possible. However, as previously noted, there are numerous state-listed aquatic, terrestrial, wetland, and avian rare animal species in the PSA, all with differing habitat requirements, habits, and life cycles. Some of these rare animal species (e.g., American bittern, common moorhen, Jefferson salamander, wood turtle) exhibit high site fidelity, in that they return to the same locations for breeding. In addition, there are numerous state-listed species of plants, which in many cases cannot be worked around or temporarily moved out of harm's way. In fact, the overall NHESP-designated Priority Habitats for the 28 state-listed rare species in the area between the Confluence and Woods Pond cover virtually the entire PSA, as shown on Figure GC10-1. In these circumstances, the access roads and staging areas would unavoidably affect at least some, and likely many, such species. This is shown in detail in Appendix B.

B. Timing/Sequencing Options

<u>Seasonal adjustments.</u> In addition to siting options, an evaluation would be made of the extent to which construction activities could be timed to avoid or minimize impacts. Seasonal and climatic factors such as the following would be considered:

- Growing season, leaf-out, and fruiting periods of resident plant communities;
- Typical breeding, spawning, and/or and nesting seasons of resident wildlife;
- Life history attributes of rare species;
- Snow cover;
- Seasonal high water or flooding conditions;
- Low-flow conditions.

However, given the numerous animal and plant species that would be affected, with different life cycles and growing seasons, there is no way that the remediation work could be timed to prevent impacts. For example, the preferred construction windows to avoid or minimize impacts for the state-listed rare species identified in Reaches 5A, 5B, and 5C, based on the life history cycles of each species, are shown in Figures GC10-2a, GC10-2b, and GC10-2c, respectively. As shown on these figures, there is no time during the year that remediation work could be performed in the preferred construction windows for all these species.

Moreover, the impacts of the remediation work would last far beyond the construction season itself. For example, as discussed further in Section III below, the impacts from riverbank removal and stabilization would be permanent, the impacts from clearing mature floodplain trees would last at least many decades, and the impacts from remediation within the large number of vernal pools or other sensitive wetlands that would be affected by most of the floodplain removal alternatives would be either permanent or very long-lasting. As a result, adjusting the timing of remediation work would have no significant effect on avoiding or minimizing the adverse impacts of that work.

The various groups of state-listed rare species adversely impacted by these activities are identified on Figures GC10-2a through GC10-2c. Since the listed plants are stationary, remediation work in their habitats or immediately adjacent areas will remove substantial soil or substrate, including all plants and seeds in the seed bank. Therefore, for affected plant species with small ranges within the PSA or whose ranges are widely impacted by remediation work, there is no window for remediation work that would avoid endangering their survival. For animal species with high site fidelity (such as the American bittern, common moorhen, wood turtle, and Jefferson salamander), remediation work within their habitat, even if occurring during periods of the year when they are not present, will adversely impact that habitat for multiple years, disrupting their life cycles.

Thus, for remedial alternatives with impacts on these habitats, there are no times of the year when remediation would not disturb these species and/or their habitats. Although a few temporal strategies could reduce the harm to some degree, any significant avoidance and minimization of adverse impacts must come from greatly reducing the spatial extent of impacts within the PSA, such as would occur with the ecologically sensitive alternative that GE is currently discussing with EPA and the Commonwealth.

<u>Sequencing of work.</u> The effects of sequencing the work over many years would also be considered. Since the removal alternatives evaluated in the CMS would have implementation durations ranging from 10 to over 50 years, the remediation work would be spread out over multiple years. In theory, this would allow some portions of the system to begin recovery while work is ongoing in more downstream sections. In fact, however, this sequencing would not prevent the adverse impacts of the remediation work, both because

the work in a given season would itself produce substantial harm to the habitat and associated wildlife in the affected area and because, as noted above, the impacts of the work would last far longer than the construction season and, in some cases, would be permanent.

C. Use of Best Management Practices (BMPs)

An evaluation would also be made of feasible BMPs and the extent to which implementation of such BMPs would avoid or minimize adverse impacts. Numerous material and process-oriented BMPs are available for multi-habitat restoration projects involving wetland habitats, and an evaluation would need to be conducted to determine which combination of these would be appropriate as part of sediment and floodplain alternatives selected. These BMPs include the following:

- Minimizing width of access roads for construction vehicles;
- Use of timber mats or alternative matting (e.g., AlturnaMats, plywood sheets for smaller vehicles) to cross wetlands or temporarily bridge small streams;
- Use of poled fords to cross wetlands;
- Use of vehicles with rubberized tracks or wide tires, light-weight or smaller vehicles, and low-pressure construction equipment to minimize soil compaction and limit soil scarification;
- Use of long-reach excavators;
- Use of straw-based materials (e.g., hay bales, straw bales, straw wattles) for erosion control;
- Use of silt fencing for erosion control;
- Use of sheetpiling, coffer dams, and/or silt curtains for in-water activities and siltation control
- Use of erosion control blankets for slope stabilization;
- Use of temporary swales and basins to control stormwater and/or to dewater excavation areas;

- Use of coffer dams and other means to temporarily circumvent flows around excavation areas; and

- Use of water bars and check dams to control water velocities in temporary stormwater swales.

The typical applicability of these BMPs and their limitations are listed in Table GC10-3. These BMPs would be carefully evaluated based on the proposed activities and the nature of sensitive area(s) encountered at each area of the PSA in which remediation work would occur. In addition, an evaluation would be performed to determine the actual availability of necessary proper construction equipment, materials, and qualified labor.

Although use of these BMPs, where applicable and appropriate, would help to control the impacts of the construction activities to some degree, they would not prevent or even significantly reduce the adverse impacts of the remediation, as discussed further in Section III below.

D. Conclusion

The above measures would be evaluated during design to assess the extent to which they would avoid or minimize the adverse impacts of the selected remedial alternative. Figure GC10-3 provides an example decision tree that could be used to evaluate such measures. However, for the reasons given above, for any of the more intrusive remedial alternatives discussed in the CMS Report – namely, SED 3 through SED 8 and FP 3 through FP 7 – these measures could not avoid and would not significantly minimize the ecological harm that would result from the implementation of the alternative.

The best way to avoid or minimize such harm is to adopt a different alternative – one that is specifically designed to avoid or minimize the adverse impacts. It is for that reason that GE is currently discussing with EPA and the Commonwealth the development of such an ecologically sensitive alternative, as discussed in the Introduction to this Interim Response.

III. Description and Evaluation of Impacts and Restoration Methods

As discussed in Section I of this response, the riverine, riparian, and floodplain system within the PSA possesses exceptional natural resource characteristics that provide numerous ecological functions that are of regional significance. Most of the remedial alternatives evaluated in the CMS would require substantial disturbances of that system. As discussed in Section II, there is no feasible way to avoid or significantly reduce the adverse impacts to the PSA that would result from those disturbances. Accordingly, it is critical to consider whether and to what extent this unique system can be restored to its pre-remediation condition and level of function. EPA's comment asks for a description of the "methods that can be used to restore or replicate the ecological functions and services of habitat . . . that are affected by implementation of an alternative."

Ecological restoration is a relatively new discipline. As defined by SERI (2004), "ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." Because the natural resource variables that give rise to ecological characteristics are complex, and the means of restoring those characteristics are still being developed and do not have a long track record, the ability to accurately predict the outcome of restoration efforts has significant limitations in any event. However, generally speaking, restoration of a small area involving one or a limited number of natural resources is more likely to succeed than the restoration of a large, complex, multi-resource riverine, riparian, and floodplain system like that of the PSA. This is true because, among other reasons, the habitats of the PSA do not exist in isolation. They are functionally interdependent and together comprise the large, contiguous corridor of the PSA. For example, aquatic riverine habitat cannot be considered separately from the banks, floodplain, and associated uplands, and the life cycles of many aquatic species have aerial/terrestrial periods or are dependent upon terrestrial processes (e.g., food inputs). Therefore, the prospect of in-stream restoration success cannot be evaluated without also considering the adverse impacts of related activities (e.g., bank remediation, floodplain remediation, construction of access roads and staging areas) on adjacent wetland/terrestrial habitat, which in many instances is essential to the survival of species associated with the river. Because of the unprecedented magnitude of the damage to these related habitats inherent in the implementation of most of the sediment and floodplain soil removal alternatives discussed in the CMS Report, restoration of the current ecological functions of the PSA would be very unlikely.

To respond to EPA's comment, this section discusses the potential and methods for restoration for each of the major ecological habitat types that would be affected by the remedial alternatives. For purposes of this discussion, the various specific natural community types that were identified by Woodlot (2002) within the PSA, using classifications of community types from the NHESP (Swain and Kearsley 2000), have been grouped into five broader categories of habitat types. Those habitat types are: (a) riverine habitat (including both the in-stream habitat and the riverbanks); (b) impoundments; (c) forested wetlands; (d) emergent/shrub wetlands; and (e) vernal pools. The different community types in the PSA are shown on Figure GC10-4. In order to assess the potential for restoration of these habitat types, it is important to understand the characteristics of the habitat, the extent and type of negative impacts that would result from the implementation of the remedial alternatives, and the inherent constraints on the ability to restore the habitat from those impacts. Thus, for each of the foregoing habitat types, the following sections present: (1) a description of the habitat type; (2) a discussion of the adverse impacts of the sediment and/or floodplain remedial alternatives (as relevant) on the habitat; (3) an identification and discussion of the key constraints on the ability to restore the habitat; (4) a description of the methods that would be used for restoration; and (5) an assessment of the likelihood of success of restoration efforts in re-establishing the pre-remediation level of function of the resources.

A. Riverine Habitat

1. Description of Habitat

<u>Habitat Types Within the Riverine Environment</u>

The Housatonic River between the Confluence and Woods Pond includes two primary flowing water habitat designations (as defined by NHESP, Swain and Kearsley 2000): Medium Gradient Stream (MGS) and Low Gradient Stream (LGS). In this stretch of the river, there are 9 acres of MGS, running from the Confluence to approximately the Holmes Road bridge, and 117 acres of LGS, from approximately Holmes Road to Woods Pond, although the boundary between these two habitats is not well defined. Two other aquatic habitats are distinguished from the stream itself by NHESP (Swain and Kearsley 2000): Riverine point bars and mud flats. Riverine point bars include deposits of coarse material near the edge of the river, typically at a bend, and occupy only 1 acre in the PSA, spread among 7 locations in Reaches 5A and 5B. Mud flats are composed of finer material deposits, usually of higher organic content, also along the river edge. The extent of mud flats has not been quantified within the PSA, but they are noted as a seasonally available habitat, associated with low late summer and early autumn water levels, entirely in association with LGS in Reach 5C.

An additional habitat type of interest within the river consists of backwaters, addressed in the RCRA Facility Investigation (RFI) Report (BBL and QEA 2003) and the CMS Report, but not defined by NHESP in its habitat inventory (Swain and Kearsley 2000). Backwaters are distinguished from the more strictly riverine environment by reduced flow and circulation. Backwaters occupy about 86 acres in the PSA, nearly 80% of which is associated with LGS.

While not strictly aquatic habitat, the riverbanks are included as part of the riverine habitat, as they are physically and ecologically inseparable from the river itself. The riverbanks have not been quantified in terms of area, but cover approximately 131,500 linear feet within the PSA (a distance of 65,750 feet on both sides of the river). The exact area of riverbank will vary with the slope, and estimates of area have been included in the river area estimate for purposes of assessing the impact of remedial alternatives. Yet with changing water levels, no separate quantification of riverbanks has been derived, much as with mud flat habitat.

Despite the differentiation and quantification of habitat types for inventory purposes, habitats in the Housatonic River corridor within the PSA form a contiguous, inter-related, and complex ecosystem. All of the sub-habitats grade into each other and have no rigid boundary. The total area of riverine habitats covered in this assessment is 213 acres. The wetland and upland areas in the floodplain and even beyond are relevant when discussing the ecology of riverine habitat or the impacts of possible remediation work on that habitat, but this section will focus on the 213-acre area delineated as riverine habitat.

Physical Features

The Housatonic River within the PSA transitions from moderate to low channel slope. Elevational gradient along the river length within the PSA is a primary factor in establishing the features of the riverine environment and the associated habitat types. Water velocity, channel depth, river width, substrate, and bank slope are all affected by stream gradient. In the upstream MGS area, water velocities are at least moderate and substrate is dominated by coarse sand to gravel or even cobble, with some boulders present and very little silt. Maximum water depth is typically 1.5 to 5 feet in the main channel, with some pools and riffles but mostly run habitat (moderate to rapid non-turbulent flow with little exposed substrate). Banks are high in most MGS area, but there are sufficient cuts in the bank to provide functional linkage with the adjacent floodplain.

Stream gradient declines downstream of Holmes Road, and a transition to LGS occurs. For purposes of classification in this response, the transition zone has been included with LGS in the characterization of habitat areas, but the change is actually quite gradual.

Riverine point bar habitat is formed at points where higher water velocities transition to lower velocities as a function of channel changes, usually on the inside of a river bend, but where velocities are rarely high enough to wash away accumulated sediment. These conditions are relatively rare in the PSA, and riverine point bar habitat occupies only an acre of the 213-acre riverine habitat.

Progressing downstream in the river channel, the substrate becomes dominated by silts, organic muck, and fine sand in the LGS area. Some gravel, cobble, or boulders may be present, particularly along the margins, but are not a major component of the submerged substrate. Mud flats may form as water levels decline during prolonged periods of low flow. Maximum water depth can be 10 feet in the main channel, but is more typically 6 to 7 feet in the PSA. LGS area occupies the valley floor and contains considerable meanders, providing much more river length per mile than the actual linear distance between two points a mile apart. Water levels will fluctuate seasonally, as with a lake, but are subject to more rapid rises in response to storms, and are usually highly connected to the floodplain, allowing high flows to spread laterally into adjacent wetlands. Woods Pond Dam accentuates the LGS attributes, backing up water during high flow events and possibly altering the location and extent of the transition zone from MGS to LGS.

The lower gradient of the downstream reach facilitates backwater formation, with large expanses of low areas adjacent to the river being flooded for a substantial portion of the year. Although limited, some water movement between these backwaters and the river tends to maintain connectivity. Backwaters may shrink in dry summers, creating additional MF area, but few dry out completely and maintain biotic communities not identical to those in the river. Woods Pond Dam maintains substantial areas of backwaters upstream of that pond.

Dead trees and branches that fall into the river create habitat features that are very important to physical structure, localized flow pattern, substrate features, and overall habitat value for many species. Woody debris is a dominant visual aspect of MGS and much of the transition zone to LGS. Woody debris is present but often submerged in LGS; while it may not be visually obvious, it adds considerable structure and affects depositional patterns within the LGS. Woody debris creates variation in habitat over space and time in the river; old debris eventually decays, crumbles, and moves downstream, while newer debris replaces it, although not at a uniform rate and often not in the same locations.

In the PSA, MGS and the transition to LGS occur in Reach 5A, while Reaches 5B and 5C are entirely LGS. The riverine point bar habitat occurs in Reaches 5A and 5B; velocity changes in Reach 5C are generally not suitable for riverine point bar formation, despite the presence of many riverbends. Mud flats and backwaters are associated with LGS in Reach 5C. The riverbanks run along the entire length of the river in the PSA, but their character changes along the length of the PSA. Banks are higher and have more mature trees in Reaches 5A and 5B, while larger trees are less common and the banks are lower in Reach 5C.

<u>Biological Communities</u>

Upstream areas (Reach 5A, MGS, and transition to LGS) host only sparse aquatic vegetation as a function of substrate and water velocity limitations. Aquatic vegetation is more abundant in the downstream area (Reach 5C), but is still not a dominant structural feature of the river. The primary aquatic plant species in the Housatonic River are Eurasian watermilfoil, curly-leaf pondweed, narrow-leaf burreed, giant burreed, flatstem pondweed, Canada waterweed, and duckweed. The watermilfoil and curly-leaf pondweed are invasive species. Shading by shoreline trees and shrubs occurs, restricting light and limiting temperature rise, further controlling aquatic plant growth. Aquatic vegetation is limited to small patches in sandy areas in Reach 5A and much of Reach 5B. Cover and overall habitat structure are more often associated with woody debris in those reaches. Dense patches of aquatic vegetation occur in Reach 5C, particularly peripherally and in backwaters, and submergent coverage may be substantially greater than is obvious from the river surface. Denser aquatic plant growths occur in backwater areas, and include waterlilies and various emergent plants. Algal growths are limited by water velocity, but cyanobacterial and green algal mats are observed on some sandy to rocky substrates, and diatoms coat many of the rocks, trapping some silt.

Vegetation along the banks grades from mostly trees in Reach 5A and most of Reach 5B to a shrub-dominated mix with some trees and herbaceous growths in Reach 5C. Silver maple, red maple, eastern cottonwood, and box elder form much of the canopy in the upstream area, and the subcanopy, shrub and herbaceous layers are minimized by light limitation. Further downstream, the canopy tends to be sparse and includes mainly red and silver maple, black willow and gray birch. A variety of shrubs are abundant there, including silky and red osier dogwoods, silky and pussy willows, winterberry, speckled alder, meadowsweet, buttonbush, blueberry and northern arrowwood. Herbaceous species in lighted areas include various ferns, grasses, aster, goldenrod, and the invasive purple loosestrife. State-listed rare species include intermediate spike-rush, wapato, crooked-stem aster, and narrow-leaved spring beauty.

A wide range of aquatic invertebrates utilize the Housatonic River within the PSA (Woodlot Alternatives, 2002), including a number of state-listed rare species. The state-listed rare species include four species of dragonflies (brook snaketail, riffle snaketail, arrow clubtail, and zebra clubtail) and the triangle floater (a freshwater mussel). The snaketails and triangle floater are restricted to MGS habitat and the transition zone to LGS within the PSA, preferring gravelly substrates. The clubtail dragonflies can be found throughout the PSA in silty sediments. Other invertebrates commonly found in the PSA include other dragonfly species, damselflies, a variety of true bugs (Hemiptera), beetles, caddisflies, a wide range of true flies (Diptera), freshwater shrimp (Amphipoda), two native species of crayfish, and two other species of mussels (Eastern floater and Eastern elliptio) not state-listed rare species. All but a few of these species live in the river in a larval form, morphing into a flying adult stage during spring and/or summer, although with long-lived larval stages or multiple generations in a year, the river is never without invertebrates. A few species, like mussels and some true bugs and beetles, never leave the stream in any life form. The adult stages of many aquatic invertebrates utilize the adjacent riverbanks and floodplain, as do many terrestrial insects.

Fish in the PSA are mostly warmwater species, with 25 species detected in surveys from 1998-2000, including sunfish species, perch, various minnow species, suckers, several species of bass, pickerel species, bullheads, goldfish and carp. Three coldwater trout species have been found in surveys since 1998, but are not abundant and only one (brook trout) is native. No state-listed rare fish species are known to exist in the PSA. In 2000, the most abundant fish species in the upstream portion of the PSA (Reach 5A) was the white sucker, at 65% of the biomass, but other commonly occurring species included largemouth and rock bass, yellow perch, and various minnow species (Cyprinidae) (Woodlot Alternatives, 2002). In Reaches 5B and 5C white sucker was again the most abundant species, at about 41% of the biomass, followed by largemouth bass, yellow perch, rock bass and common carp (Woodlot Alternatives, 2002). In backwater areas, goldfish and common carp are the dominant fish species, and bullheads and sunfish increase in abundance over the mainstem river channel. The backwater areas appear to be the primary spawning area and nursery for most of the fish in the river.

A variety of reptiles, amphibians, birds and mammals can be found in the riverine corridor in the PSA, at great abundance in some areas. Beaver dens and trails are evident in many areas, muskrat, mink and otter have been sighted, raccoons frequent the river, and slightly less water-dependent fauna such as bats, deer, fox, coyote and bear use this corridor. Among the birds, belted kingfishers and swallows are commonly observed in the PSA, and rely on the overhanging banks for their burrows. The state-listed American bittern and common moorhen forage along the river and in the backwater areas; and many species of waterfowl, such as wood ducks, mergansers, geese, and herons, frequent the river and adjacent backwaters. Amphibians and reptiles tend to be more abundant in the adjacent floodplain, but leopard and bull frogs, painted and snapping turtles, and newts can be found in backwater habitat and sometimes at the edge of the river. The state-listed wood turtle also utilizes the riverine habitat.

In total, there are 15 state-listed rare plant and animal species with NHESP-mapped Priority Habitat within the riverine environment of the PSA, including the riverbanks. These species are listed in Table GC10-4.

Table GC10-4. Rare Species Associated with the Riverine Habitats of the PSA, Including Banks.

Common Name	Scientific Name	State Status
Arrow clubtail	*Stylurus spiniceps*	Threatened
Brook snaketail	*Ophiogomphus aspersus*	Special Concern
Mustard white (Butterfly)	*Pieris oleracea*	Threatened
Riffle snaketail	*Ophiogomphus carolus*	Threatened
Triangle floater	*Alasmidonta undulate*	Special Concern
Zebra clubtail	*Stylurus scudderi*	Special Concern
Wood turtle	*Glyptemys insculpta*	Special Concern
Water shrew	*Sorex palustris*	Special Concern
American bittern	*Botaurus lentiginosus*	Endangered
Common moorhen	*Gallinula chloropus*	Special Concern
Bristly buttercup	*Ranunculus pensylvanicus*	Special Concern
Crooked-stem aster	*Symphyotrichum prenanthoides*	Threatened
Intermediate spike-rush	*Eleocharis intermedia*	Threatened
Straight-leaved pondweed	*Potamogeton strictifolius*	Endangered
Wapato	*Sagittaria cuneata*	Threatened

2. Effects of Sediment Remedial Alternatives

Alternatives SED 1 and SED 2 do not involve construction activities within the riverine habitat. Alternatives SED 3 through SED 8 would all impact riverine habitat to varying extents, and in different ways, depending on the remediation technique applied. Table GC10-5 lists the extent of each type of riverine habitat that would be affected by each sediment remedial alternative. The following subsections describe the types of effects that would be caused by the different remedial techniques.

Table GC10-5. Alteration of Defined Riverine Habitats by Remediation in Sediment Alternatives.*

Remedial Alternative	Affected Habitat	Direct Impact from Sediment and Bank Soil Remediation (acres or linear feet)	Percent of Total Riverine Acreage in PSA Affected	Estimated Duration of Work (years)
SED 1	None	0	0	0
SED 2	None	0	0	0
SED 3	MGS LGS RPB RB	9 ac (excavation/capping) 33 ac (excavation/capping) 37 ac (thin-layer capping) 0.8 ac (excavation/capping) 84,000 linear feet	37%	10
SED 4	MGS LGS RPB BW RB	9 ac (excavation/capping) 44 ac (excavation/capping) 36 ac (thin-layer capping) 37 ac (other capping w/o removal) 0.9 ac (excavation/capping) 0.1 ac (thin-layer capping) 54 ac (thin-layer capping) 84,000 linear feet	88%	15
SED 5	MGS LGS RPB BW RB	9 ac (excavation/capping) 79 ac (excavation/capping) 37 ac (other capping w/o removal) 1 ac (excavation/capping) 61 ac (thin-layer capping) 84,000 linear feet	88%	18
SED 6	MGS LGS RPB BW RB	9 ac (excavation/capping) 117 ac (excavation/capping) 1 ac (excavation/capping) 15 ac (excavation/capping) 55 ac (thin-layer capping) 84,000 linear feet	93%	21
SED 7	MGS LGS RPB BW RB	9 ac (excavation/capping) 117 ac (excavation/capping) 1 ac (excavation/capping) 32 ac (excavation/capping) 39 ac (thin-layer capping) 84,000 linear feet	93%	25
SED 8	MGS LGS RPB BW RB	9 ac (excavation/capping) 117 ac (excavation/capping) 1 ac (excavation/capping) 86 ac (excavation/capping) 84,000 linear feet	100%	52

* MGS = medium gradient stream; LGS = low-gradient stream; RPB = riverine point bar; BW = backwaters; RB = riverbanks.

Impacted areas are based on the following estimates of total areas of defined habitat types: MGS = 9 ac; LGS = 117 ac; RPB = 1 ac; BW = 86 ac; RB = 131,500 linear feet.

<u>In-Stream Sediment Removal</u>

Excavation of sediment would be followed in all cases by either installation of a cap or backfilling. The actual removal of sediment is expected to involve either dewatering of a section of stream to facilitate excavation without mobilization of sediment downstream (water would bypass the work area in a channel to one side or the other) or dredging "in the wet," using either mechanical or hydraulic dredging techniques without draining any portion of the river. The current MGS areas will be subject to dewatering and excavation, while the LGS and backwater areas are more likely to be dredged through wet dredging techniques when removal is called for under the corresponding sediment alternative.

With dewatering, disruption of aquatic habitat would be complete; no aquatic organisms remaining in the work area would survive and most non-aquatic animal species able to flee would be chased away by construction activities. With mechanical or hydraulic dredging in the wet, mobile organisms such as fish will be able to vacate the work area, but immobile or less mobile species (most invertebrates, all plants) will still be subject to high mortality. Non-aquatic species of animals would also be disturbed by construction activities.

Removal of sediment will cause removal of viable propagules (the organisms and their eggs, seeds, or regenerative tissue of any kind) within those sediments, even with the shallowest planned excavation (1 foot). Following the excavation, backfilling or capping at depths of at least a foot and up to 4 feet will bury any remaining aquatic invertebrates and aquatic plants present in the remediated area. These removal and capping activities, together with the riverbank remediation, over long stretches of the river will disrupt existing benthic communities and their habitats and, by extension, other elements of the riverine ecosystem (e.g., insect predators, fish, piscivorous birds and mammals). Changed sediment conditions are to be expected for a considerable period of time following placement, continuing the disruption of habitat and altering ecological function beyond the remediation work.

In addition, woody debris, which is a major component of the riverine habitat of the PSA, would be removed as part of any excavation or capping. This will have multiple adverse impacts as woody debris is direct habitat for many species and also affects localized flow patterns to create habitat for still more species; and thus the loss of woody debris will drastically and negatively affect the character of the in-stream habitat.

Further, following excavation and capping or backfilling, there is a high potential for invasion by non-native species already a major threat to the unique flora and fauna of this region (NHESP 2003). The species best adapted to colonize open areas may not be those that were present previously, when physical features were different. Rather, it is invasive species such as Eurasian watermilfoil and curly-leaf pondweed (already present in the PSA) and others not yet able to establish populations under current conditions that are likely to immigrate and dominate within the areas where sediment has been removed and new material put in place, unless an active control program is sustained for many years and an introduction program is conducted with desirable native species. However, intensive invasive species control programs may not be practical in many cases for the reasons discussed below in Section III.A.3.

Some invertebrates would recolonize areas in which remediation work occurs, but different species would be expected to dominate, at least initially, as a result of changed substrate. The pace and nature of recolonization will be determined by (among other factors) the scale, timing, and sequencing of the remedial alternative implemented. In the meantime, the species dependent on the benthic organisms would be adversely affected. Moreover, there could be a complete loss of rare species (such as the larvae of the state-listed rare dragonfly species and the triangle floater mussel) if the remediation adversely impacts a significant portion of the local population, as discussed further in Appendix B.

Finally, due to the change in substrate and burying of aquatic macroinvertebrates and aquatic plants, a change in the fish community would be expected. While fish will move back into the remediated areas, they would be challenged by the changed food resources and would likely have an altered species composition, at least initially. Bottom-feeding species which root around in soft organic sediments to obtain food would be replaced by more centrarchids (sunfish and bass), as the substrate will be more favorable to them for foraging. White sucker could still be the primary fish in the PSA, as they tolerate the greatest range of substrate conditions, but loss of cover may make these and other species more vulnerable to predation. In addition, there may be some reduction in the number of fish for several years, which could also affect piscivorous predators (e.g., kingfisher, mink, otter).

As deposition returns surficial sediments to prior conditions, the establishment of a biological community consistent with those conditions would be expected, although the length of time for that to occur, the abundance of organisms in that community, and the presence of any specialized species (including rare species) are all uncertain.

Habitat alterations of primary concern for in-stream excavation and related backfilling or capping undertaken as part of the sediment alternatives can be summarized as:

- Dewatering impacts on organisms and resting stages (eggs, seeds, overwintering forms);

- Direct impacts from equipment (tire treads, mats) in dewatered areas;

- Generation of turbidity and downstream movement of suspended sediment from areas not dewatered;
- Removal of sediment and any associated organisms;
- Removal of woody debris, rocks and other structural habitat elements;
- Burial of any remaining organisms under backfill or capping material;
- Changed substrate features that may not support previously resident species of both invertebrates and fish;
- Potential permanent loss of rare species; and
- Colonization by invasive species.

The impacts to the defined riverine habitats are functionally similar for sediment removal with backfilling or capping. The nature of the backfill/capping material is more conducive to recovery in MGS areas (where coarse sand and gravel are dominant substrate components), whereas LGS and backwater areas will have to accumulate organic matter before any recovery. Riverine point bar and mud flat habitats will be destroyed and will not be restored by the backfill process; riverine processes will have to rebuild those areas over time, assuming that flow patterns are not altered by the removal and backfilling processes. However, flow patterns are likely to be altered by riverbank remediation, addressed separately below.

Sediment removal and associated covering under SED 3 would impact 20% of the aquatic habitat area in the PSA, while those activities would impact 25% of that area under SED 4, 42% under SED 5, 67% under SED 6, 75% under SED 7, and 100% under SED 8.

Capping Without Removal

Engineered capping without prior removal would involve the placement of layers of one foot of sand and one foot (or, in some cases, 6 inches) of armor stone on top of existing sediments, except in backwater areas, where the cap would consist of a stable 12-inch stable sand layer (which may include some stone mixed in) but no additional armor stone layer. (Thin-layer capping is addressed separately in the next section.)

The impacts of engineered capping on existing aquatic biota are the same as with sediment removal followed by backfilling or capping. That is, this remedial technique would be expected to cause complete destruction of any non-mobile organisms that might be in the remediation zone, as well as the other impacts discussed above for sediment removal with backfilling or capping.

There are no engineered capping operations associated with SED 3 or SED 6 through SED 8. Capping operations under SED 4 and SED 5 would directly impact 17% of the aquatic habitat in the PSA, all in the downstream portion of Reach 5C leading to Woods Pond.

Thin-layer Capping

A thin-layer cap would be applied in LGS and backwater areas under some of the sediment remedial alternatives. The effects of a thin-layer cap depend on the material type, the thickness of the cap, and the method and rate of placement. For purposes of assessing the impacts of this activity, it has been assumed that the thin-layer cap would consist of a 6-inch layer of sand placed in one lift. The placement of such a cap would adversely impact many species inhabiting the LGS and backwater habitats. Most, if not all, of the non-mobile organisms in the remediation zone, including plants and invertebrates, would perish by being smothered by the cap material. Only the hardiest plants (including invasive species) and invertebrates could regrow or make their way through the cap material, which is not desirable for maintaining biological diversity.

Recolonization by invasive plant species is typical in such circumstances, and both Eurasian watermilfoil and curly-leaf pondweed are present already and could dominate the post-remediation plant community. Some invertebrates will recolonize over time. In the meantime, the species dependent on the missing invertebrates will be adversely affected. As with areas subject to removal and capping or engineered capping alone, fish will move back into the area, but will likely have altered species composition. For example, carp and goldfish dominate in backwaters now, but would not be expected as dominants after thin-layer capping as these species feed in muck sediments that would be buried under sand. There may also be a reduction in fish numbers for several years. Eventually, as substrate converts back to the finer sediments typical of LGS and backwater habitats, the establishment of a biological community consistent with those conditions would be expected, although the length of time for that to occur, the abundance of organisms in that community, and the presence of specialized species (including rare species), if any, are all uncertain.

Thin-layer capping in SED 3 would affect 17% of the aquatic habitat in the PSA, while in SED 4 it would affect 46%. The extent of area that would receive thin-layer caps would be 29% in SED 5, 26% in SED 6, and 18% in SED 7, and no thin-layer capping would be applied in SED 8.

<u>Riverbank Remediation</u>

Excavation and stabilization of riverbanks are part of SED 3 through SED 8, with both sides of the river impacted in Reaches 5A and 5B, a total of 42,000 linear feet of river and 84,000 linear feet of riverbank habitat. Vegetation, including trees, will be removed, soil will be excavated, and the slope of the banks would be altered. Restoration will involve some form of stabilization.

These activities will cause numerous adverse impacts, regardless of the type of stabilization and restoration used (e.g., armoring or bioengineering), as discussed in the Response to General Comment 6. Those impacts include the following:

- The bank stabilization will alter the natural river geomorphic processes that maintain the diversity of riverine and floodplain habitats. In the PSA, conditions are conducive to the formation of meanders. An essential aspect of meander formation is that riparian banks, primarily on the outer curve of the meander, will erode, producing overhanging, vertical, or near-vertical slopes. Bank stabilization will interfere with these natural geomorphic processes, and alter the type and availability of specific habitat that support the high biodiversity found in these areas. The biological communities that inhabit forested riparian corridors have adapted to these dynamic processes and the resultant features; and in fact, some are dependent on these features during all or part of their life cycle, as discussed below.

- The bank stabilization will result in the direct elimination of habitat for a number of riparian species that utilize the banks. Of particular concern is the loss of nesting sites for belted kingfishers and bank swallows, which build nest burrows in the vertical banks that are formed in the PSA. These species are known to return to these nest burrows over multiple years, demonstrating very strong site fidelities. Similarly, the bank remediation would eliminate denning sites for species such as mink, river otter, and water shrew, which also use these banks. Individual birds and mammals of these species returning to these locations would find unsuitable habitat, since the vertical and overhanging banks would be replaced with cut-back banks with stabilization structures. Other species would also be affected. For example, wood turtles, a species of concern in the Commonwealth, use overhanging banks for cover and overwintering, as do painted and snapping turtles. A variety of vertebrates (e.g., northern and Louisiana waterthrushes, northern water snake) and invertebrates (e.g., dragonflies, crayfish) depend on an appropriate mix of herbaceous, living woody, and dead woody vegetation for breeding, foraging, and basking sites along riparian banks. Further, although beaver and muskrat also construct lodges and houses when water depths allow, they both construct bank burrows when suitable banks are available.

- The bank remediation would curtail or eliminate movement and dispersal corridors for resident and migratory species that use the banks for those purposes. With long reaches of riparian banks altered, species moving either along the river bank edge or through the riparian cover at the tops of banks would lose travel and migratory corridors. Neo-tropical migrant songbirds such as blackpoll warblers and water thrushes might not use these corridors any longer, which could severely lower their population numbers in the Rest of River. In addition, two of the state-listed rare dragonfly species depend on large trees during their adult life cycle, which would be removed in the course of bank remediation. Overall, having long sections of stabilized banks would force species into suboptimal habitat (where they would be subject to increased predation) or eliminate these sections as dispersal and migratory corridors.

- The removal of mature overhanging trees on the banks that will be necessary for the bank remediation, as well as the reduction in bank slopes, will also result in the loss of the source of woody debris that defines so much of the aquatic habitat structure of the river. In addition, there will be a reduction of shading and an attendant change in environmental conditions of the river such as an increase in the water temperature, especially during summer low flows of the river. While the river is principally a warmwater fisheries currently, some use by coldwater fisheries has been documented, and such changes could affect the aquatic biological community.

- The bank remediation will also alter the in-stream habitats for fish and aquatic invertebrates by changing the hydraulics that produce deep pools and highly variable bottom substrates. Additionally, the changes in the types and quantities of organisms utilizing the riverbank habitat will affect food resources for aquatic species and the flow of energy in the river, which in turn can alter suitability of the riverine habitat even without physical changes in aquatic habitat.

- Finally, connectivity between aquatic habitats and adjacent upland areas will be disrupted, affecting virtually every species that uses the upstream two-thirds of the PSA river corridor in its current state.

In short, the bank remediation and stabilization that are part of SED 3 through SED 8 will have major and permanent effects on the river, the banks, and the adjoining floodplain. Under these alternatives, both banks will be totally disrupted in the upper 64% of the river within the PSA. This is the most natural area along the river, and its character will be drastically changed.

<u>Indirect Impacts</u>

In addition to work in riverbank and aquatic habitats, floodplain remediation activities and the construction of access and staging areas are also expected to affect the river. Vegetation clearing creates potential for short-term erosion and will alter shading and food inputs (e.g., leaves, associated insects) for decades at least. Further, the life cycles of many aquatic species have aerial/terrestrial periods or are dependent upon terrestrial processes (e.g., food inputs), and thus the impacts of floodplain activities (e.g., access roads, staging areas, floodplain soil removals) on adjacent terrestrial habitat will in many instances affect processes that are essential to survival of species associated with the river.

Work in the floodplain (FP 2 through FP 7) involves 28 to 431 acres within the drainage area of the Housatonic River in the PSA. Up to 387 acres will be subject to excavation activities and up to 44 acres will be impacted by access roads and staging areas. Vegetative clearance and soil disturbance in these areas can impact riverine habitat by sediment releases, could alter the quality or reduce the quantity of food inputs to the river, and will alter habitat for riverine species that have a terrestrial phase.

Additionally, dewatering target areas adjacent to non-target aquatic areas would require either dewatering those non-target areas or additional construction to sequester those areas, with attendant physical impacts. SED 3 through SED 5 will require separating backwater areas from the river channel during remediation activities in the channel for one or more years if those backwater areas are not dewatered. Even then, conditions during separation from the channel will represent highly altered ecology for most species. SED 6 and SED 7 involve different remedial actions in different parts of the same backwaters, adding complications to the construction sequence and increasing attendant impacts in those backwater areas beyond just separation from the river channel. All backwater areas are to be excavated in SED 8, affecting all backwater habitat.

Summary and Assessment of Measures to Avoid or Minimize Impacts

Given the remediation required by alternatives SED 3 through SED 8, there is no way to avoid the direct effects of these alternatives on the riverine habitat, and at least some indirect impacts are unavoidable as well. Wherever excavation is involved, the habitat will be completely altered and all *in situ* aquatic organisms will be extirpated. Where engineered capping is applied, the habitat will be completely disrupted as well and existing populations will be eliminated. Thin-layer capping, as described above, will also result in the destruction of most, if not all, of the benthic invertebrates and aquatic plants in the areas subject to that technique.

Some impacts from remediation activities and provision of access roads and staging areas to support riverine and non-riverine remediation can be reduced by well planned and carefully implemented sedimentation and erosion control plans. Yet the loss of vegetation will adversely affect the nutrients and food web in the riverine environment for many years and loss of trees will impact some riverine species for decades or more through loss of shade and habitat for terrestrial life stages of aquatic species such as dragonflies. Moreover, regardless of the restoration technique used, the bank remediation will change the character of the banks and thus permanently alter the natural river geomorphic processes, the habitat of the banks for certain riparian species, and the movement and dispersal corridors for resident and migratory species.

3. Key Constraints in Restoration

For the Rest of River, there are numerous constraints on the ability to restore the riverine habitat (including the in-stream habitat and the associated riverbanks) to its current condition. These constraints include the following:

Loss of Rare Species. The remediation of both the in-stream habitat and the riverbanks would cause the loss of a number of state-listed rare species that use those habitats, including those listed in Table GC10-4 above. This is discussed further in Appendix B. State-listed rare species tend to be so listed because alterations of habitat that eliminate them may preclude recolonization. Thus, the loss of these species constitutes a serious constraint on restoration in that such species may not ever recolonize the adversely impacted areas in the PSA.

Change in Substrate Type. In areas subject to removal followed by capping or subject to engineered capping alone, placement of the cap material will change the surficial substrate from its current condition to one consisting of armor stone (in channel areas) or stable sand (in backwater areas where there would not be a separate armor layer). This change will be more extreme in the more downstream areas, where the substrate is currently dominated by silts and fine sand, than in the more upstream areas, where the substrate is dominated by sand, gravel, and even cobbles. Backfilling with sand and gravel in removal areas that will not be capped will also cause some change in substrate but to a lesser degree. Placement of a thin-layer cap consisting of sand in areas dominated by silty sediments will also change the substrate type. These changes in surficial substrate type will result in a change in the organisms present in the sediments. Over time, deposition of natural sediments on top of the cap or backfill materials would be expected to naturally change the substrate back to a condition approximating its prior condition, with sand in the upper portion of the PSA and finer sediments downstream. But this could take years, during which other species, some invasive, may become dominant. In addition, stabilization of the riverbanks will alter sedimentation features, and therefore delay or change the equilibrium condition of riverine sediments.

Loss of Woody Debris. As previously noted, woody debris is a major component of habitat in the riverine environment of the PSA and would be removed as part of any excavation or capping. Replacement of such debris in stream restoration efforts typically involves embedding or anchoring the debris in the substrate (see FISRWG, 1998; Saldi-Caromile et al., 2004), but this cannot be done without disturbing any capping material in place. Thus, while successful restoration depends on the presence of woody debris, it is constrained by the fact that the anchoring of such debris is a threat to the continued integrity of any cap. Further, loss of woody vegetation from the riverbanks will eliminate the natural process by which woody debris is replaced in the river and altering a major ecological aspect of riverine habitat.

Stabilization of Riverbanks. Under SED 3 through SED 8, riverbanks will be fundamentally altered, with armored or bioengineered slopes replacing vegetated or open (and naturally eroding) banks. As discussed in the Response to General Comment 6 and noted in Section III.A.2 of this response, no restoration techniques, including bioengineering, can prevent such a permanent change in the character of the banks. This will not only hinder the restoration of the banks, but also interfere with the ability to restore the in-stream aquatic habitat by reducing shade (as well as woody debris) and changing the geomorphology and hydrology of the river, as discussed above.

Rate of Recolonization of Aquatic Habitat. As discussed above, aquatic habitat remediation will destroy most, if not all, non-mobile organisms present in the target area. For any area subject to excavation with backfilling or capping, engineered capping alone, or thin-layer capping, biological recovery will depend on the nature and rate of recolonization from outside the area, and the nature and rate of recolonization will be determined by many factors, including the scale, timing, and sequencing of the remedial alternative. In general, the larger the area affected, the more uncertain the nature and rate of any recovery of the species currently present, particularly the state-listed rare species.

Recolonization from the downstream direction would be greatly limited by the sequential remediation of river segments at rates of 4,000 to 10,000 linear feet per year, depending on the technique and location. This would require that macroinvertebrates and fish travel great distances to recolonize remediated habitats from the downstream direction. As an example, if remediation commences in a new section of river 4,000 feet long after completion of the previous contiguous section the year before, organisms will have to travel at least 4,000 feet to reach that previously remediated area from the downstream direction. Moreover, movement of the organisms from downstream sections will be hindered by the remediation occurring in those sections at the time.

Thus, recolonization of remediated areas in the PSA is expected to be largely a function of transport of organisms and sediment from upstream. Initially, with sand, gravel, or cobble as the surficial sediment in remediated areas, certain groups of aquatic plants and invertebrates can be expected to recolonize from similar upstream aquatic habitats, although plant recolonization may be slower with less growth due to coarser substrates. As discussed above, the nature and rate of recolonization would depend, in part, on the extent of remediation upstream of the area in question (i.e., the extent of unremediated patches that could supply organisms to downstream areas), as well as how far the recolonizers have to move to reach the remediated areas. Moreover, species not represented further upstream, including some state-listed rare species like the triangle floater mussel, are unlikely to recolonize at all, and an increase in invasive species would be expected.

Over time, in the upper portion of the PSA, as observed in the remediated 1½-Mile Reach, sand will become the dominant substrate. In that case, a gradual establishment of a biological community consistent with those conditions would be expected, although the length of time for that to occur, the abundance of organisms in that community, and the presence of any specialized species are all uncertain. In particular, any rare species whose local populations were adversely affected by the remediation may be absent, and additional opportunistic or invasive species that take advantage of open space and available resources are likely.

Further downstream, if the remediation affects the LGS and/or backwater habitats dominated by finer sediments prior to remediation, there will be an initial change to surficial sediments dominated by gravel, sand, and/or cobble. A natural progression to finer surficial sediments will ensue as a natural riverine process. Again, a gradual establishment of a biological community consistent with those conditions would be expected, but the length of time for that to occur, the types and numbers of organisms that may be present, and the presence of any specialized species are all uncertain. As with upstream areas, loss of rare species whose local populations were adversely affected, as well as increased abundance of invasive species adapted to open or disturbed areas, is likely. The rate and extent of recolonization in these areas will depend, among other things, on the extent to which the remedial alternative would leave upstream areas undisturbed to supply organisms for recolonization.

Colonization by Invasive Species. As previously noted, the species best adapted to colonize open areas may not be those that were there previously, when physical features were different. Rather, it is invasive species such as Eurasian watermilfoil and curly-leaf pondweed (already present in the PSA) and others not yet able to establish populations under current conditions that are likely to immigrate and dominate within the areas where sediment has been removed and new material put in place, unless an active control program is sustained for many years and an introduction program is conducted with desirable native species. Invasive species control programs are possible but not practical in many cases. Detection of invading species is difficult in the early stages of invasion without intense monitoring that itself may represent disturbance and a risk of damage to desirable species. Manual control of invasive species is very difficult except on a very small scale, necessitating very early detection of the invasive plants. More widespread controls involve either mechanical disturbance (e.g., excavation, harvesting) or chemical controls (i.e., herbicides, pesticides), each of which represents a major disturbance and risk to multiple non-target species.

Relationship to Other Habitats. Finally, the ability to restore the riverine habitat is constrained by the impacts of the remediation on adjacent floodplain habitats. Evaluation of the extent to which any one defined habitat in this analysis can be successfully restored requires consideration of its relationship with other, adjacent habitats. The number of such adjacent habitats is high in the Housatonic River system in the PSA, greatly complicating restoration efforts. For example, tree removal is essential to floodplain remediation and provision of access roads and staging areas. Restoration of this tree cover is, at best, a multiple-decade process that will have significant impacts on the physical and biological features of the riverine environment. In the meantime, physical alteration of the habitat of many organisms will be extreme, limiting recolonization and use of the river corridor by those organisms.

4. Restoration Methods

As discussed above, there are many significant constraints on the ability to restore the riverine aquatic habitat and associated banks to their current condition. With the constraints in mind, this section outlines the methods that would be used for restoration of those habitats.

Data Collection and Planning

The first steps in any restoration effort are to collect information on current conditions, and then to plan and design restoration efforts focused on those aspects. Re-population cannot be force fit, so data collection and design should focus on physical habitat restoration to the extent possible. Defining aspects for the in-stream habitats include representative water depths and velocities, substrate types, and physical structures (e.g., woody debris, larger rocks, and sediment slopes). For the riverbanks, key physical aspects include current slope, substrate type, erodability, presence and type of vegetation, and physical structures. Another important factor relates to river-riverbank interfaces. Many species move between the river and the riverbank on a daily to seasonal basis, and the nature of the interface and features of the riverbanks, including slope and cover, determine suitability for those species. Water levels rise and fall, and the interaction with the riverbank is an integral part of system ecology.

Restoration Methods for Aquatic Riverine Habitats

The methods and protocols that are available to perform restoration of disturbed riverine aquatic habitats focus on restoring physical features that determine habitat quality (Gore, 1985; FISRWG, 1998; Saldi-Caromile et al., 2004). The construction phase of restoration for these in-stream habitats would consist primarily of placement of capping material or backfill as required by the remedial alternative selected. Since, as noted above, aquatic vegetation would be expected to re-establish itself through transport from upstream sources of plants, it is anticipated that the restoration program would rely, at least in part, on natural recolonization of plants in areas where vegetation is currently present. However, depending upon the extent of potentially impacted riverine wetland areas, plantings of emergent vegetation would be considered. In addition, placement of aquatic habitat enhancement structures, such as boulders, would be considered as appropriate. As noted above, however, the addition of woody debris is more problematic, since proper placement according to established protocols, which involves anchoring the debris, would disrupt the sediment caps.

Restoration Methods for Riverbanks

Restoration of riverbanks will involve some form of stabilization and revegetation (where possible), which overlaps with the remediation. Potential techniques include "hard" structural techniques, such as placement of revetment mats or armoring, or bioengineering techniques. These techniques and their potential application to the riverbanks in Reaches 5A and 5B are discussed in detail in the Response to General Comment 6.

In the case of armored riverbank areas, restoration activities would be restricted to selective plantings where the armoring allows and where post-remediation soil conditions are favorable. For bioengineered areas, more extensive planting could be conducted, involving the planting of understory species on the banks themselves, with the possibility of the planting of some canopy species on the top of the banks (where that is practical and would not undermine the stability of the banks). However, replacement of the current configuration of overhanging canopy species will not be possible. There is an intermediate option, in which the base of the riverbank, essentially the interface with the river between normal low and high water levels, would be armored or structurally stabilized, with the higher portion of the riverbank subject to bioengineering and more extensive planting.

Where armoring is appropriate, it is customary to place rock on a geotextile fabric, possibly with some gravel or sand to fill interstices. Planned planting is possible but complete coverage is not achievable. For greater plant cover, bioengineering techniques are typically applied. For bioengineering on gentle slopes, various biodegradable fiber mats are often used to prevent erosion while seeds or plants grow to a point where they can stabilize the underlying soil. Where bioengineering is practical on steeper slopes, some form of structural grid material that holds soil in place but allows easy rooting by plants is normally placed, followed by planting as seeds, seedlings, livestaking, or even larger plants as conditions allow. However, as discussed in the Response to General Comment 6, use of bioengineering techniques will not prevent most of the adverse impacts of the riverbank remediation.

<u>Monitoring</u>

Following restoration, a monitoring program would be conducted, typically for a period of 5 years. Monitoring programs for stream and bank restoration can involve a stream-specific suite of physical, chemical, and/or biological variables through a combination of quantitative and qualitative methods. It is anticipated that this program would include: (a) visual observations of the restored aquatic habitat within the river to assess substrate features and any habitat enhancement structures placed in the river; (b) visual observations of the restored riverbanks to monitor for potential erosion, riverbank stability, and any other conditions that could jeopardize the bank stabilization/restoration measures; and (c) quantitative and/or qualitative monitoring of plantings on the banks (i.e., trees, shrubs, ground cover) to assess planting survival, areal coverage by herbaceous species, and the presence and extent of any invasive species. An invasive species control program would also be a likely part of this program. The details of the monitoring and maintenance program would be determined during design. Mid-course corrections or "adaptive management" during this period may also be triggered as part of this program

5. Likelihood of Success in Restoration

With respect to the impacts from remediation within the Housatonic River itself, natural processes could, given enough time, result in some degree of recovery. However, given the extensive river and riverbank remediation in alternatives SED 3 through SED 8, some important riverine physical processes will be altered, so post-remediation conditions will not be congruent with pre-construction conditions in terms of appearance or function. As a result, it is expected that biological conditions will not return to pre-remediation status, especially for certain biota that depend on the riverbanks, as a variety of forces interact to create a dynamic system. Even with attempted restoration efforts, the level of disruption to processes and biological communities will be severe enough to create an alternative biological state along the river in much of the PSA.

As discussed in Section III.A.3 above, the primary factors that will interfere with restoration success include:

- Potentially permanent loss of state-listed rare species and other uncommon or sensitive species;
- Substrate changes due to placement of sand, gravel, or cobble on top of existing sediments, affecting the organisms present in the sediments;
- Loss of woody debris from removed bank vegetation, coupled with the inability to replace woody debris due to the resulting threat to cap integrity;
- Loss of mature trees from the adjacent banks and floodplain, resulting in a reduction in shade and alteration of the habitat of both the river and banks;
- Remediation and stabilization of long reaches of riverbanks in Reaches 5A and 5B, resulting in permanent elimination of habitat for certain riparian species that utilize the banks for nesting, breeding, basking, or overwintering; elimination of movement and dispersal corridors for other species that depend upon the riverbanks as an interface between the river and adjacent habitats; alteration of the geomorphology and hydrology of the river; and (as noted above) loss of woody debris and cover for the river;
- Limitations on recolonization of affected areas by native plant and animal species; and
- Likely increase in the presence and extent of invasive species.

We have found no precedent for a stream restoration project on the scale that would be involved in SED 3 through SED 8. A number of publications (Gore, 1985; Petersen, 1986; Cairns, 1995; FISRWG, 1998; Saldi-Caromile et al., 2004) describe stream restoration case histories and extract recommendations and lessons for future efforts. Examples focus heavily on watershed management to limit inputs associated with adverse impacts (e.g., contaminants, sediment) and structural alteration to enhance habitat (e.g., pool creation, cover provision). No cases were found in peer-reviewed literature or textbooks involving restoration of a river and associated floodplain as heavily influenced by sediment removal and fill placement as the Rest of River would be under the above sediment alternatives. Examples of other environmental sediment dredging projects are discussed in the Response to General Comment 25. As shown in that response, none of those projects provides a precedent for a remediation or restoration project of the size that would be required under SED 3 through SED 8 in a setting like that of the Housatonic River in the PSA, which winds for 10 miles in a sinuous manner through a natural, biologically rich, and environmentally sensitive ecosystem.

In terms of just riverbank remediation, there are many literature examples of small- or even medium-scale efforts in which eroding banks were successfully stabilized. Virtually none are in forested settings like those in Reaches 5A and 5B. For the reasons discussed above, the remediation and stabilization of the riverbanks in those subreaches, regardless of whether armoring or bioengineering techniques are used, will result in a permanent change in the character of the banks, affecting both the bank habitats and those within the river and the adjacent floodplain as well.

In summary, while recovery of some biotic communities within the Housatonic River from the effects of in-stream remediation may occur over time (e.g., fish and some benthic invertebrate communities and a submerged aquatic plant community), there are some habitats, notably the riparian banks, that cannot return to their current structure or function because the remediation would render them unsuitable or suboptimal habitat. On the whole, the changes resulting from the large-scale river and riverbank remediation in SED 3 through SED 8 would be so extensive that it is unlikely that the overall riverine habitat of the affected portions of the PSA (considering the river and banks together) could be returned to its current condition regardless of the restoration methods employed.

B. Impoundment Habitat

1. Description of Habitat

This section addresses six impoundments in the Rest of River area in Massachusetts within the reaches being considered for remediation: Woods Pond in Reach 6; Columbia Mill Pond, Eagle Mill Pond, Willow Mill Pond, and Glendale Pond in Reach 7; and Rising

Pond in Reach 8. Woods Pond is the most upstream impoundment, located in Lenox and Lee. Columbia Mill Pond is just over two miles downstream of Woods Pond, in Lenoxdale. The dam creating Eagle Mill Pond was breached, but the former mill pond area, about half a mile downstream of Columbia Mill Pond in Lee, would be affected as part of the remediation program under some alternatives. Willow Mill Pond is another 6 miles downstream in Lee. Glendale Pond is another 6.5 miles downstream in Stockbridge. Rising Pond is the most downstream impoundment implicated; it is located 3.5 miles downstream of Glendale Pond and approximately 18 miles downstream from Woods Pond. Partial characterization of these impoundments has been conducted as part of past resource assessments (e.g., Swain and Kearsley, 2000; Woodlot Alternatives, 2002; MDEP, 1998).

The primary habitat type associated with these impoundments is characterized as moderately alkaline pond (Woodlot Alternatives, 2002), although as impoundments they are influenced by riverine flows to a greater extent than many moderately alkaline ponds in this region that are not on the mainstem of the Housatonic River. Sedimentation occurs at a faster rate and plankton communities may not be as important as in less well flushed waterbodies in this area.

Physical Features

Moderately alkaline ponds have gently sloped shores and soft substrate bottoms with upper horizons comprised of organic sediment over silt and fine sand. This lacustrine habitat type is usually found on limestone and marble bedrock in the Housatonic River valley (Swain and Kearsley, 2000; BBL and QEA, 2003).

The six impoundments addressed here (Woods Pond, Columbia Mill Impoundment, the former Eagle Mill Pond, Willow Mill Pond, Glendale Pond, and Rising Pond) have approximate areas of 60 acres, 10 acres, 8 acres, 8 acres, 10 acres, and 41 acres, respectively. The average depths of Woods Pond, Columbia Mill Impoundment, Willow Mill Impoundment, Glendale Impoundment, and Rising Pond are approximately 5.0 feet, 3.0 feet, 3.0 feet, 4.7 feet, 5.3 feet, and 3.8 feet, respectively (BBL and QEA, 2003). Woods Pond has a maximum depth of 15 feet in a relatively deep hole located in the southeastern portion of the pond, away from the dam. The other impoundments tend to have their deepest point near the dam; Rising Pond also has a maximum depth of 15 feet, while Columbia Pond is listed as having a maximum depth of 20 feet. Maximum depths for Willow and Glendale Ponds are not precisely known, but are very likely similar to the others, having been created in much the same manner. As the former Eagle Mill Pond dam was breached, it is likely to have a lower maximum depth, perhaps about 8 feet.

Sediment thickness in Woods Pond is substantial, as much as 16 feet. Sediment accumulations along the northwestern side have resulted in island formation, and movement of unconsolidated sediment in shallow areas during periods of high flow is apparent. The path of the river through Woods Pond along the west side is evident from aerial photographs, with minimally submerged sediment on either side of the channel.

Sediment thickness in Rising Pond ranges from 1 to 8 feet. The accumulation of sediment in Rising Pond is very heterogeneous and does not always follow the bathymetric contours (BBL and QEA, 2003). Exposed sediment and very shallow areas are evident in aerial photographs in multiple parts of the pond.

The average sediment thickness in the other impoundments exceeds 2 feet (ARCADIS and QEA, 2007; BBL and QEA, 2003). Columbia Mill Impoundment, the former Eagle Mill Pond, Willow Mill Pond, and Glendale Pond will be subject to cycles of deposition and scour related to flows. Each is more linear than Woods Pond or Rising Pond; Willow Mill Pond in particular is only marginally wider than the river channel upstream or downstream of it. Areas of exposed or very shallow submerged sediment are evident in aerial photographs of Columbia and Glendale Ponds.

<u>Biological Communities</u>

Many species of submerged and floating-leaved aquatic species may be present in shallow areas of this habitat type (Woodlot Alternatives, 2002). Some of the more commonly found plants are coontail, naiad, Canada waterweed, water celery, long-beaked water crowfoot, and various species of pondweed. Moderately alkaline pond communities are highly susceptible to some of the more invasive aquatic plant species, such as Eurasian watermilfoil, curly-leaf pondweed, and water chestnut, all of which are found in at least Woods Pond. Aquatic plant growths can become very dense, affecting ecology and human uses.

The aquatic macroinvertebrate community associated with impoundments of the Housatonic River is extensive (Woodlot Alternatives, 2002). Mussels such as eastern floaters and eastern elliptio are found in most impoundments and lakes along the river. No state-listed rare mussels have been identified in any of these impoundments. A substantial number of dragonfly and damselfly species are typically found, but GE does not have information specifically indicating the presence of any state-listed rare dragonflies in these impoundments. Other typical invertebrates include a variety of true bugs (Hemiptera), beetles, caddisflies, a wide range of true flies (Diptera), and fresh water shrimp (Amphipoda).

Many species of fish utilize this community type. Woods and Rising Ponds were surveyed in 1997 and 1998 and were shown to contain landlocked alewife, common carp, spottail shiner, golden shiner, white perch, largemouth and smallmouth bass, bullhead catfish, and several species of sunfishes (Woodlot Alternatives, 2002). Bluegill sunfish, pumpkinseed sunfish, yellow perch, chain pickerel, and brown bullhead are also common in moderately alkaline pond habitats (Swain and Kearsley, 2000), and were recorded in Woods Pond and nearby backwaters (Woodlot Alternatives, 2002).

Reptiles associated with this habitat include snapping and painted turtles (Woodlot Alternatives, 2002). They are largely associated with soft aquatic sediments. Northern water snakes are known to occur in lakes and have been observed in Woods Pond. Amphibians such as green frogs and bullfrogs are expected in these impoundments (Woodlot Alternatives, 2002). Pickerel frogs, northern leopard frogs, wood frogs, and American toads are also likely to be found. Red-spotted newts are common throughout the eastern United States and are abundant in permanent pools associated with the river and are expected to be found in the impoundments.

Several species of swallows are known to feed on insects over this habitat type (Woodlot Alternatives, 2002), including tree swallows, bank swallows, barn swallows, and northern rough-winged swallows. Great blue herons, green herons and American bitterns are wading birds that would be expected to hunt for food in these impoundments. The least bittern and the black crowned night heron are relatively uncommon but likely inhabitants as well. The American bittern and the least bittern are listed by the state as endangered. Belted kingfishers are common in this area and would forage at the impoundments. Several species of swans, geese, and ducks, including wood ducks, mallards, and Canada geese, have been observed at one or more impoundments during the nesting period and another nine species of waterfowl are expected during migration. A variety of raptor species are expected to utilize moderately alkaline pond habitat for feeding, based on their distribution and habits in the geographic area (Woodlot Alternatives, 2002). Of these, two species in particular focus on aquatic habitats: osprey and bald eagle. Both species nest near water and feed on fish. Bald eagles are listed as endangered in Massachusetts.

Long-tail weasels, minks, river otter, raccoons, and beaver commonly use this habitat type (Woodlot Alternatives, 2002). Little brown bats, which feed over open water, are very likely to occur. Silver-haired bats, which feed above watercourses, are uncommon to the Northeast, but were found to be present in the Housatonic River area. Northern myotis are uncommon but also forage above waterways in forested areas and winter hibernacula include hydroelectric dams.

There are four rare plant and animal species with NHESP-mapped Priority Habitat within Woods Pond, as shown in Table GC10-6. Columbia Mill Pond, Eagle Mill Pond, Willow Mill Pond, Glendale Pond, and Rising Pond are all located, in whole or part, within the overall NHESP-designated Priority Habitat downstream of Woods Pond (see Figure GC10-5). However, NHESP has not to date provided GE with species-specific Priority Habitat maps for areas downstream of the PSA, so GE cannot identify the specific rare species with Priority Habitat in those impoundments.

Table GC10-6. Rare Species Associated with Woods Pond.

Common Name	Scientific Name	State Status
American bittern	*Botaurus lentiginosus*	Endangered
Common moorhen	*Gallinula chloropus*	Special Concern
Bur oak	*Quercus macrocarpa*	Special Concern
Wapato	*Sagittaria cuneata*	Threatened

2. Effects of Remedial Alternatives

Alternatives SED 1 and SED 2 do not involve construction activities within impoundments. Alternatives SED 3 through SED 8 would impact impounded aquatic habitat to varying extents and in different ways, depending on the remediation technique applied. Table GC10-7 lists the extent of acreage that would be affected by each sediment remedial alternative. The following subsections describe the types of effects that would be caused by the different remedial techniques.

Table GC10-7. Alteration of Impoundment Habitat by Remediation in Sediment Alternatives.

Remedial Alternative	Impoundment	Direct Impact from Sediment Remediation (acres)	Percent of Total Impoundment Acreage Affected	Estimated Duration of Work (years)
SED 1	No Action	0	0	0
SED 2	N/A - MNR	0	0	0
SED 3	Woods Columbia Eagle Willow Glendale Rising	60 ac (thin layer capping) No action No action No action No action No action	44%	1.1
SED 4	Woods Columbia Eagle Willow Glendale Rising	37 ac (excavation/capping) 23 ac (thin layer capping) No action No action No action No action No action	44%	2.3
SED 5	Woods Columbia Eagle Willow Glendale Rising	37 ac (excavation/capping) 23 ac (engineered capping) No action No action No action No action 41 ac (thin layer capping)	74%	3.2
SED 6	Woods Columbia Eagle Willow Glendale Rising	37 ac (excavation/capping) 23 ac (engineered capping) 10 ac (thin layer capping) 8 ac (thin layer capping) 8 ac (thin layer capping) 12 ac (thin layer capping) 19 ac (thin layer capping) 22 ac (engineered capping)	100%	4.6
SED 7	Woods Columbia Eagle Willow Glendale Rising	37 ac (excavation/capping) 23 ac (engineered capping) 5 ac (excavation/capping) 5 ac (thin layer capping) 3 ac (excavation/capping) 5 ac (thin layer capping) 4 ac (excavation/capping) 4 ac (thin layer capping) 6 ac (excavation/capping) 6 ac (thin layer capping) 6 ac (excavation/capping) 13 ac (thin layer capping) 22 ac (engineered capping)	100%	6.8

Remedial Alternative	Impoundment	Direct Impact from Sediment Remediation (acres)	Percent of Total Impoundment Acreage Affected	Estimated Duration of Work (years)
SED 8	Woods Columbia Eagle Willow Glendale Rising	60 ac (excavation/capping) 10 ac (excavation/capping) 8 ac (excavation/capping) 8 ac (excavation/capping) 12 ac (excavation/capping) 41 ac (excavation/capping)	100%	24.6

Sediment Removal

Excavation of sediment would be followed in all cases with either installation of a cap or backfilling. The actual removal of sediment is expected to involve removal "in the wet," using mechanical or hydraulic dredging techniques. With such dredging, mobile organisms such as fish will be able to vacate the work area, but immobile or less mobile species (most invertebrates, all plants) will still be subject to removal and high mortality.

Removal of sediment will cause removal of viable propagules (the organisms and their eggs, seeds, or regenerative tissue of any kind) in those sediments, even with the shallowest planned excavation (1 foot). Post-excavation capping or backfilling at depths of at least a foot and up to 4 feet will bury any remaining non-mobile aquatic invertebrates and aquatic plants present in the remediated area. Eventually, as discussed above respecting the aquatic riverine habitat, some invertebrates and aquatic plants would recolonize the impoundments, although different species would be expected to dominate, at least initially, due to changed substrate.

In addition, following excavation and capping or backfilling, there is a high potential for invasion by non-native species, such as Eurasian watermilfoil and curly-leaf pondweed (already present in Woods Pond) and others not yet able to establish populations under current conditions. Such species are likely to immigrate and dominate, unless an active control program is sustained for many years and an introduction program is conducted with desirable native species – which may be difficult and/or impractical, as discussed below.

The impacts of removal and capping or backfilling in the impoundments on the fish community would be similar to those discussed in Section III.A.2 above respecting aquatic riverine habitat. The fish would be disrupted and move away during construction activities, but at least some would eventually return. For some years after remediation, the fish species composition would likely be changed and the number of fish may be reduced, but gradually the fish community should resemble a typical pond community.

Habitat alterations of primary concern for excavation and related capping or backfilling in the impoundments can be summarized as:

- Removal of sediment and any associated organisms;
- Removal of woody debris, rocks, and other structural habitat elements;
- Generation of turbidity and downstream movement of suspended sediment out of the impoundment;
- Burial of any remaining organisms under backfill or capping material;
- Changed substrate features that may not support previously resident species; and
- Colonization by invasive species.

The impacts to impoundments are functionally similar for sediment removal with backfilling or capping. The nature of the backfill/capping material may induce some variation in response, but many biological components of the impoundments will be altered at least temporarily.

SED 3 would involve no sediment removal in impoundments, and in SED 4, SED 5 and SED 6, 37 acres Woods Pond would be subject to such removal. SED 7 would involve excavation of 60 acres of impoundments, with some excavation in each impoundment. SED 8 calls for excavation of 100% of all five impoundments (139 acres), although the depth of excavation varies among impoundments.

<u>Capping Without Removal</u>

The addition of capping material involves spreading suitable material over the surface of target areas. Engineered capping without prior removal in the impoundments would involve the placement of layers of one foot of sand and one foot (or, in some cases, 6 inches) of armor stone on top of existing sediments. (Thin-layer capping is addressed separately in the next subsection.) The impacts of engineered capping on existing aquatic biota are the same as with sediment removal with backfilling or capping.

There are no engineered capping operations associated with SED 3, SED 4, or SED 8. Engineered capping operations under SED 5 would directly impact 23 acres of Woods Pond. Engineered capping operations under SED 6 and SED 7 would directly impact 23 acres of Woods Pond and 22 acres of Rising Pond.

Thin-layer Capping

A thin-layer cap would be applied to some impoundment areas in some of the sediment alternatives. As previously discussed with respect to riverine habitat, the effects of a thin-layer cap would depend on the material type, the thickness of the cap, and the method and rate of placement. Again, for purposes of assessing the effects of such a cap, it has been assumed that the thin-layer cap would consist of a 6-inch layer of sand placed in one lift. In such a case, most, if not all, the aquatic plants and invertebrates in the remediation zone would be covered and destroyed by the cap material. Only the hardiest plants (including invasive species) and invertebrates could regrow or make their way through the cap material, which is not desirable for maintaining biological diversity.

Recolonization by invasive plant species is typical in such circumstances, and both Eurasian watermilfoil and curly-leaf pondweed are present already and could dominate the post-remediation plant community. Water chestnut, another invasive species, is abundant in Woods Pond and may be present in the downstream impoundments; however, this species might be limited by burial of seeds in the capping process. As discussed with respect to thin-layer capping in LGS and backwater habitats, some invertebrates will recolonize the impoundments over time, but in the meantime, the species dependent on the missing invertebrates will be adversely affected. In addition, fish will move back into the impoundments, but will likely have altered species composition as a result of changed substrate. For example, more centrarchids (sunfish and bass) are likely as the substrate will be more favorable to them than to carp, goldfish, and other bottom feeders. As also noted above, as the substrate converts back to finer sediments, the establishment of a biological community consistent with those conditions would be expected, although the length of time for that to occur, the abundance of organisms, and the presence of specialized species, if any, are all uncertain.

Thin-layer capping would be used in SED 3 to address all 60 acres of Woods Pond. In SED 4, thin-layer caps would be applied to 23 acres of Woods Pond, and in SED 5, this technique would be applied to 23 acres of Woods Pond and all 41 acres of Rising Pond. SED 6 would utilize thin-layer capping in 57 acres of impoundment, and SED 7 would do so over 33 acres of impoundment. Thin-layer capping would not be used in SED 8.

Summary and Assessment of Measures to Avoid or Minimize Impacts

Combinations of excavation with capping or backfill, engineered capping without excavation, and thin-layer capping without excavation would be applied to one or more of the six identified impoundments under the various sediment alternatives. Primary impacts are removal or burial of aquatic organisms and alteration of the substrate features. Of the 139 acres of impoundment area considered in this assessment, 44% would be impacted under SED 3 and SED 4, 74% under SED 5, and 100% under SED 6, SED 7 and SED 8 (see Table GC10-7).

While BMPs would be implemented as appropriate during these construction activities, given the removals and/or capping required by these alternatives, there is no feasible way to avoid or significantly minimize these effects.

3. Key Constraints in Restoration

The primary biological constraint on the restoration of impoundments is the rate of recolonization by desired species. Impoundment remediation will destroy most organisms and displace the rest, at least temporarily. Biological recovery will thus depend on colonization from outside the impoundments. Commonly occurring macroinvertebrates from upstream areas would be expected to recolonize the impoundments, as would aquatic plants, with such plants or their propagules arriving with flow into the impoundments. Initially, the species composition of these invertebrates and plants would differ from those currently present due to the change in substrate. Similarly, as noted above, while fish will move back into the remediated impoundments, the composition and relative abundance of fish are likely to be different, at least initially. Eventually, as sand and organic sediments develop due to deposition from upstream, a biological community in the impoundments that is consistent with those conditions would be expected to develop, although the length of time for that to occur, the number of organisms that may be present, and the presence of any specialized species are all uncertain. The extent and rate of such recolonization will depend, in part, on the extent of remediation in areas upstream of the impoundment – i.e., the extent to which upstream areas are disturbed rather than being left alone to provide organisms to the impoundments. In particular, if the upstream remediation should cause the loss of a significant portion of the local population of a rare species, then the sources of that species to the impoundment would be eliminated or reduced.

In addition, as noted above, there is a high potential for colonization by invasive species and for those species to dominate over native species, unless an active control program is sustained for many years and an introduction program is conducted with desirable native species. However, implementation of an intensive invasive species control program in the impoundments would be logistically difficult and may not be practical or desirable. Widespread controls involve either mechanical disturbance (e.g., excavation, harvesting) or chemical controls (i.e., herbicides, pesticides), each of which represents a major disturbance and risk to multiple non-target species. Moreover, native species introductions are a highly experimental area of lake management with no proven track record (Wagner et al. 2009).

4. Restoration Methods

Given that the placement of capping or backfill material would result in new surficial sediments at the bottom of the impoundments, no additional action would be necessary to restore the physical condition of the impoundment beds. Similarly, given the likelihood of natural recolonization of the impoundments by invertebrates and aquatic plants from upstream, it is anticipated that restoration would rely on such recolonization. However, supplemental replanting would be considered if necessary.

Following restoration, a monitoring program would be conducted, typically for a period of 5 years. In this case, it is anticipated that the monitoring program would involve annual surveys of sediment features to document the condition of backfill and caps. The biological composition of impoundments is typically set by natural river processes of colonization and population control. Preventing invasive species from getting into the impoundments would be desirable but extremely difficult, and may not be practical or desirable, as discussed above.

5. Likelihood of Success in Restoration

Unlike the case with the other habitat types discussed in this Section III (i.e., the riverine/riverbank habitats discussed above and the wetland habitat types discussed below), the impoundments subject to remediation under SED 3 through SED 8 could recover over time, although that result is by no means certain.

Other than lowering exposure to PCBs, the remediation/restoration program will have little effect on water quality in the impoundments, which is controlled by watershed point and nonpoint source inputs unrelated to this program. Consequently, the many biological elements linked to water quality would be expected to remain unchanged. Likewise, flow pattern is a major determinant of biological features in these impoundments, and flows will be unaffected by the remediation/restoration program.

Physical changes as a result of excavation and capping/backfill, engineered capping alone, and thin-layer capping with a 6-inch layer of sand placed in one lift will wipe the rooted plant and benthic macroinvertebrate slate nearly clean. Subsequently, macroinvertebrates, aquatic plants, and fish could recolonize the impoundments from upstream with no external aid. However, they may have different species composition due to changed substrate. It is anticipated that a biological community typical of such impoundments would eventually develop, with the rate unknown and influenced by the extent of upstream remediation, except that the community may not include certain specialized native species and may be dominated by invasive species.

In short, the likelihood of success for impoundment restoration can be judged possible but uncertain.

C. Forested Wetlands

1. Description of Habitat

Nearly 400 acres of forested wetlands occur within the PSA. Four different natural community types are represented within these forested wetlands, including black ash-red maple-tamarack (BA-RM-T) calcareous seepage swamp, red maple swamp, transitional floodplain forest, and high terrace floodplain forest. The acreage of these community types is summarized in Table GC10-8.

Table GC10-8. Breakout of Forested Wetland Natural Communities within the PSA.

Forested Natural Community Type	Acreage within the PSA
BA-RM-T Calcareous Seepage Swamp	79
Red Maple Swamp	102
Transitional Floodplain Forest	199
High Terrace Floodplain Forest	11
TOTAL	**391 acres**

<u>Black Ash-Red Maple–Tamarack Calcareous Seepage Swamp</u>

This forested wetland type occupies about 79 acres within the PSA. These are mixed deciduous-coniferous forested swamps occurring in areas where there is calcareous groundwater seepage. The species-rich herbaceous layer is characterized by calciphilic (calcium-loving) species. Calcareous seepage swamps can also be called forested fens. A variable mixture of deciduous and coniferous trees forms the canopy of this natural community, but black ash, tamarack, and red maple are most common. Numerous other tree species are found in association with those dominant species. The shrub layer can be dense, and the herbaceous layer is diverse with many calciphilic species mixed in with other common wetland plants. This community type also has a concentration of state-listed rare plant species, as noted below. Parts of calcareous seepage swamps can function as vernal pool habitat if water remains standing for 2-3 months and they lack fish.

Red Maple Swamp

This forested wetland type occupies approximately 102 acres within the PSA. Red maple swamps occur in a variety of physical settings. Golet et al. (1993) describe three basic types: hillside seeps and upland drainageways fed primarily by groundwater seepage and overland flow; seasonally flooded basin swamps in undrained basins; and alluvial swamps. Depending on the physical setting, red maple swamps receive water through surface runoff, groundwater inputs, or stream and lake overflow. The hydrogeologic setting is the primary determinant of water regime and the plant community structure and composition. Soils have shallow to thick organic layers overlying mineral sands/silts. Red maple is usually strongly dominant in the overstory, and often provides more than 90% of the canopy cover. A variable mixture of tree species co-occurs with red maple. The shrub layer of red maple swamps is often dense and well-developed, generally with >50% cover but it can be variable. The herbaceous layer is highly variable, but ferns are usually abundant. Parts of red maple swamps that have two or three months of ponding and lack fish can function as vernal pools.

Transitional Floodplain Forest

This forested wetland type occupies approximately 199 acres within the PSA. Transitional floodplain forests generally experience annual flooding. The severity of flooding, soil texture, and soil drainage of transitional floodplain forests are intermediate between major-river and small-river floodplain forests. Soils are either silt loams or very fine sandy loams, and soil mottling is generally present within 60 centimeters (cm) (2 feet) of soil surface. A surface organic layer is typically absent. Silver maple is dominant in the canopy, but unlike in major-river forests, cottonwood is typically absent. Similar to small-river forests, green ash and American elm are present. A shrub layer is generally lacking; however, saplings of overstory trees are common. Vines are abundant; and the herbaceous layer is typically an even mixture of wood-nettle, ostrich fern, sensitive fern, and false nettle. Transitional floodplain forests often contain meander scars or sloughs that can function as vernal pools.

High Terrace Floodplain Forest

This forested community type occupies approximately 11 acres within the PSA. High-terrace floodplain forests occur on raised banks adjacent to rivers and streams, on steep banks bordering high-gradient rivers in western Massachusetts, on high alluvial terraces, and on raised areas within major-river and small-river floodplain forests. They are river-influenced and mesic, but they typically are not flooded annually as indicated by the presence of a distinct surface, soil organic layer. Soils are typically silt loams. The canopy is a mixture of floodplain taxa, such as red and silver maple, and mesic, deciduous hardwoods. The shrub layer varies from sparse to well-developed, and the herbaceous layer is a mixture of the characteristic floodplain forest ferns. High-terrace floodplain forests can contain low wet depressions that function as vernal pools.

Forested Wetland Functions

The forested wetlands within the PSA provide a number of wetland functions, including:

- Wildlife habitat for both resident and migratory species;
- Habitat for rare plant/animal species;
- Groundwater recharge/discharge;
- Flood flow alteration;
- Sediment/shoreline stabilization;
- Nutrient removal/retention/transformation;
- Sediment/toxicant retention; and
- Production export.

This section focuses on forested wetlands generally; vernal pools are discussed separately in Section III.E below.

Maps provided by NHESP show Priority Habitats of 27 rare plant and animal species listed under MESA within the forested wetlands of the PSA, as summarized in Table GC10-9.

Table GC10-9. Rare Species with NHESP-Mapped Habitat within the Forested Wetlands of the PSA.

Common Name	Scientific Name	State Status	Comments
Wood turtle	*Glyptemys insculpta*	Special Concern	---
Jefferson salamander	*Ambystoma jeffersonianum*	Special Concern	---
American bittern	*Botaurus lentiginosus*	Endangered	Forested wetlands are not primary habitat
Bald eagle	*Haliaeetus leucocephalus*	Endangered	---
Common moorhen	*Gallinula chloropus*	Special Concern	Forested wetlands are not primary habitat
Water shrew	*Sorex palustris*	Special Concern	---
Arrow clubtail	*Stylurus spiniceps*	Threatened	Forested wetlands used by adult stage of this species
Brook snaketail	*Ophiogomphus aspersus*	Special Concern	Forested wetlands used by adult stage of this species
Riffle snaketail	*Ophiogomphus carolus*	Threatened	Forested wetlands used by adult stage of this species
Zebra clubtail	*Stylurus scudderi*	Special Concern	Forested wetlands used by adult stage of this species
Mustard white	*Pieris oleracea*	Threatened	---
American clam shrimp	*Limnadia lenticularis*	Special Concern	---
Triangle floater	*Alasmidonta undulata*	Special Concern	Forested wetlands are not primary habitat
Bristly buttercup	*Ranunculus pensylvanicus*	Special Concern	---
Bur oak	*Quercus macrocarpa*	Special Concern	---
Crooked-stem aster	*Symphyotrichum prenanthoides*	Threatened	---
Culver's root	*Veronicastrum virginicum*	Threatened	---
Fen cuckoo flower	*Cardamine pratensis* var. *palustris*	Threatened	---
Foxtail sedge	*Carex alopecoidea*	Threatened	---

Common Name	Scientific Name	State Status	Comments
Gray's sedge	*Carex grayi*	Threatened	
Hemlock parsley	*Conioselinum chinense*	Special Concern	--
Hairy wild rye	*Elymus villosus*	Endangered	--
Long-styled sanicle	*Saniula odorata*	Threatened	Preferred habitat is moist woodlands, including forested wetlands
Intermediate spike-rush	*Eleocharis intermedia*	Threatened	Forested wetlands are not primary habitat
Narrow-leaved spring beauty	*Claytonia virginica*	Endangered	---
Wapato	*Sagittaria cuneata*	Threatened	---
White adder's-mouth	*Malaxis monophyllos var. brachypoda*	Endangered	---

2. Effects of Remedial Alternatives

All of the floodplain remedial alternatives (except FP 1) would impact forested wetland habitat within the floodplain and adjacent to the riverbanks of the PSA through soil removal activities and construction of access roads and staging areas; and many of these alternatives (i.e., FP 3 through FP 7) would produce significant adverse impacts, as described below.

<u>Direct Effects from Soil Removal Activities</u>

Soil removal activities will cause direct impacts to forested wetlands through cutting of trees and shrubs in advance of soil removal, grubbing of tree stump and roots in advance of soil removal, and soil excavation, removal, placement, and grading. Table GC10-10 provides a summary, by alternative, of the direct impacts to the forested wetlands in the PSA from floodplain soil removal activities, independent of access roads and staging areas.

Table GC10-10. Alteration of Forested Wetlands from Soil Removal Activities in Floodplain Alternatives.

Remedial Alternative	Direct Impact from Soil Removal (acres)	Percentage of Total Forested Wetlands Acreage in PSA Affected
FP 2	6	2%
FP 3	14	4%
FP 4	40	10%
FP 5	31	8%
FP 6	96	25%
FP 7	172	44%

The main direct effect on forested wetlands from the soil removal in these floodplain alternatives would be from tree removal. Tree clearing will cause substantial direct effects to the forested wetlands of the PSA, as these mature communities provide:

- Physical habitat for resident birds, amphibians, reptiles, mammals, and invertebrates;
- Important temporal habitat for certain migratory bird species that use such forested wetlands for periods during their migrations, such as blackpoll warbler and northern parula;
- Vital shade which helps control surface water, soil and air temperatures, and evaporative losses of the floodplain wetlands and river channel;
- A significant yearly infusion of biomass – fallen leaves and decaying coarse woody material – which make up the major component of the humus on underlying the forest floor, and which, in conjunction with sunlight, provide the foundation of the food chain of these ecosystems; and
- A mechanism whereby massive volumes of groundwater and the dissolved constituents within it are removed from the ground and seasonally pumped into the living tissue of the trees, substantially affecting the local hydrology and attendant wetland functions (groundwater recharge/discharge, flood flow alteration, sediment/toxicant retention, and nutrient removal/retention/transformation).

Soil disturbance and grubbing of tree stumps and roots will produce an additional direct impact with significant implications. Loss of these large and numerous physical structures would affect flood flow characteristics. The removal of the root structures would negatively affect shoreline stabilization, as in many areas of the riverbank and floodplain these woody plants are critical to binding soils in this high energy system in place. The extensive losses of this vegetative cover along the banks and in the floodplain would cause a risk of erosion and associated water quality impacts. Further, the removal of surface soils and leaf litter at the ground surface in these wooded wetland would cause substantial harm to the many animal species that use these areas for forage, cover, aestivation, and/or hibernation.

In addition, compaction or disruption of the soils of these forested wetlands by heavy machinery would probably cause direct mortalities to small and slower-moving animals, and at a minimum, would disrupt important elements of their life cycles. Soil compaction would also affect the subsequent permeability of these soils, which influences plant colonization, flood flow alteration and groundwater recharge/discharge functions.

Additional Effects from Access Roads and Staging Areas

The remedial alternatives involving removal, including both the sediment and floodplain alternatives, would also have additional effects on forested wetlands through removal of vegetation and soil disturbance in adjacent areas not targeted for soil remediation. These additional impacts would include:

- *Vegetation cutting*: Cutting of trees and shrubs would be needed for the construction of access roads and staging areas, and to provide ample space beyond the actual work area to install sedimentation and erosion controls (e.g., hay bales and silt fence). Much of this impact would occur to portions of the forested floodplain which are currently undisturbed mature forest, and not within the geographical limits of the required soil removal areas.

- *Root zone removal (grubbing)*: Grubbing of tree stumps and roots would be required in adjacent floodplain forests for access road and staging area construction.

- *Access road construction*: Temporary access roads would likely be constructed of a combination of timber mats or geotextile fabric overlain by coarse gravel. The travel surface would likely need to be 15 feet wide, and with typical side slopes would extend to a 20-foot-wide width of impact (for gravel roads), plus additional room on each side of the road that may be needed to install sedimentation and erosion controls. In addition, increased road widths would be required to provide for pull-offs in discrete areas in order to allow construction vehicles to pass each other if heading in and out of the site at the same time. These access roads would remove substantial additional portions of the forested wetlands.

- *<u>Truck and excavation equipment traffic</u>*: Construction traffic on the access roads and remediation areas would produce air quality and noise impacts, which would likely disrupt forest animals in their terrestrial stages. The volume of traffic over extended periods of time would also likely result in mortality of slow-moving, smaller animals (e.g., salamanders, snakes, frogs, toads, invertebrates).

Table GC10-11 provides a summary of the extent of impacts to the forested wetlands in the PSA from access road and staging area construction, by alternative. It is important to note that while none of the sediment remediation work would cause direct impacts to forested wetlands, impacts to this wetland type would range from 26 to 30 acres due to the impacts associated with constructing the necessary access roads and staging areas to implement SED 3 through SED 8. Further, riverbank remediation is not considered in these calculations, since that work is expressed as a linear measurement and was discussed in Section III.A. However, much of the riverbank remediation would have direct and secondary effects on adjacent forested wetlands through clearing, bank soil excavation, hydrologic changes, and light/temperature changes.

Table GC10-11. Additional Impacts to Forested Wetlands from Access Roads and Staging Areas.

Remedial Alternative	Impacts from Access Roads/ Staging Areas (acres)
FP 2	5
FP 3	7
FP 4	9
FP 5	10
FP 6	9
FP 7	8
SED 3	26
SED 4	30
SED 5	30
SED 6	30
SED 7	30
SED 8	30

<u>Summary and Assessment of Potential Measures to Avoid or Minimize Effects</u>

The combined extent of effects to forested wetlands from soil removal activities and access roads/staging areas ranges from 11 acres (FP 2) to 180 acres (FP 7). These impacts represent up to 45% of the forested wetlands in the entire PSA.

While some measures could be taken to minimize effects, such as employing BMPs, those measures could not prevent substantial adverse impacts to forested wetlands under most of the above alternatives. In the target soil removal areas, tree removal is a necessary part of the remediation. Since removal of trees represents removal of the most significant functional portion of these wetland systems, there is no way to avoid the resulting adverse impacts in those target areas.

While an effort could be made to site temporary staging areas and access roads away from forested areas, this will not be possible or reasonable in most cases, since forested wetlands are the dominant natural community through many parts of the PSA. Additionally, many of the access road alignments are constrained by severe topography, the river itself, and logical connection points to existing public roads that would be integral to the construction process. In any event, realigning access road and staging areas would simply displace impacts and create additional impacts.

3. Key Constraints in Restoration

While constraints exist in any restoration program, the Rest of River remedial alternatives involve a number of particularly significant constraints on the ability to successfully restore the affected forested wetlands within the PSA to their current condition. The most important of those constraints include the following:

<u>*Loss of Mature Trees*</u>. The most significant constraint on restoration of forested wetlands in the PSA is the unavoidable loss of mature trees that would be necessary to implement the floodplain and sediment removal alternatives. These alternatives would require clearing and removal of mature trees (many well over 100 years old) in the floodplain and along the banks of the river, in order to remove soils in the target remedial areas and to build the necessary access roads and staging areas to conduct the river, riverbank, and floodplain remediation. The presence of mature trees serves numerous, vital wetland functions within the PSA, as discussed above. Loss of mature forest trees will represent an impact that may not allow for the comparable functionality and usage of this habitat for up to 100 years or longer. In addition, finding a suitable and ample source of genetically and hydrologically compatible nursery stock to replace the substantial number of trees lost (which would range up to many thousands) would be difficult.

Loss of Coarse, Woody Debris and Annual Leaf Litter. The removal of trees would also result in the loss of woody debris that is used as structural wildlife habitat – i.e., for perching, basking, denning, nesting, cover, or escape habitat. While it is assumed that some of the coarse debris left over from cut tree trunks could be re-used in the remediated floodplain for that purpose, conditions would not be the same as under pre-remediation conditions. Similarly, while some of this material could also be chipped and left on site as an organic amendment to the imported topsoil, it would not be a soil amendment that could mimic the natural and beneficial carbon:nitrogen ratio afforded by leaf litter. In addition, the tree removal would cause the loss of yearly leaf litter that is generated by the mature deciduous trees that populate the floodplain. Significant leaf litter is generally common on the floor of a forested wetland, and this material is important as part of the food chain by affecting soil permeability, providing cover habitat for amphibians, reptiles, small mammals and invertebrates, and regulating soil temperatures and relative humidity in a wetland system. These factors thus also place a severe constraint on efforts to restore forested wetlands, at least within the decades after remediation.

Changes in Hydrology. An additional constraint on restoration efforts would be the impacts of the remediation on the hydrology of the forested wetlands. This is a complex issue as there are multiple sources of water that feed these systems (e.g., groundwater slope seepage, groundwater discharge from seasonally high water tables in the floodplain, and overbank flooding of the river). Further, since the forested wetlands in the PSA are located within the lower portion of Housatonic River floodplain closer to the river (i.e., the approximate 10-year floodplain), these areas are susceptible to dynamic changes in surface water levels, erosion, and deposition. Even with success in replicating pre-existing elevations, micro-topography, and ground contours, changes to the topography of the overall floodplain upstream or downstream of the affected area may alter the discrete flood flows that dictate the recovery of the forested wetland communities.

Loss of Connectivity to Other Natural Communities. Significant habitat alteration over widespread areas of the floodplain would result in the degradation or loss of the connections among forested habitats and between those and other habitats in the PSA. Habitat connectivity is important to the viability and sustainability of populations of most wetland-dependent amphibians, reptiles, small mammals, and non-flying invertebrates, as these animals do not have the capability to disperse or migrate if corridors are obstructed or highly disturbed or fragmented. Protecting or restoring existing forested riparian and upland corridors to optimal widths of > 1,000 feet is essential to maintain the biodiversity and ecosystem functions of the Housatonic River corridor. The loss of such connectivity thus places a severe constraint on the potential for successful restoration of this habitat.

Impacts to Multiple Rare Species with Different Life Cycles. As noted above, 27 different state-listed rare plant and animal species have Priority Habitat within the forested wetlands, and the more intrusive remedial alternatives would affect most of them. Restoration efforts are complicated by the fact that the optimal construction windows in which to minimize impacts to these species are not all the same. As discussed in Section II.B of this response and shown on Figures GC10-2a through GC10-2c, for the state-listed rare species within the PSA, there would be no time during the year in which remediation work could occur that would be within the preferred construction windows for all these species.

Soil Composition and Chemistry. Given the significant amount of surface soil excavation and removal proposed in the forested floodplains, it is assumed that a substantial amount of off-site soils would be needed in order to attempt to match the pre-existing grades and soil profile. These volumes would range from roughly 10,000 cy (FP 2) to 280,000 cy (FP 7) within forested wetlands. The availability of a source of such suitable replacement soils is another important factor governing the potential restoration success. Studies have shown that having proper soil texture and organic matter content are critical for aquatic restoration projects to be successful (National Academy of Sciences [NAS], 2001; Cavallaro and Golet, 2002). For many of these alternatives, it is doubtful that sufficient volumes of comparable forested wetland hydric soil or floodplain alluvial soil could be found (without destroying other wetlands elsewhere). This is particularly true since the soil chemistry and seed bank of the on-site soils are unique to the existing Housatonic River floodplain system and likely adapted to the particular chemistry and climatic conditions of the local environment. Changes in soil chemistry could create shifts in micro-organism and fungal composition and affect the local plant and animal communities. In short, replicating the existing surface soils with off-site materials would be difficult, if feasible at all, as commercially available topsoils originate from upland sites, not forested wetlands, and significant use of imported soils of a different character would likely affect the resulting biological communities. In addition, the annual loss of the major source of leaf litter (trees) would affect soil chemistry, and reduce the wetlands' production export functionality.

Soil Stratigraphy. Not only would soil disturbance have an immediate direct impact on forested wetland plant and animal species (including likely mortalities), but the heavy equipment required to undertake the remediation and restoration would also result in a long-term impact to soils in the form of compaction. Heavy, mechanized equipment, such as land-clearing machines, skidders, excavators, haul trucks, and bulldozers, would be required to clear vegetation, to excavate, remove, and grade the floodplain soils, and to place backfill. This would make soils less friable and conducive to the formation of the necessary subterranean burrows required by certain animals for overwintering, and hinder or prolong the reestablishment of the plant community. While the final grades of soils in the affected forested wetlands could be scarified by construction equipment (to limit compaction), this would not prevent compaction altogether.

Proliferation of Invasive Plant Species. A risk that is always present when structurally intact ecosystems exist – especially forested ones with a mostly enclosed canopy and little understory plant community – is the introduction of and/or spread of invasive herbaceous species as a result of disturbances. Parts of the PSA targeted for remediation exhibit invasive plant species, while other portions do not. Disturbances to any of these forested areas represent a prime opportunity for expansion of the extent of invasive species, as removing a mature, forested (stable) system creates primary successional conditions. The plant communities in primary successional systems are generally dynamic, and it is under these conditions that aggressive and exotic species readily take hold. This is a very real risk to the overall success of restoration activities, as the plant community is one of the foundations of the overall ecosystem. If non-native species out-compete native ones, the animals that depend on the native plants may be lost as well.

It should be noted that invasive plant species proliferation may be difficult to prevent, even under a very rigorous control program, due to the large size of the impacted areas, the strong influence of water-borne and wind-borne weed seeds in this broad floodplain valley, limitations on post-construction access to many of the remediation areas, and the desire to avoid the extensive use of herbicidal controls. Hand-pulling weeds during the first or second year following restoration is feasible at small sites (i.e., those well below an acre in size) but practically impossible at large sites – which generally necessitates the use of herbicides or execution of controlled burns. Many species are resistant to herbicides and mechanical removal methods; and if the methods used to control invasives are too severe, they can cause harm to native species and/or make the environmental conditions unsuitable for recolonization by native species. Controlled burns have seen some success in other parts of the U.S., but regional perceptions have often proven to be an obstacle to this type of invasive plant management in southern New England, and it is not clear if this method would be appropriate for the PSA, given the complex and varied life cycle requirements of all its rare species.

Proliferation of New Predatory Animal Species. In addition to controlling invasive plant species, it is important to control invasive animal species. Following construction, it is possible that the temporal losses in habitat or other factors could create changes in the current predator-prey structure in the forested wetlands. Important predators may expand into areas where they did not previously exist, and prey on the resident species. For example, increases in the populations of opportunistic predators such as raccoons and skunks should be expected from such large habitat disturbances. These predators could affect the success of the restoration efforts.

Due to these constraints, once large tracts of forested wetlands in the PSA have been disturbed by remediation, it would likely not be possible to restore them to their current functional state for many decades, if ever.

4. Restoration Methods

As discussed above, there are many significant constraints on the ability to restore forested wetlands to their current condition. Keeping those constraints in mind, the following outlines the methods that would be used in a forested wetland restoration program.

Data Collection

The first step in a restoration effort is to collect data on the existing conditions and functions of the forested wetlands involved. Data collection would include a baseline assessment that may include identification and evaluation of the geographical extent of the affected wetlands, resident plant and animal species, relatively "important" micro-habitats within the overall system, source of hydrology, typical annual water levels and duration of wetness, relationship to nearby habitats, importance of predation, composition of predator community, and soil characteristics.

Planning and Design

Following baseline data collection, a planning phase would be required in order to conceptualize the actual execution of restoration construction. The major element of this phase would be preparation of the design plans, first conceptual and then final, as the details of the design are assessed and corrected. The design drawings would likely include specifications on elevations, backfill and topsoil characteristics, planting plans, water levels, and natural physical structures to be placed in the wetlands to serve as structural wildlife habitat, as well as construction access routes and staging areas and protective measures for the surrounding habitat. Other important elements of the planning and design stage would include identifying proper construction equipment and qualified contractors, and developing appropriate performance standards.

Construction

The major elements of the construction phase of forested wetland restoration would include the following:

1. Cut trees in the target areas and set aside a portion of the coarse woody debris generated by this for re-distribution in the impacted area.

2. Following soil excavation to the target depth, replace excavated soil to the pre-existing grade with a combination of backfill and topsoil, based on the design specifications. Grade should be consistent with original surveyed topography throughout the restoration area so that hydrology can be matched.

3. Spread leftover coarse woody debris over the restored area.

4. Seed the area with a native wetland seed mix to stabilize the soil and compete with invasive species.

5. Plant native shrubs and saplings consistent with the pre-construction species, as provided in the design specifications.

Other construction considerations include construction access, timing, and sequencing. Many of the forested wetland areas targeted for restoration occur several hundred meters from the nearest public roadway infrastructure, and thus construction of access roads will cause significant secondary impacts to mature and stable upland and wetland communities (including rare plant and animal species habitats) not targeted for remediation (see Table GC10-11 above). While construction activities would ideally be timed in order to avoid the most critical windows of the year – i.e., the periods when water levels are highest and most dynamic (spring) and when the resident animals are breeding, nesting, migrating, and/or rearing young (mainly the spring and summer) – this would not be feasible in most cases, and in any event would not avoid the adverse impacts. Even if the construction were to occur during the low-flow season, and after the breeding, nesting, rearing and migration period, it would be difficult to avoid direct mortalities to animals that are occupying these forested environments, as many of them are year-round occupants that hibernate in the soils during the remaining season (winter) or are slow-moving organisms that are especially vulnerable to ground disturbance. Moreover, the impacts of the construction would last far beyond the construction period itself. Similarly, while affected forested wetland areas would be restored in a staggered fashion over a number of years under most alternatives, this would likewise not avoid widespread adverse impacts, since construction impacts from one season would affect habitat conditions over many subsequent years. In addition, this sequencing would exacerbate the secondary impacts to surrounding terrestrial habitat through longer-term use of access roads and staging areas.

<u>Monitoring</u>

Following the construction phase of restoration, a monitoring program would be established, typically for a period of 5 years after restoration. The details of this program would be determined during design, but would likely involve semi-annual or annual inspections of the forested wetlands in the growing season during that 5-year period, with quantitative and/or qualitative assessments of the plant community and hydrologic features. Mid-course corrections or "adaptive management" during this period may also be triggered under the monitoring and maintenance program

5. Likelihood of Success in Restoration

As discussed in Section III.C.3, there are numerous constraints on the ability to successfully restore the forested wetlands that would be affected by the floodplain and sediment alternatives. The most significant of these are: (1) the long-term loss of large, live, mature trees and attendant source of annual coarse debris and leaf litter; (2) potential inadvertent effects on the hydrology of these wetlands due to remediation upstream or downstream, as well as unforeseen and uncontrollable storm or other climatic events; (3) loss of connectivity to other forested communities and other habitats; (4) impacts to the habitat of numerous different rare plant and animal species with very different life cycles; (5) difficulties in locating a comparable and ample source of suitable soil for backfill/topsoil; (6) soil compaction; (7) potential proliferation of invasive plant species; and (8) potential proliferation of new predatory animals.

These constraints are particularly significant under the more intrusive remedial alternatives (i.e., FP 3 through FP 7, and SED 3 through SED 8). We have found no precedent in the Northeast for a riparian forest restoration project of the size and duration that would be involved under those alternatives. The effects of the significant loss of extensive acreages of mature floodplain and riverbank trees and need to locate a comparable, clean source of topsoil to mimic current conditions make the proposition of restoring this large system extremely vulnerable to the constraints listed above. Due to the excessive loss of habitat (i.e., mature forest), it is likely that system equilibrium – consistent with what currently exists – would take upwards of 100 years or more to achieve, if it is achievable at all.

In short, despite the implementation of the most up-to-date restoration methods and the sequencing of restoration over a number of years, it is likely, given the many constraints and challenges described above, that at least some and likely many of the affected forested wetland areas would not return to their current level of function for a long time, if ever.

D. Shrub and Emergent Wetlands

1. Description of Habitat

Approximately 280 acres of shrub and emergent wetlands occur within the PSA. Four different natural community types are represented within these wetlands, including shrub swamp, deep emergent marsh, shallow emergent marsh, and wet meadow. The acreage of these community types is summarized in Table GC10-12.

Table GC10-12. Breakout of Shrub and Emergent Wetland Natural Communities within the PSA.

Natural Community Type	Acreage within the PSA
Shrub swamp	153
Deep emergent marsh	26
Shallow emergent marsh	58
Wet meadow	43
TOTAL	**280 acres**

Shrub Swamp

This wetland type is a dominant cover type within the PSA, occupying approximately 153 acres. Shrub swamps are generally quite variable. They may be co-dominated by a mixture of species or be a near-monoculture of a single dominant shrub species. Shrub swamps may represent a successional stage leading to forested wetland, or they may be relatively stable communities. Shrub swamps are usually characteristic of wetland areas that are experiencing environmental change, and are early to mid-successional in species complement and structure. This community is seasonally flooded and often saturated near the surface when not flooded. Soils are generally mineral soils with redoximorphic features under a layer of well-decomposed organic mucks. Shrub swamps within the PSA are dominated by broadleaf deciduous plants such as silky dogwood, winterberry, speckled alder, meadowsweet, buttonbush, northern arrowwood, silky willow, and pussy willow. Shrub swamps are located throughout the PSA but the majority occur within Reach 5C.

Deep Emergent Marshes

This wetland type occupies approximately 26 acres within the PSA. Deep emergent marshes exhibit tall herbaceous vegetation and are wetlands occurring on saturated, mucky mineral soils that are seasonally inundated and permanently saturated. The substrate is flooded by waters that are not subject to violent wave action and with water depths ranging from six inches to six feet. Water levels may fluctuate seasonally, but the substrate is rarely dry, and there is usually standing water throughout the year. Deep emergent marshes are quite variable. They may be co-dominated by a mixture of species or have a single dominant species. In the PSA, dominant plant species within this natural community include broad-leaved cattail, common reed, giant bur-reed, pickerel weed, tuckahoe, common arrowhead, and purple loosestrife. Deep emergent marshes are located throughout the PSA and are closely associated with open backwater habitats.

Shallow Emergent Marshes

This wetland type occupies approximately 58 acres within the PSA, most commonly in Reaches 5B and 5C. Shallow emergent marshes are grass-, sedge-, and/or rush-dominated wetlands on mucky mineral soils that are seasonally inundated and permanently saturated. No canopy is present within this habitat and the shrub layer is usually sparse and intermixed, though dense shrub colonies can occur in patches. Based on species composition alone, it can be difficult to differentiate shallow emergent marshes and wet meadows, but they occur in different physical settings and hydrologic regimes. In the PSA, dominant plant species within this natural community include false water-pepper, woolgrass, dotted smartweed, cuckoo-flower, common arrowhead, purple loosestrife, water parsnip, and northern water-plantain.

Wet Meadows

This wetland type occupies approximately 43 acres within the PSA. Wet meadows are wetlands which often resemble grasslands and are typically drier than other marshes except during periods of seasonal high water. For most of the year, wet meadows are devoid of standing water, though a high water table allows the soil to remain saturated. The wetland substrate consists of mineral soils with redoximorphic features, sometimes with a surface layer of well decomposed organic material. A variety of water-loving grasses, sedges, rushes, and wetland wildflowers proliferate in the highly fertile soil of wet meadows. In the PSA, dominant plant species within this natural community include reed canarygrass, spotted touch-me-knot, Canada blue-joint, lakeside sedge, spotted joepye weed, swamp and common milkweed, and stinging nettle. Wet meadows are located throughout the PSA but the majority of these wetlands are associated with agricultural fields in Reach 5B.

Shrub/Emergent Wetland Functions

The shrub and emergent wetlands within the PSA provide a number of wetland functions and values, including:

- Wildlife habitat, including habitat for rare plant/animal species;
- Groundwater recharge/discharge;
- Flood flow alteration;
- Sediment/shoreline stabilization;
- Nutrient removal/retention/transformation;

- Sediment/toxicant retention; and
- Production export.

All of these wetland types often contain habitat which functions as vernal pools in areas that exhibit extended periods of ponding and a lack of a breeding fish population. However, this section focuses on shrub and emergent wetlands generally; vernal pools are discussed separately in Section III.E below.

Maps provided by NHESP show Priority Habitats of 13 state-listed rare plant and animal species within the shrub and emergent wetlands of the PSA, as summarized in Table GC10-13.

Table GC10-13. Rare Species Associated with the Shrub and Emergent Wetlands of the PSA.

Common Name	Scientific Name	State Status
Wood turtle	*Glyptemys insculpta*	Special Concern
Jefferson salamander	*Ambystoma jeffersonianum*	Special Concern
American bittern	*Botaurus lentiginosus*	Endangered
Common moorhen	*Gallinula chloropus*	Special Concern
Water shrew	*Sorex palustris*	Special Concern
American clam shrimp	*Limnadia lenticularis*	Special Concern
Bristly buttercup	*Ranunculus pensylvanicus*	Special Concern
Culver's root	*Veronicastrum virginicum*	Threatened
Foxtail sedge	*Carex alopecoidea*	Threatened
Hemlock parsley	*Conioselinum chinense*	Special Concern
Intermediate (matted) spike-rush	*Eleocharis intermedia*	Threatened
Wapato	*Sagittaria cuneata*	Threatened
White adder's-mouth	*Malaxis monophyllos var. brachypoda*	Endangered

2. Effects of Remedial Alternatives

All of the floodplain remedial alternatives (except FP 1) would impact shrub and emergent wetland habitat within the PSA through soil removal activities and construction of access roads and staging areas; and many of these alternatives (i.e., FP 3 through FP 7) would produce significant adverse impacts, as described below.

Direct Effects from Soil Removal Activities

Soil removal activities would directly affect shrub and emergent wetlands primarily through vegetation and soil removal, although direct impacts would also result from dewatering where necessary in these wetlands to control water levels during excavation. Table GC10-14 provides a summary, by alternative, of the direct impacts to the shrub and emergent wetlands in the PSA from floodplain soil removal activities, independent of access roads and staging areas.

Table GC10-14. Alteration of Shrub and Emergent Wetlands from Soil Removal Activities in Floodplain Alternatives.

Remedial Alternative	Direct Impact from Soil Removal (acres)	Percentage of Total Shrub & Emergent Wetland Acreage Affected
FP 2	1	< 1%
FP 3	8	3%
FP 4	10	4%
FP 5	24	9%
FP 6	78	28%
FP 7	68	24%

The main direct effect to shrub and emergent wetlands from these floodplain alternatives would be from vegetation and soil removal. Vegetation clearing would cause substantial direct effects, as these wetlands provide: (1) nesting, burrowing, and/or escape habitat and food for birds, amphibians, reptiles, mammals, and invertebrates, including important nesting habitat for migratory neo-tropical songbirds and, in the emergent areas, nesting habitat for two of the rare bird species (American bittern and common moorhen); (2) vital shade which helps control surface water, soil and air temperatures, and evaporative losses; (3) a significant yearly infusion of biomass, consisting of fallen leaves, decaying herbaceous plants, and woody material, which make up a significant component of the underlying organic layer and which is part of the foundation of the food chain of these ecosystems; (4) a system whereby massive volumes of surface water and the dissolved constituents within it are removed and seasonally pumped into the living tissue of the shrubs and herbaceous vegetation, substantially affecting the local hydrology and attendant wetland functions (sediment/toxicant retention, and nutrient removal/retention/transformation); and (5) a complex physical structure that helps to attenuate flood flows and prevent storm damage.

Soil disturbance would also produce direct impacts with significant implications. The removal of root zone soils would negatively affect sediment and shoreline stabilization. In many areas of the floodplain, root systems are critical to binding soils in place. The losses of vegetative cover and soils in the floodplain, which would be immense under the larger floodplain alternatives, would also create a substantial risk of erosion and associated receiving water impacts. Additional impacts would result from the removal of surface soils and organic litter in these wetlands, since many animal species use these areas as forage, cover, aestivation, and/or hibernation habitat.

In addition, compaction or disruption of the soils of these wetlands by heavy machinery would likely cause direct mortalities to small and slower-moving animals, and at a minimum, would disrupt important elements of their life cycles. Soil compaction would also affect the subsequent permeability of these soils, which influences plant colonization (e.g., slows the process of recolonization by native species and makes surface soils more susceptible to proliferation of invasive species) and would likely impair the flood flow alteration, sediment/toxicant retention, nutrient removal/retention/transformation and groundwater recharge/discharge functions of these wetlands.

<u>Additional Effects from Access Roads and Staging Areas</u>

All the remedial alternatives involving removal, including both the sediment and floodplain alternatives, would have additional effects on non-target shrub and emergent wetlands through related construction activities. These additional impacts are essentially the same as those discussed for forested wetlands in Section III.C.2 and include:

- Cutting of trees and shrubs for the construction of access roads and staging areas and installation of sedimentation and erosion controls;

- Grubbing of stumps and roots in adjacent floodplain wetlands for access road and staging area construction;

- Construction of temporary access roads in or adjacent to non-target wetlands; and

- Air quality and noise impacts resulting from truck and excavation equipment traffic and disrupting animals which utilize the wetland habitats.

Table GC10-15 provides a summary of the additional impacts to the shrub and emergent wetlands in the PSA from access road and staging area construction, by alternative. It is important to note that while none of the sediment remediation work would cause direct impacts to these wetland types, impacts to shrub and emergent wetlands would range from 7 to 10 acres due to the impacts associated with constructing the necessary access roads and staging areas to implement SED 3 through SED 8. Further, while riverbank remediation is not considered in these calculations (since that work is expressed as a linear measurement and was discussed in Section III.A), much of the riverbank remediation will adversely affect adjacent shrub and emergent wetlands through riverbank soil excavation, hydrologic changes (perhaps temporary), and light/temperature changes.

Table GC10-15. Additional Impacts to Shrub and Emergent Wetlands from Access Roads and Staging Areas.

Remedial Alternative	Impacts from Access Roads/ Staging Areas (acres)
FP 2	1
FP 3	7
FP 4	8
FP 5	6
FP 6	7
FP 7	6
SED 3	7
SED 4	9
SED 5	9
SED 6	7
SED 7	7
SED 8	7

Summary and Assessment of Potential Measures to Avoid or Minimize Effects

The combined effects of soil removal activities and access roads/staging areas to shrub and emergent wetlands impact only about 2 acres in FP 2, in the range of 15 to 18 acres for FP 3 and FP 4, about 30 acres for FP 5, 74 to 85 acres for FP 7 and FP 6, and in the range of 7 to 9 acres for SED 3 through SED 8. At the highest levels, these impacts represent up to about 30% of the overall shrub and emergent wetlands in the entire PSA.

While some measures could be taken to minimize effects, such as employing BMPs, those measures could not prevent the adverse impacts to shrub and emergent wetlands. This is because, in the target removal areas, removal of the vegetation and soils is a necessary part of the remediation and represents removal of the most significant functional portion of these wetland systems.

While an effort could be made to site temporary staging areas and access roads away from these wetlands, this will not be possible or reasonable in many cases, since many of these wetlands occupy broad expanses of the floodplain through many parts of the PSA. Additionally, many of the access road alignments are constrained by severe topography, the river channel itself, and logical connection points to existing public roads that would be integral to the construction process.

3. Key Constraints in Restoration

For the shrub and emergent wetlands in the PSA that would be unavoidably impacted by the remediation, there are a number of constraints on the ability to restore those wetlands to their current level of function. The most significant of those constraints (many of which are similar to the constraints discussed for forested wetlands in Section III.C.3) include the following:

Soil Stratigraphy. This is likely the greatest challenge to wide-scale restoration of shrub and emergent wetlands in the PSA. Not only would soil disturbance have an immediate direct impact on the plant and animal species (including mortalities), but the heavy equipment required to undertake the remediation and restoration would also result in a long-term impact to soils in the form of compaction. Heavy mechanized equipment, such as land-clearing machines, excavators, haul trucks, and bulldozers, would be required to clear vegetation, to excavate, remove, and grade the floodplain soils, and to place backfill. This would make soils less friable and conducive to the formation of the necessary subterranean burrows required by certain animals for overwintering, hinder or prolong the reestablishment of a native plant community, and facilitate proliferation of invasive plant species. In addition to compaction, final graded soils could subside more than expected, affecting water levels in a fashion that limits successful use by certain plant or animal populations (e.g. breeding amphibians). While soil compaction is a constraint to restoring any of the wetland types in the PSA, it is particularly problematic when considering expansive earthwork in shallow and deep emergent marshes. These wetland types harbor deep, organic soils that are extremely difficult to work in with heavy machinery when wet – which is most, if not all, of the time – and very difficult to keep dewatered during construction.

Changes in Hydrology. An additional important constraint on the ability to restore the shrub and emergent wetlands would be presented by the impacts of the remediation activities on the hydrology in the area. As with the forested wetlands, this is a complex issue since there are multiple sources of water that feed these systems (e.g., groundwater slope seepage, groundwater discharge from seasonally high water tables in the floodplain, and overbank flooding of the river). In addition, since most of the acreage of these wetlands in the PSA is located within the lower portion of the Housatonic River floodplain nearer the river, these areas are susceptible to dynamic changes in surface water levels, erosion, and deposition. Even with success in replicating pre-existing elevations, micro-topography, and ground contours, changes to the topography of the overall floodplain upstream or downstream may alter the discrete flood flows that dictate the recovery of the individual shrub and emergent wetland communities, and would likely dictate the exact distribution of these separate wetland natural communities if the system recovers. In short, after a restoration attempt, the geographic distribution and acreage of deep emergent marshes, shallow emergent marshes, and shrub wetlands are quite likely to change, even if the basic restoration elements succeed.

Soil Composition and Chemistry. To match the pre-existing grades and soil profile of the affected shrub and emergent wetlands, off-site soils would be needed. The necessary volumes would range from roughly 2,000 cy (FP 2) to 111,000 cy (FP 7). At least for the larger alternatives, it would likely be very difficult, if not infeasible, to find sufficient volumes of comparable soils from off-site sources, since the soil chemistry and seed bank of the on-site soils are unique to the existing Housatonic River floodplain system. As with the forested wetlands, changes in soil chemistry could create shifts in micro-organism composition, and the substantial native seed bank present in the soils to be removed, which is adapted to the particular chemistry and climatic conditions of the local environment, would be difficult to replace.

Loss of Connectivity to the Nearby Wetland Communities. With any significant habitat alteration over widespread areas of the floodplain, the connections among shrub/emergent wetlands and their landscape settings in a forested habitat matrix would be degraded or lost entirely. This places another constraint on the ability to successfully restore these wetlands, since most wetland-dependent amphibians, reptiles, small mammals, and non-flying invertebrates are unable to disperse or migrate if corridors are obstructed or highly disturbed. Thus, maintaining habitat connectivity is key to maintaining the viability and sustainability of the populations of these animals.

Proliferation of Invasive Plant Species. The ability to successfully restore shrub and emergent wetlands is also constrained by the potential introduction and/or spread of invasive herbaceous species. Portions of the emergent marshes in the PSA targeted for restoration exhibit some degree of invasive plant species (e.g., purple loosestrife), while most portions do not. As is the case with forested wetlands (discussed above), disturbances to any of these areas represent a prime opportunity for expansion of the extent of invasive species, since removing a mature, stable system creates primary successional conditions, and it is under these conditions that invasive species readily take hold. This is a very real risk to the overall success of restoration activities, as the plant community is one of the foundations of the overall ecosystem, and if invasive species drive out native species, the animals that depend on the native plants may be lost as well. Further, as previously noted, invasive plant species proliferation may be difficult to prevent even under a very rigorous control program.

Proliferation of New Predatory Animal Species. Finally, the success of restoration of shrub and emergent wetlands could be undermined by the introduction of invasive animal species (e.g., raccoons, skunks) due changes in habitat, for the same reasons discussed under the forested wetlands (see Section III.C.3).

4. Restoration Methods

As discussed above, there are many significant constraints on the ability to restore shrub and emergent wetlands to their current condition. Keeping those constraints in mind, the following outlines the methods that would be used in a shrub/emergent wetland restoration program.

Data Collection and Planning

The data collection and planning/design steps that would be involved in a restoration effort for shrub and emergent wetlands would be essentially the same as those described for forested wetlands in Section III.C.4 above.

Construction

The major elements of the construction phase of a shrub or emergent wetland restoration would include the following, after the required excavation of soils:

1. Replace excavated soil to the pre-existing grade with a combination of backfill and topsoil, based on the design specifications. Grade should be consistent with original surveyed topography throughout the restoration area so that hydrology can be matched.

2. Seed the area with a suitable, native wetland seed mix to stabilize the soil and compete with invasive species.

3. Plant native shrubs and emergent plant plugs consistent with the pre-construction species, as provided in the design specifications.

Other construction considerations are the same as those discussed for forested wetlands in Section III.C.4.

Monitoring

Following the construction phase of restoration, a monitoring program would be established, typically for a period of five full years after restoration. The details of this program would be determined during design, but would likely involve semi-annual or annual inspections of the shrub and emergent wetlands during the growing season each year, with quantitative and/or qualitative assessments of the plant communities and hydrologic features. Mid-course corrections or "adaptive management" during this period may also be triggered under the monitoring and maintenance program

5. Likelihood of Success in Restoration

As discussed in Section III.D.3, there are numerous constraints on the potential for successful restoration of the shrub and emergent wetlands that would be impacted by the sediments and floodplain alternatives. The main ones are: (1) potentially irreparable and widespread soil compaction; (2) changes in the hydrology of these wetlands due to remediation in the area, as well as unforeseen and uncontrollable storm or other climatic events; (3) difficulties in locating a comparable and ample source of suitable soil for backfill/topsoil; (4) loss of connectivity to other wetland communities and other habitats; (5) potential proliferation of invasive plant species; and (6) potential proliferation of new predatory animals.

These constraints are particularly significant under the more intrusive remedial alternatives that will affect a substantial amount of the shrub/emergent wetlands in the PSA (i.e., FP 3 through FP 7). We have found no precedent in the Northeast for an inland shrub swamp/marsh restoration project of the size and duration that would be involved to implement those alternatives. Given the magnitude of impacts to these types of wetlands under such a project, coupled with the unique characteristics of the PSA and the above-listed constraints, it is likely that that at least some and likely many of the affected wetland areas would not return to their current level of function.

In short, given the many constraints and challenges described above, it is unlikely that restoration efforts would be successful in restoring all the affected shrub and emergent wetland areas in the PSA to their current condition and level of function; and under the more intrusive alternatives, it is probable that many of those wetlands would not do so.

E. Vernal Pools

1. Description of Habitat

EPA has identified 68 vernal pools in the floodplain of the PSA totaling approximately 34 acres. The MESA regulations define vernal pool habitat as "confined basin depressions which, at least in most years, hold water for a minimum of two continuous months during the spring and/or summer, and which are free of adult fish populations, as well as the area within 100 feet of the mean annual high water boundaries of such depressions" (301 CMR 10.04). Vernal pools supply essential breeding habitat for a variety of amphibian species such as the wood frog and spotted salamander, provide a variety of important habitat functions for numerous other wildlife species, and are critically relied upon by multiple state-listed rare species, including the Jefferson salamander and the American clam shrimp, which have been identified in the PSA. Other state-listed rare species in the PSA that would be expected to use vernal pools, mainly in a feeding capacity, are the wood turtle, zebra clubtail, arrow clubtail, riffle snaketail, and brook snaketail; and the host plants of the mustard white (butterfly) could also occur along the margins of vernal pools.

Vernal pools are not simply isolated depressions that are seasonally filled with water. They constitute a relatively uncommon habitat type because their presence and functionality during most years are reliant upon the co-occurrence of so many different variables, including spatial, chemical, physical, climatic, and biological factors. The right combination of the following characteristics is vital for a given basin to function during most years as viable vernal pool habitat:

> *Topography*. While vernal pool habitat can occur in large, multi-habitat wetlands, it is the smaller, isolated depressions surrounded by forested habitat that typically provide the best habitat for the rare species typically associated with vernal pools. Areas formed in ice-contact glacial outwash and remnant depressions in floodplains typically provide the type of micro-topography conducive to types of isolated basins generally viewed as "classic" vernal pool habitat.
>
> *Hydrologic Regime and Water Depth*. It is the isolation, proper water depths (not too shallow, but not too deep), and duration of flooding in vernal pool depressions, that generally keep them free of adult fish, which are more common in perennially aquatic systems and can be predators on amphibian eggs and larvae. This is one of the most critical parameters for successful vernal pool amphibian development. The pools need to hold ice-free water to the proper depths and duration (usually around 2-3 months) in order for amphibians to breed, for eggs to develop, and for larvae to grow and successfully transform into juveniles which disperse into the surrounding terrestrial lands. If the pool dries too soon, significant or total mortality can occur to larvae. If the

pool stays wet too long, it can become amenable to population by predatory fish. This is particularly true in floodplain settings where overbank flooding can allow fish to access the vernal pools. The hydrology of a vernal pool can be influenced by many climatic and hydrological factors, including, but not limited to, direct precipitation, groundwater discharge, and overbank flooding. Each vernal pool is affected by a unique combination of these factors specific to that pool. Hydroperiod is strongly correlated with amphibian species richness and total number of metamorphosing juveniles (Pechmann et al., 1989; Babbit and Tanner, 2000; Snodgrass et al., 2000a, b). Pools that dry too soon prohibit amphibian larvae from completing metamorphosis to terrestrial juvenile stages, which can result in complete reproductive failure (Pechmann et al., 1989; Skelly 1996; Paton and Crouch, 2002).

Bottom Sediments Composition. The composition and structure of bottom sediments in a vernal pool play an important role in the development of vernal pool amphibians. Significant leaf litter is generally common, and this material often provides the basis for the food chain upon which amphibian larvae are a part. Young frog larvae may feed directly on algae attached to leaf litter, while salamander larvae are generally carnivorous and prey upon the smaller microorganisms that feed upon leaf litter and algae. In addition to being a potential food source, bottom sediments and soils in a vernal pool factor into the overall permeability of the depression – which may dictate how long and to what depths the pool holds surface water.

Water Chemistry and Temperature. Water temperature, pH, and dissolved oxygen are just a few factors than can dictate successful timing of amphibian breeding and larval development in a vernal pool. Water temperature and dissolved oxygen are significantly influenced by the shading effect of mature trees over the pool (Werner and Glennemeier, 1999), which can influence survivorship and growth rates of developing larvae (Seale, 1982).

In-Pool Physical Structure. In addition to leaf litter, fallen brush, emergent plants, and coarse woody debris play an important role in vernal pools, as these provide protective cover for larvae or the vital physical structure on which amphibians may locate or attach egg masses (Gates and Thompson, 1981; Seale, 1982; Egan and Paton, 2004). These structures are essential to vernal pools with thriving vertebrate and invertebrate populations.

Surrounding Land Uses. One of the most important factors dictating a viable long-term population of vernal pool animals is not related to the pool itself, but the composition of the surrounding landscape. Many vernal pool amphibians, such as mole salamanders and wood frogs, spend the majority of their annual life cycles in terrestrial lands beyond the vernal pool – often several hundred meters away (McDonough and Paton, 2007;

Rittenhouse and Semlitsch, 2007). A deciduous forested habitat is preferred in most cases, as it provides shade during warmer months that keeps air temperatures cooler and surface soils moist below the leaf litter, which prevents desiccation of the amphibians. Coarse woody debris and the burrows of small mammals are also important for protective cover and overwintering habitat for salamanders and frogs. Further, a mature forest surrounding a vernal pool depression provides the critical overhanging canopy that keeps the pool shaded and water temperatures within a tolerable range. A vernal pool with the best structure will not produce a successful population of breeding amphibians without the proper surrounding habitat. Dispersal is key for recolonization of local subpopulations and maintenance of regional populations, and this dispersal is largely influenced by the surrounding land uses. Juvenile survivorship is dependent upon the ability to reach forested areas, and is correlated with distance.

Relationship and Proximity to Other Vernal Pools. Vernal pools may function as singular aquatic systems, but often occur in clusters, allowing a meta-population of amphibians to disperse among the pools in search of suitable mates and habitat – i.e., when the carrying capacity of a pool for a given species is reached, or when the hydrologic or other factors of a given pool are not sufficient during a given year, but *are* adequate in a neighboring pool. It is the proximity of vernal pools with slightly differing, but suitable, characteristics which can provide the necessary network to keep the local population of a species intact. Vernal pool species display a high degree of fidelity to breeding sites as an evolutionary mechanism to ensure reproductive success (Berven and Grudzien, 1990). Part of that success is predicated upon having opportunities for occasional exchange of genetic material among individuals from different subpopulations, especially individuals within the local meta-population (Hanski, 1998). This can occur when a cluster of suitable pools occur in proximity within an appropriate habitat matrix, which in this case is a contiguous area of mature forest. If the physical structures or hydrologic regimes of the pools are altered, or the habitat matrix shifts to a non-forest habitat type, then that meta-population is at risk to be displaced by a completely different community of organisms that can tolerate the altered conditions.

The majority of the 68 vernal pools in the PSA (about 2/3 of them) are located north of New Lenox Road. This is due mainly to the common occurrence of depressions in the forested floodplain that are seasonally filled with water due to overbank flooding of the Housatonic River, groundwater seepage, and/or a seasonally elevated water table. The remaining 1/3 of vernal pools in the PSA exist south of New Lenox Road, and appear to be less common in these reaches of the river due to the lower-gradient flow regime, broad and relatively flat floodplain, and relative scarcity of seasonally-filled micro-depressions due to the effects of the Woods Pond Dam. The vernal pools in the PSA are generally sparsely to moderately vegetated, with typical species consisting of red maple, silky dogwood, highbush blueberry, buttonbush, and winterberry. Soil conditions within the vernal pools consist of mineral soils under a surface layer of organic matter. Surrounding land use varies throughout the PSA but is dominated by palustrine forested habitat. Table GC10-16 provides a summary of the vernal pools within the PSA.

Table GC10-16. Summary of Vernal Pools within the PSA.

#	Vernal Pool Name	Class	Permanency	Reach	Obligate Species Observed[1]	Facultative Species Observed[1]
1	5-VP-1	SEM	T	5A	FS	None
2	5-VP-2	SEM	T	5A	None	None
3	5-VP-3	SS	P	5A	None	ST, WT, AT, SP, NLF, GF
4	8-VP-1	DEM	T	5A	SS, WF, FS	ST, PT, RSN, SP, GTF, NLF, GF
5	8-VP-2	SEM/SS	T	5A	WF, FS	ST, PT, SP, NLF, GF
6	8-VP-3	SS	T	5A	FS	None
7	8-VP-4	DEM	P	5A	SS, WF,FS	None
8	8-VP-5	SS	T	5A	WF, FS	None
9	8-VP-6	SS	T	5A	None	GF
10	12-VP-1	SS	P	5A	SS, WF	SP, GTF
11	18-VP-1	DEM/SS	T	5A	WF, FS	SP, NLF, GF
12	18-VP-2	DEM/SS	T	5A	SS, WF, FS	RSN, SP,NLF, PF, GF
13	19-VP-1	SEM	T	5A	WF, FS	None
14	19-VP-2	SEM	T	5A	FS	None
15	19-VP-3	SEM	T	5A	None	None
16	19-VP-4	SEM	T	5A	None	None
17	19-VP-5	SEM	T	5A	WF,	PT, NLF, PF, GF
18	19-VP-6	DEM	P	5A	WF	PT, SP, NLF, GF
19	19-VP-7	SEM	T	5A	WF	NLF, GF
20	19-VP-8	SEM	P	5A	WF	PT, NLF, GF
21	23-VP-1	SS	T	5A	None	None
22	23-VP-2	SEM	T	5A	None	None
23	23-VP-3	DEM	P	5A	None	ST, PT, GF
24	23A-VP-1	DEM/SS	P	5A	SS, JS, WF	ST, RSN, SP,NLF, GF
25	23B-VP-1	SS	T	5A	WF, FS	ST, PT, SP, NLF,GF
26	23B-VP-2	SS	T	5A	WF, FS	PT, SP, NLF, GF
27	26-VP-1 (A+B)	SS	T	5A	SS, WF	RN, SP,NLF
28	27-VP-1	DEM	P	5A	WF	PT, NLF, GF
29	27-VP-2	DEM	P	5A	None	ST, PT, GF
30	27A-VP-1	TFF	T	5A	SS, FS	GF
31	27B-VP-1	TFF	T	5A	FS	GTF, GF
32	27B-VP-2	TFF	T	5A	WF	GF
33	27B-VP-3	TFF	T	5A	WF	GF
34	33-VP-1	TFF	T	5A	FS	None
35	33-VP-2	SS	T	5A	FS	SP
36	38-VP-1	SEM	T	5B	SS, WF, FS	ST, RSN, SP,NLF, GF
37	38A-VP-1	SS	T	5B	SS, WF, FS	None
38	38-VP-2	SEM	T	5B	SS, WF, FS	ST, PT, RSN, SP,NLF, GF
39	38-VP-3	SEM	T	5B	SS, WF, FS	None
40	39-VP-1	DEM	P	5B	SS, WF	PT, RSN, NLF

#	Vernal Pool Name	Class	Permanency	Reach	Obligate Species Observed[1]	Facultative Species Observed[1]
41	40-VP-1	SEM	T	5B	SS, WF	SP, GTF, NLF,GF
42	40-VP-2	DEM/SS	P	5B	WF	PT, SP, GTF, NLF, GF
43	40-VP-3	DEM/SEM	T	5B	WF	RN, SP, GTF, NLF,GF
44	40A-VP-1	SEM	T	5B	None	None
45	42-VP-1	DEM	T	5B	WF	SP, NLF, GF
46	42-VP-2	SEM	T	5B	WF	SP,N LF, GF
47	42-VP-3	DEM	T	5B	WF	SP, NLF, GF
48	42-VP-4	DEM	T	5B	None	SP, NLF
49	42-VP-5	SEM	T	5B	WF	None
50	42A-VP-1	DEM	P	5B	None	SP, NLF, GF
51	46-VP-1	SS	T	5C	SS, WF, FS	ST, PT, SP,N LF, GF
52	46-VP-2	DEM/SS	P	5C	SS	PT, RSN, GF
53	46-VP-3	DEM	P	5C	SS	PT, GF
54	46-VP-4	RMS	T	5C	WF	None
55	46-VP-5	RMS	T	5C	SS, JS, FTS, WF, FS	ST, PT, RSN, SP, NLF, GF
56	49-VP-1	DEM	P	5C	None	RSN, GF
57	49A-VP-1	SS	T	5C	SS, WF	RSN, GF
58	49B-VP-1	TFF	P	5C	SS, WF	NLF, GF
59	54-VP-1	DEM	P	5C	SS, WF	ST, RSN, SP, GTF, NLF, PF, GF
60	55-VP-1	DEM	P	5C	None	PT, SP, GF
61	55A-VP-1	DEM	P	5C	SS, WF	ST, RSN, NLF, PF, GF
62	56A-VP-1	DEM	P	5C	SS	RSN, SP, NLF
63	58A-VP-1	DEM	P	5C	SS, WF	ST, RSN, SP, NLF, PF, GF
64	61A-VP-1	DEM	P	5C	SS, WF	ST, RSN, SP, NLF, PF, GF
65	61A-VP-2	DEM	P	5C	SS, WF	ST, RSN, SP, NLF, PF, GF
66	66A-VP-1	RMS/SS	T	5C	SS, WF	GF
67	67A-VP-1	DEM/SS	T	5C	SS	None
68	69-VP-1	SEM/SS	T	6	SS	None

Table Legend
[1] per Woodlot Alternatives (2002)

Class
SEM = shallow emergent marsh
DEM = deep emergent marsh
SS = shrub swamp
TFF = transitional floodplain forest
RMS = red maple swamp

Permanency
P = permanent waterbody
T = temporary waterbody

Obligate Species
SS = spotted salamander
WF = wood frog
FTS = four-toed salamander
FS = fairy shrimp

Facultative Species
ST = snapping turtle
WT = wood turtle
PT = painted turtle
RSN = red spotted newt
SP = spring peeper
GTF = gray treefrog
NLF = northern leopard frog
PF = pickerel frog
GF = green frog

2. Effects of Floodplain Remedial Alternatives

Direct Effects from Remediation within Vernal Pools

Five of the floodplain remedial alternatives, FP 3 through FP 7, would have direct impacts on vernal pool habitat within the PSA, because they would involve soil removal within vernal pools. These direct impacts would include: cutting of trees and shrubs in the pools in advance of soil removal; grubbing of tree stump and roots in the pools in advance of soil removal; dewatering of the pools (if necessary) to allow excavation; and soil removal, replacement, and grading. There would be no direct impacts to vernal pools from FP 2.

Table GC10-17 provides a summary, by alternative, of the number, acreage, and proportion of the vernal pools in the PSA that would be subject to these direct impacts (independent of access roads and staging areas).

Table GC10-17. Alteration of Defined Vernal Pool Habitat from Soil Removal in Floodplain Alternatives.

Remedial Alternative	Number of Vernal Pools Affected	Direct Impact from Soil Removal (acres)	Percentage of Total Vernal Pool Acreage in PSA Affected
FP 2	0	0	0
FP 3	60	15	44%
FP 4	60	15	44%
FP 5	24	3	9%
FP 6	39	10	29%
FP 7	62	17	50%

Soil disturbance that is part of the floodplain alternatives would have a significant direct effect on vernal pool life. The highly organic soils in the pools are an important component of vernal pool ecology (e.g., by providing a medium that supports the food chain, affecting permeability so as to keep the pools from drying out too soon, and facilitating groundwater flow in groundwater-influenced vernal pools). The surface soils and leaf litter at the ground surface in the surrounding woodlands are critically important as well, since many vernal pool amphibians and reptiles use these surrounding areas as forage, cover, aestivation, and/or hibernation habitat. If the soils are removed, compacted, or otherwise disrupted by heavy machinery, direct mortalities to vernal pool animals are probable throughout most of the year, but at a minimum, important elements of the life cycle will be disrupted for an undetermined length of time. This would result in either long-term or permanent cessation of breeding. Thus, the potential for immediate mortality of individuals or long-term disruption to life cycles is substantial for a variety of species.

Tree clearing within and adjacent to the vernal pools will also produce substantial direct adverse effects, as these mature trees provide vital shade which helps control surface water, soil, and air temperatures, evaporative losses, and additionally provide a significant yearly infusion of biomass – fallen leaves – which make up a significant component of the bottom sediments within the pools and surface litter and coarse woody debris along the edges of the pools, all of which provide critical habitat cover from predators.

As shown in Table GC10-17, alternatives FP 3, FP 4, and FP 7 would have the most severe direct impacts on vernal pools, followed by FP 6, and then FP 5.

Secondary Effects

All the of the floodplain alternatives involving removal would have indirect effects on vernal pools through removal of vegetation in key forested areas surrounding and nearby the pools. These impacts would arise from the following:

- *Vegetation cutting:* Cutting of trees and shrubs in floodplain areas in the vicinity (i.e., within about 200-300 meters) of the vernal pools would be needed both for remediation in those areas and for the construction of access roads and staging areas and the installation of sedimentation and erosion controls. Much of this impact will occur to portions of the floodplain which are currently undisturbed, intact mature forest. This cutting within about 200-300 meters of vernal pools would impact the vernal pools by removing forested areas that provide critical habitat for many vernal pool amphibians for the majority of their life cycle after they leave the pools. Other species reliant upon vernal pools in an intact forest riparian corridor would also be negatively impacted. Such cutting would negatively impact the wide-ranging wood turtles that forage and hibernate in vernal pools, star-nosed moles that burrow and forage along moist edges, and migratory songbirds like the northern and Louisiana waterthrushes that forage along the pool edges under forest cover during both breeding and migratory seasons.

Diverse biological communities flourish or at least exist at sustainable levels in vernal pools throughout the PSA under current conditions. Vernal pool amphibians are much more sedentary throughout their life cycle than migratory birds, but each benefits from having intact naturalistic corridors within their daily, seasonal or lifetime home ranges. When landscape connectivity is lost or degraded, as would occur in connection with the vegetation cutting required in connection with the implementation of floodplain removal alternatives FP 3 through FP 7, then populations of species that require these features are either reduced in number or subjected to increased isolation from other populations, thereby increasing the risk of local extinctions.

- *Root zone removal (grubbing):* Grubbing of tree stumps and roots in floodplain areas near the vernal pools would be needed for the same purposes as described above. This would impact the vernal pools by interfering with surface and groundwater inputs, changing shade regimes, and altering buffer conditions around the pools where amphibians typically find cover immediately after exiting or before entering the vernal pools.

- *Access road construction:* Temporary access roads would need to be constructed in areas near vernal pools. These access roads would affect nearby vernal pools by eliminating overstory trees, fragmenting dispersal routes in and out of the pools, and creating unsuitable "attractant" habitats (e.g., flooded tire tracks used by breeding amphibians, unsuitable egg-laying areas for turtles).

- *Truck and excavation equipment traffic:* Construction traffic on the access roads and in remediation areas would produce air quality and noise impacts, which would likely disrupt vernal pool animals in their terrestrial stages. The volume of traffic over extended periods of time would result in mortality of slow-moving reptiles and amphibians.

All of the floodplain removal alternatives would involve the negative effects described above. Although FP 2 would not involve any remedial work in vernal pools, it would indirectly affect 14 vernal pools due to the close proximity of access roads and staging areas. Under FP 5, in addition to the 22 vernal pools that would be directly affected by remediation, 40 additional vernal pools would be affected due to the close proximity of access roads and staging areas. Alternatives FP 3, FP 4, FP 6, and FP 7 would not only directly affect 60, 60, 42, and 62 vernal pools, respectively, but would also cause substantial disturbance to nearby areas due to construction of access roads and staging areas. Moreover, each of the floodplain alternatives would involve floodplain soil removal activities within 300 meters of the majority of all the vernal pools in the PSA – including 42 pools for FP 2, 59 for FP 3, 64 for FP 4, 61 for FP 5, all 68 for FP 6, and 67 for FP 7.

Summary and Assessment of Potential Measures to Avoid or Minimize Effects

As shown above, all the floodplain removal alternatives, especially FP 3 through FP 7, would cause adverse effects within or near vernal pools, thus affecting the vernal pool animals.

While EPA suggests (e.g., Specific Comment 105) that measures could be taken during implementation of these alternatives to avoid or minimize impacts on vernal pools (e.g., limiting work to periods after the amphibians have left the pools for the season, siting staging areas and access roads away from vernal pools when feasible), these measures would not prevent substantial adverse effects on the vernal pools, as described below. In fact, there are no times during the year when vernal pool species are not using the pools or their surrounding buffer areas.

Working in the pools when the amphibians have left the pools for the season would avoid one set of impacts (i.e., to the breeding and larval stages), but would simply displace impacts to the terrestrial life stage of the vernal pool amphibians, as many vernal pool species spend a substantial portion of their annual life cycle in the surrounding woodlands. Even if the remediation work were to occur during the low-flow season, and after the spring breeding and migration period, this would not avoid direct mortalities to vernal pool animals that are occupying the surrounding terrestrial environments (e.g., the leaf litter and shallow root zone). These are slow-moving organisms that are especially vulnerable to ground disturbance. Further, the impacts of remediation in a given pool would last multiple years beyond the season in which that remediation takes place, thereby adversely affecting the breeding potential of the local population. Because vernal pool amphibians have strong site fidelities, they will unsuccessfully attempt to return to the disturbed vernal pool via routes rendered unsuitable by removal activities.

While an effort could be made to site temporary staging areas and access roads away from vernal pools, this will not be possible in connection with most of the remedial alternatives because of the access required within or near the vernal pools. Additionally, many of the access road alignments for the floodplain alternatives are constrained by severe topography, the river itself, and logical connection points to existing public roads that would be integral to the construction process. In any event, realigning access road and staging areas would not prevent the impacts that would unavoidably occur from soil removal, recontouring, and replacing appropriate substrate within and near the vernal pools targeted for remediation.

3. Key Constraints in Restoration

For those vernal pools that would be unavoidably impacted by the remediation, there are a number of constraints on the ability to restore those pools to their current function. Approaches involving individual pool restoration – which represents the bulk of vernal pool restoration conducted in the Northeastern U.S. to date – do not address the issues of replacing clusters of ponds in mature forests such as occur in the PSA, and the implications of interrupting or obstructing genetic flow among subpopulations of vernal pool animals. Specific constraints to successfully restoring the vernal pools in the PSA include the following (many of which are similar to the constraints discussed for forested and shrub/emergent wetlands in Sections III.C.3 and III.D.3 above):

Inadequate Hydrology and Water Chemistry. Since the vernal pools in the PSA are located within the lower portion of Housatonic River floodplain (i.e., relatively near the river), they are highly susceptible to dynamic changes in surface water levels, groundwater hydrology, erosion, and deposition. Even with success in replicating pre-existing elevations, micro-topography, and contours of the vernal pools themselves, changes to the topography in the immediate vicinity of the vernal pool or of the overall floodplain upstream or downstream may alter specific flood flows that dictate whether a given pool fills with water at the appropriate time and to the proper levels, or does not fill at all. Vernal pool hydrology within the floodplain may be driven by overbank flooding of specific storm-events; or it may result from backwater flooding via braided channel networks; or it may be fed by groundwater. Sufficiently understanding and re-establishing these specific sources of hydrology and/or any combination of these hydrologic sources would be essential in any effort to restore vernal pools. But that would be extraordinarily difficult for the number of the vernal pools involved. Obtaining a firm enough understanding of the hydrologic inputs in each of the vernal pools to attempt hydrologic replication would require targeted surface and groundwater monitoring over multiple years, coupled with hydrologic modeling.

More importantly, the reconstruction process necessary to re-create the vernal pools does not, in any way, mimic the processes by which they are formed. Soil compaction, alteration of subtle hydrologic flow paths, and the loss of surrounding mature forest habitat make the likelihood of failure extremely high. If pools are too dry or dry too quickly, they would not allow for proper conditions for vernal pool animals to reproduce and metamorphosize, and reproductive failures increase the likelihood of local extinction. If pools are too wet, then there can be an increase in predatory species and predation on the more vulnerable life stages of the vernal pool animals. It is also important to note that water quantity and quality differ between natural and created wetlands due to varying evapotranspiration rates, a variable capillary fringe, organic and mineral soil components (Calhoun and deMaynadier, 2004; Campbell et al., 2002; Brooks et al., 2005).

Factors Affecting Reproductive Success. Approaches involving individual pool restoration do not address the issues of replacing clusters of ponds in mature forests, and the implications of interrupting or obstructing genetic flow among subpopulations, which is critical to reproductive success for meta-populations of vernal pool animal species. In addition, created pools often fail to replicate natural pool hydrology, and when they lure dispersing amphibians away from suitable breeding sites, they end up serving as biological or reproductive "sinks."

Impacts on Surrounding Habitat. Another key constraint on successful vernal pool restoration is the impact of the remediation on the forested habitat surrounding the pools. As discussed above, the floodplain removal alternatives call for clearing and removal of mature trees (many well over 100 years old) in forested floodplain areas surrounding vernal pools. The combination of direct and secondary impacts to forested floodplain from the FP alternatives ranges from 11 acres (FP 2) to 140 acres (FP 7). The trees in these forested floodplains provide critical canopy cover which helps to keep the understory air temperatures relatively cool and limits evaporative losses from the pools and soils of the forest floor. These lower air temperatures and moist soils can be vital in terms of keeping vernal pool amphibians from desiccating during the dry summer months. This shading also regulates temperatures of the surface water in the pools. It has been shown that water temperature can affect embryo development of vernal pool animals (Good, 2006; Werner and Glennemeier, 1999; Seale, 1982).

The accumulation of organic materials, such as twigs and branches that provide egg-laying substrates, would be altered. Loss of mature forest trees will represent an impact that may not allow for the successful usage of this habitat by terrestrial stages of vernal pool animals for up to 100 years or longer, even with successful vegetation development. The result may be complete elimination of the affected portion of the meta-population of these species of concern.

Loss of Connectivity to the Network. Similarly, the restoration of vernal pools would be strongly influenced by the extent to which the connectivity among the various vernal pools in the floodplain and between the vernal pools and important non-vernal pool habitat for the vernal pool species is adversely affected. Due to the significant habitat alteration called for over widespread areas of the floodplain under alternatives FP 3 through FP 7, it is likely that even if individual pools could be successfully restored, the connections among some number of vernal pools, and between vernal pools and other related habitats, would be degraded or lost entirely. Most wetland-dependent amphibians do not have the capability to disperse or migrate if corridors are obstructed or highly disturbed; therefore, habitat connectivity is key to the viability and sustainability of amphibian populations. Conservation strategies recommend forested core zone widths of 200-300 meters around ponds, with additional forested corridors into surrounding landscape. The amount of forest within 1 kilometer (km) is positively correlated with the presence and abundance of wood frogs and spotted salamanders (Homan et al., 2004; Herrmann et al., 2005; Egan and Paton, 2008; Semlitsch and Bodie, 1998). Movements of animals as they leave vernal pools are non-random, proceeding in a specific direction, avoiding non-forest habitats, so pool location within the surrounding landscape is critical (deMaynadier and Hunter, 1999).

Soil Composition and Chemistry. Given the significant amount of surface soil excavation and removal that would be required in the vernal pools and surrounding floodplain and the fact that the removed soils cannot be stockpiled and reused due to their PCB concentrations, it is assumed that a substantial amount of off-site soil inputs would be needed in order to attempt to match the pre-existing grades and soil profile, particularly under the alternatives that involve a large amount of soil removal within and near (i.e., within 200-300 meters of) vernal pools. The availability of a source of such suitable replacement soils is another important factor governing the potential restoration success. In this case, as with the forested and shrub/emergent wetlands discussed above, it would be very difficult, if feasible at all, to find sufficient volumes of comparable soils from off-site sources, as the soil chemistry and seed bank of the on-site soils are unique to the existing Housatonic floodplain system (see Sections III.C.3 and III.D.3 above). In addition, the surface structure of leaves and twigs on the pool bottoms would be extremely difficult to replicate, since this process occurs naturally under a forest canopy.

Soil Stratigraphy. The restoration would also be affected by the use of heavy equipment in the remediation and restoration, which would result in a long-term impact to soils in the form of compaction, as previously discussed in connection with forested and shrub/emergent wetlands. This could have a particularly serious effect on the formation of the necessary subterranean burrows required by certain vernal pool animals for overwintering (Montieth and Paton, 2006). In addition to compaction, final graded soils could subside more than expected, affecting water levels in the restored pool in a fashion that limits successful use by breeding amphibians.

Proliferation of Invasive Plant Species. An additional serious constraint on the ability to successfully restore vernal pools is the very real risk of introduction and/or spread of invasive herbaceous species as a result of disturbances. As discussed above under forested wetlands, disturbances to these forested areas represent a prime opportunity for expansion of the extent of invasive species, as removing a mature, forested system creates primary successional conditions, and it is under these conditions that aggressive invasive species readily take hold. This could undermine the overall success of vernal pool restoration activities, as the plant community within and near the vernal pools is critical to that habitat.

Proliferation of New Predatory Animal Species. Finally, the success of vernal pool restoration could be threatened by the introduction of invasive animal species due to changes in habitat resulting from the remediation. Non-native amphibian species could invade and prey on native species. Important predators (e.g., bullfrogs) may be introduced to individual vernal pools where they did not previously exist, and these predators could affect the success of the restoration efforts.

In short, due to the constraints discussed above, once a combination of vernal pools and the surrounding area in the PSA has been disturbed by remediation on the scale required by FP 3 through FP 7, it is highly unlikely that these pools could recover to their current functional states.

4. Restoration Methods

As discussed above, there are many significant constraints on the ability to restore vernal pools to their current function. Keeping those constraints in mind, this section outlines the methods that would be used to restore vernal pools, where such restoration is at least theoretically possible.

Data Collection

The first step in a restoration effort would be to collect data on the existing conditions and functions of a vernal pool or vernal pool network. Data collection would include a baseline functional assessment, which would include the size and geographical extent of the pool(s), resident plant and animal species, source of hydrology, typical annual water levels and duration of wetness, relationship to other vernal pools in the network, usage of adjacent habitats (including predominant migratory patterns) by vernal pool animals, and composition of the predator community. In addition, as micro-topography and elevations within a given depression can be the most important factor influencing requisite vernal pool water levels, a detailed pre-construction topographic survey is critical to the restoration of a vernal pool.

Planning and Design

Following baseline data collection, a planning phase would be required in order to conceptualize the actual execution of restoration construction. The major element of this phase of restoration would be preparation of design plans as details of the design are assessed and modified. The design drawings would likely include specifications on the same parameters described for forested wetlands in Section III.C.4. Other important elements of the planning and design stage would include identifying proper construction equipment and qualified contractors, and developing appropriate performance standards.

<u>Construction</u>

The major elements of the construction phase of restoration would include the following steps after the required excavation of soils:

1. Replace excavated soil with similar clean mineral soil to a depth of four to six inches below original grade. Grade should be consistent with original surveyed topography throughout the restoration area so that hydrology can be matched.

2. Place four to six inches of clean, un-compacted topsoil (containing 9 to 21% organic matter) evenly across the bottom of the pool.

3. Seed the area with a native wetland seed mix to stabilize the soil and compete with invasive species.

4. Plant around the edges of the restored vernal pool with suitable native trees and shrubs to provide structure and shade for the pool.

5. Add a suitable amount of downed coarse woody debris in the pool and around its periphery to provide for cover habitat and egg mass attachment sites.

Other construction considerations include determining the appropriate timing and sequencing of the restoration activities. As discussed above (Section III.E.2), while the construction phase of restoration could be timed to avoid the period encompassing immigration and emigration of adults to and from the pools, breeding, larval development, metamorphosis, and emigration of metamorph from the pool, such timing would not avoid substantial adverse effects on the vernal pool species. This is true both because of the impacts on the surrounding terrestrial environments and because the impacts of remediation in a given pool would last beyond the season in which that remediation takes place.

In addition, since vernal pool animals spend the majority of their annual life cycle beyond the actual pool, protection and restoration of the surrounding terrestrial habitat are as important as restoration of the pool itself. However, as also discussed above, given the need for an extensive network of construction access roads and staging areas in order to execute various of the remedial alternatives, significant short-term and long-term impacts to these surrounding areas would occur.

<u>Monitoring</u>

Following the construction phase of restoration, a monitoring program would be established, typically for a period of 5 years after restoration. The details of this program would be determined during design, but would likely include annual or semi-annual inspections of the replanted vegetation during the growing season, as well as annual inspections of the vernal pools in the spring during that 5-year period, with photographs of the restored vernal pools and surrounding areas. Mid-course corrections or "adaptive management" during this period may also be triggered under this program.

5. Likelihood of Success in Restoration

Given the magnitude of the vernal pool restoration program that would be required under most of the floodplain alternatives, and the unique characteristics of the PSA, successful restoration of the suite of affected vernal pools is highly unlikely. As discussed in Section III.E.3 above, the factors that are likely impossible to adequately address at this scale include: (1) achieving and maintaining adequate hydrology and finish grades; (2) the long-term temporal loss of mature forested habitat near the vernal pools; (3) loss of connectivity among pools, or to other critically related habitats used by the vernal pool animals; (4) obtaining a sufficiently similar and ample source of suitable soil for backfill and topsoil; (5) soil subsidence and compaction; (6) potential proliferation of invasive plant species; and (7) potential proliferation of new predatory animal species.

These difficulties are exacerbated in the case of the alternatives that would affect substantial portions of the vernal pools in the PSA and/or nearby areas – i.e., FP 3 through FP 7. The science of vernal pool habitat creation is fairly new, and there is no literature reporting the long-term success of restoration of vernal pools of the sort and scale that would be involved in implementation of these alternatives. Under alternatives involving such widespread disturbance, the factors discussed above – most notably: (1) the significant loss of extensive acreages of mature floodplain trees in the vicinity of the vernal pools; (2) the difficulty of replicating a combination of hydrologic inputs at discrete locations within a large, dynamic, high-energy floodplain; and (3) the difficulty of obtaining a comparable, clean source of topsoil to mimic shallow root zone conditions of excavated areas – present significant challenges and constraints that make restoration success at this site highly unlikely. Further, due to the extensive temporal loss of surrounding habitat (i.e., mature forest), it is likely that system equilibrium – consistent with what currently exists – could take upwards of 100 years or more to achieve, if it is possible at all. We have found no precedent in the Northeast for a vernal pool restoration project that would involve the number and acreage of vernal pools and critically related habitat areas, or the proportion of a site's overall vernal pool habitat, that would be involved under the more intrusive alternatives. The track record of vernal pool restoration/creation efforts in the Northeast is limited, and generally pertains to small, isolated depressions that offer no meaningful analogy to the alternatives involved here.

The sequencing of vernal pool restoration over a number of years would not avoid these problems. Even if all the factors that would be necessary to replicate the conditions in a given vernal pool came together to allow replication of that pool itself, that would not be sufficient for certain animal species that used the pool prior to construction if the connectivity between that pool and other pools, vital terrestrial habitats, or the river is lost. Moreover, apart from the condition of individual pools, there would be a loss of extensive acreages of mature floodplain forests around the vernal pools, which are necessary for the vernal pool species during the majority of their lives that they spend outside the pools and which would, even if restoration were successful, require upwards of 100 years or more to resemble current conditions. Further, the prospect of extensive invasive species colonization (by both plant and animal species) is by itself an issue which places the potential for successful vernal pool restoration at a low level under these floodplain alternatives.

In short, despite the implementation of the most up-to-date and rigorous restoration methods, it is likely, given the many constraints and challenges described above, that many of the affected vernal pools would not return to their current level of function for a long time, and may never do so.

F. Conclusions

While the foregoing sections have separately discussed five general habitat types in the Rest of River, it is critical to remember, in assessing both the impacts of the remedial alternatives and the likelihood of successful restoration, that these habitats do not exist in isolation. Rather, they are fundamentally interrelated and interdependent and together make up the sensitive river/floodplain ecosystem in the PSA. As such, the constraints on restoration for a given habitat type affect not only that habitat type, but others as well. For example, as discussed in Section III.A above, the success of in-stream river restoration would be significantly affected by any stabilization actions taken on the banks, as well as by remediation activities and construction of access roads and staging area in the floodplain. Similarly, the ability to restore forested wetlands would be affected by the impacts on adjacent and nearby shrub/emergent wetlands, and vice versa. For example, changes in hydrology induced by excavating and remediating a shrub/emergent wetland may affect adjacent forest wetlands. Further, as discussed in Section III.E, vernal pools, and their ability to be restored, would be vitally affected by changes in the surrounding forested floodplain habitat. Even impoundments, which would be less affected by impacts in the floodplain than the other habitat types, would be directly affected by changes in the upstream riverine environment.

In these circumstances, the numerous constraints on restoration of the various habitat types will have a cumulative effect on the ability to successfully restore the overall ecosystem following the disruptions caused by the remedial alternatives. We have found no precedent for the type of overall ecological restoration project that would be necessary under the more intrusive remedial alternatives – i.e., SED 3 through SED 8 and FP 3 through FP 7. Given (1) the extensive adverse impacts to the various habitats resulting from those alternatives, (2) the unique characteristics of the river/floodplain system in the PSA, and (3) the numerous above-discussed constraints on the restoration of the affected habitat types, individually and together, there is virtually no likelihood that, following implementation of any combination of those alternatives, the overall affected ecosystem of the PSA could be returned to its current condition and level of function.

IV. Process for Determining Performance Standards

The last prong of EPA's General Comment 10 states that GE should describe "[t]he process by which performance standards shall be established with stakeholder input to assess the success of the restoration." As defined by SERI (2005), a performance standard (also called a design criterion or success criterion) is a specific state of ecosystem recovery that indicates or demonstrates that an objective has been attained. SERI gives the following examples:

> "For example, if the objective is to reestablish tree cover with a particular species composition and abundance on former cropland . . . and an intervention to realize that objective is to plant tree saplings of particular species at specified densities . . . , then a plausible performance standard would be the establishment of a young forest that contained certain species of trees with minimal thresholds for tree species density, tree height, and collective canopy closure within a specified timeframe. Another potential example of performance standards would be the attainment of a threshold percentage of herbaceous vegetative cover in a seeded area within a given timeframe." (SERI 2005, p. 12)

SERI notes further that monitoring protocols should be geared specifically to performance standards. When a monitoring protocol is selected, a procedure for the analysis of monitoring data should be specified.

In response to EPA's comment, this section discusses the process for determining performance standards for restoration of habitats affected by the Rest of River remediation, keeping in mind, as discussed above, that under the more intrusive remedial alternatives evaluated in the CMS, full restoration of the affected habitats to their current condition and level of function would not be feasible.

A. Development of Draft Performance Standards

The initial step in the process of determining performance standards for restoration of affected habitats would be to develop a draft set of performance standards. This step would involve a number of important considerations, as described below.

First, it will be necessary to determine the type of performance standards to be established – i.e., general goals versus specific measurable criteria. General goals might include, for example, such objectives as no net loss of function for wetlands, no significant erosion on riverbanks, maintenance of overall flood storage capacity, preservation of viable habitat for state-listed rare species (if feasible), etc. Specific measurable criteria could include criteria such as survival of planted trees and shrubs, areal cover by native herbaceous species, cover by invasive species, percent of riverbank without active erosion, percent of an area covered by a particular type of wetland, criteria based on hydrologic parameters (e.g., hydroperiod, mean water level, water table fluctuations), depth and percent organic matter of topsoil, pool-riffle ratio, fraction of specified substrate types or embeddedness of rocks, amount of coarse woody debris per riverbank length or wetland acre, etc.

Second, it is important that performance standards be expressed in terms of measurable or observable parameters that are amenable to being designed, controlled, and managed, which are generally structurally based parameters. As discussed in Section I.C of this response, such structurally based parameters, which are usually the result of physical processes, are related to and give rise to the ecological functions of the relevant habitats; but they are less variable and more reliably measured than most functions themselves and are more amenable to being designed, controlled, and managed as part of a restoration program (although in some instances, as discussed in Section III, even these parameters cannot in fact be controlled or managed). Thus, such parameters should serve as the basis for the performance standards.

Third, performance standards must be realistic. As discussed in Section III of this response, under the more intrusive remedial alternatives in the CMS, reestablishment of existing conditions and functions for many of the affected habitats is unlikely to occur or would take many decades, if it would occur at all. This needs to be recognized in setting performance standards so as to avoid setting standards that are unlikely to be achieved and so that the standards that are set take into account the constraints involved for each habitat type. For example, standards for tree restoration should not call for the establishment of canopy species in riverbank areas where, due to stabilization techniques, such trees could not be planted, and should in other areas reflect the fact that the newly planted trees cannot be expected to resemble the removed mature trees for many decades. As another example, where restoration of a network of currently viable vernal pools, such as those supporting the state-listed Jefferson salamander, is unlikely to result in the re-establishment of the breeding population of that species, a performance standard based on re-establishment of that population should not be set, as achievement of that standard would be expect to fail. Setting unrealistic performance standards in the face of assessments indicating a high probability of failure is not a rational approach.

Fourth, consideration would also be given to use of models in setting performance standards. For example, performance standards could potentially be based on the HGM approach or the HSI approach described in Section I.B of this response, utilizing either the measurements of site variables that are prescribed in those models or the model results themselves.

Fifth, it will be necessary to consider the most appropriate methods for assessing achievement of the performance standards. This will depend on how the standards are expressed. For certain pre-established numerical standards, achievement would be assessed simply by comparison of measured parameters to those standards. This would include standards such as, for example, 80% survival of trees, 95% coverage by herbaceous species outside the foliar coverage of trees, less than 5% coverage by invasive species, and the like. Another potential means of assessing achievement of performance standards (which would be necessary with the use of models) would be to compare measured parameters in the restored areas to a reference condition. The reference condition could include either the pre-remediation conditions of the affected areas themselves or contemporaneous (post-remediation) conditions in similar unaffected areas in the same region (reference areas), or both. Both of these approaches would involve some problems, since: (a) comparisons to pre-remediation conditions would not take account of regional watershed changes that may result in differences between pre- and post-remediation conditions that have nothing to do with the remediation or restoration; and (b) suitably similar unaffected resource areas to serve as reference areas may be difficult or impossible to find. Further, if an appropriate reference condition can be established or found, it will be necessary to consider the most appropriate technique to make the comparisons. Such techniques could range from simple numerical comparisons to complex statistical methods.

Sixth, as part of developing performance standards for any restoration scenario, a monitoring program will be developed to measure the parameters that form the basis for that standard. Monitoring will be needed to assess the status and progress of the restoration areas in achieving performance standards, and also to identify corrective actions warranted to maintain recovery on the proper trajectory. Monitoring will be conducted on each of the community types subject to restoration activities, with data obtained on specific variables pertinent to each community type as established in the performance standards (see, e.g., the above examples of specific measurable goals). In the event that the performance standards involve comparisons to pre-remediation conditions and/or agreed-upon reference areas, the monitoring program will also need to include the collection of data on the pre-remediation conditions or in the reference areas. Appropriate sampling procedures will be developed for each variable, and applicable statistical tests will be employed, if necessary, to conduct comparisons between monitoring results and the selected standards or reference conditions. Depending upon the assessment procedure selected, monitoring may focus on specific variables used in the assessment; for example, HGM models will require specific variables to be measured and then assessed in model equations in comparison to reference areas or pre-remediation conditions.

Seventh, time frames will be established both for monitoring and for assessing achievement of the performance standards. Time frames could be specific (e.g., 5 years), or could be tied to the achievement of a specific performance standard (e.g., 80% cover of native plant species) or group of standards, or could be a combination of these options. Certain standards may have short-term targets or benchmarks with a more intense level of monitoring, followed by longer-term monitoring at reduced intensity provided short-term goals are met. Where appropriate, goals may be based upon establishing a trajectory to success over a multi-year period, with monitoring frequency adjusted over that period provided the rate of trajectory is being met.

Finally, in addition to a monitoring program, a plan will be developed that will outline the nature and timing of specific management or corrective actions to be taken depending on the results of environmental monitoring. This plan may be an adaptive management plan. Adaptive management is an approach for coping with the complexity of natural resource management through the application of site-specific information in an iterative process of monitoring and response. Under this approach, response measures are taken (if needed) based upon the results of monitoring to react to undesirable results, the response measures are then also monitored to obtain feedback, and an iterative approach develops in the process of achieving project restoration goals. This approach allows for mid-course corrections to respond to monitoring results and other factors that affect the trajectory toward achieving performance standards. Adaptive management also includes provisions for adjustment or revision of the performance standards themselves if the monitoring data indicate that the standards initially established will not be achieved regardless of the actions taken.

B. Process for Finalizing Performance Standards

In the development of draft performance standards, methods of achieving those standards, and the associated plans discussed above, GE would consult and coordinate with EPA and the pertinent state agencies. A complete draft of performance standards would then be developed, and input from other stakeholders would be obtained through soliciting their comments on the draft performance standards. The performance standards would then be revised based upon the stakeholder input, and the standards would be finalized through the process of GE's submission and EPA approval of a document setting forth those standards and associated plans.

General Comment 11 (Page 3): *GE shall revisit the operation, maintenance, and monitoring (OMM) described in the CMS for restoration and provide a more thorough description of the approach to OMM for restoration and costs including expanding the duration to a minimum of 5 years of active monitoring (these may or may not be sequential), dependent on the required restoration activities that are implemented for a given alternative. Use of the five-year period in the in the evaluation is for cost estimate purposes only; EPA's selected remedy will not necessarily require or limit these activities to this time period.*

GE Response: GE has reevaluated the elements of the operation, maintenance, and monitoring (OMM) programs for restoration. In doing so, GE has considered the OMM requirements specified in the *Removal Action Work Plan - Upper ½-Mile Reach Housatonic River* (BBL, 1999), the *Interim Post-Removal Site Control Plan for the 1½-Mile Removal Reach* (Weston Solutions, 2008), and the *Final Completion Report for Removal Action for Housatonic River Floodplain – Current Residential Properties Adjacent to 1½-Mile Reach* (ARCADIS, 2008a); those on which GE and EPA have agreed for inclusion in the *Final Completion Report for Removal Action for Housatonic River Floodplain – Non-Residential Properties*; and those described in Section III of the Response to General Comment 10, which discusses restoration methods for the various types of affected habitats. Based on review of this information, GE anticipates that the OMM program for restoration would include the following components for a five-year period after completion of installation of the restoration measures:

- Periodic inspections of restored riverbanks and floodplain areas to assess: (a) the effectiveness of erosion controls in areas where vegetation is not yet established; (b) any areas where excessive settlement has occurred relative to the surrounding areas; (c) any drainage problems; (d) any areas of erosion; and (e) other conditions that could jeopardize the performance of the completed restoration actions (e.g., burrows, vehicle ruts);

- Periodic inspections of areas of re-planted trees, shrubs, and herbaceous vegetation on both riverbanks and affected floodplain areas to assess planting survival rates, extent of herbaceous cover, and presence and extent of any invasive species – likely on a semi-annual basis for that five-year period, with a qualitative assessment in the spring and a quantitative assessment in designated monitoring plots in the summer to evaluate the achievement of various specific performance standards;

- Annual inspections of restored aquatic habitat within the river to assess the components of that restoration – e.g., substrate features and any habitat restoration structures installed, such as boulders or weirs;

- Annual spring inspections of restored vernal pools to assess and document the conditions of the vernal pools, as well as semi-annual inspections of the replanted vegetation in and around the vernal pools (see second bullet above);

- Periodic inspections of other restored wetlands to assess pertinent hydrologic features as necessary;

- If appropriate, further evaluation to assess the causes or extent of any problematic conditions noted during the above inspections; and

- Performance of maintenance, repair, and other corrective actions as necessary to address any physical deficiencies noted during the above inspections – e.g., repair of riverbank stabilization measures or placement of additional bank stabilization measures; placement of additional topsoil in areas of erosion or settlement; additional planting, seeding, and/or fertilization (if necessary) to replace dead, dying, or sparse vegetation; removal or control of invasive species over a specified percentage; removal of other vegetation that is adversely affecting the survival of the vegetation planted; replacement or repair of in-river habitat restoration structures; and other actions identified in the applicable restoration plans as appropriate for correcting structural conditions that are not meeting or are not on a trajectory to meet applicable performance standards. See Section IV of Response to General Comment 10.

For purposes of the cost estimates provided in this Interim Response, it has been assumed that, for both the sediment and floodplain alternatives, restoration OMM activities would be conducted for five consecutive years after completion of the remediation/restoration activities in a given area. While it is difficult to make a reliable estimate of the costs of the particular OMM activities identified above prior to the development and EPA review of a detailed restoration and OMM plan, a rough general estimate has been made for each sediment and floodplain alternative for purposes of this response. Those revised estimated costs for implementation of the restoration OMM program for 5 years have been included in the overall revised costs for the sediment and floodplain remedial alternatives presented in Appendix D.

General Comment 12 (Page 4): *EPA believes that the CMS does not address General Condition 5 of the April 13, 2007 Conditional Approval of the CMS-P, which directed GE as follows: "[f]or each alternative being considered in the CMS evaluation, GE shall include operation, maintenance, and monitoring requirements commensurate with the alternative being considered in the CMS evaluation." GE shall provide a discussion of the types of maintenance or corrective actions that could be required for each alternative (including river banks and large woody debris that may adversely impact remedy performance), and a plan for OMM to insure the ongoing performance of any remediation, particularly following large storm events. In addition, GE shall revise the costs of OMM to 100 years for the purpose of the CMS. Use of the 100-year period in the evaluation is for cost estimate purposes only; EPA's selected remedy will not necessarily require or limit these activities to this 100-year period but this will simply provide a more realistic expectation and costs associated with implementing OMM for alternatives such as those considered in the CMS.*

GE Response: GE has developed a set of assumed requirements for a long-term post-remediation OMM program (in addition to the restoration OMM program described in the prior response) for each sediment alternative (other than SED 1) and also for TD 2 and TD 3. No long-term post-remediation OMM program, other than the restoration OMM program described above, has been developed for the floodplain alternatives or TD 4 and TD 5.

The assumed long-term OMM programs that were developed for the sediment alternatives were initially presented in the CMS Report (Sections 4.3.1, 4.4.1, 4.5.1, 4.6.1, 4.7.1, and 4.8.1). In response to EPA's comment, these programs have been revised to extend the duration of the monitoring activities to a period of 100 years for cost estimating purposes and to provide additional details regarding program components. The revised OMM components are summarized in Table GC12-1.

Maintenance activities for the sediment alternatives are intended to promote the ongoing performance of the implemented remedy and would be undertaken as necessary based on the results of the monitoring activities presented in Table GC12-1. As indicated in the CMS Report subsections on Technical Component Replacement Requirements, technologies included in the sediment alternatives "were selected for application in the River where site conditions are expected to support long-term reliability with minimal maintenance requirements" (pp. 4-42, 4-76, 4-109, 4-142, and 4-177). However, if maintenance activities are necessary, these activities could include removal of large woody debris from the River and banks, repair of the armor layer of the cap, repair of the bank stabilization materials, etc. In addition, details on potential maintenance activities for the restoration components are provided in the Response to General Comment 11. It is anticipated that OMM activities (as presented in Table GC12-1) would also be performed following a significant storm event.

The assumed OMM programs for TD 2 and TD 3 were initially presented in the CMS Report (Sections 7.2.1 and 7.3.1). These programs have likewise been revised to extend the duration of the monitoring activities to a period of 100 years for cost estimating purposes. Specifically, the monitoring components for TD 2 would be implemented following closure of the CDF(s), and are assumed to include long-term groundwater monitoring (five locations assumed per CDF) and visual inspections of the facility components and access restrictions (e.g., fences). The monitoring components for TD 3 would be implemented for the Upland Disposal Facility, and are assumed to include groundwater monitoring (10 locations) and inspection activities focusing on the cover system and other associated components (e.g., surface water drainage system, leachate management system, fences, and warning signs). For purposes of the cost estimates provided in this Interim Response, it has been assumed that the long-term groundwater monitoring would be conducted twice annually in Years 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 50, 75, and 100, and that the visual inspections would be conducted twice annually in the first five of those years and annually in each of the remaining listed years.

Maintenance activities for TD 2 and TD 3 would be performed to promote the reliability and effectiveness of these alternatives, and would be conducted as necessary based on the results of the monitoring activities described above. Maintenance activities for TD 2 could include the following activities: periodic repairs to the CDF berms and cover; re-seeding or maintenance of vegetation in cover areas; and maintenance and repair of the fences and signs. Maintenance activities for TD 3 could include the following activities: periodic repairs to the Upland Disposal Facility cap; cleaning and repair of the stormwater conveyance and collection system; re-seeding of cover areas; maintenance of vegetation along the perimeter of the facility; mowing; maintenance and repair of the fences and signs; and routine leachate treatment/disposal.

As indicated above, it is assumed that there will be no need for a long-term post-remediation OMM program associated with the floodplain alternatives, apart from the restoration OMM program described in the Response to General Comment 11.

The revised estimated costs for implementation of the above-described 100-year post-remediation OMM programs for SED 2 through SED 8 and for TD 2 and TD 3 have been included in the revised estimated costs for those remedial alternatives, presented in Appendix D.

General Comment 13 (Page 4): *EPA believes GE has placed too much weight on its analysis of "significant incremental reduction" in its CMS Report. "Significant incremental reduction" is not one of the Selection Decision Factors. While the descriptions of incremental reductions may be accurate (with the exception noted in Comment 18), such an argument is not appropriate for providing a discussion of reductions in residual risks (a component of the Standard for Protection of Human Health and the Environment) or achieving IMPGs (a Selection Decision Factor). Moreover, as, for example with the sediment alternatives, the first two alternatives evaluated included no sediment removal, the next alternative evaluated will necessarily have the greatest incremental reduction, regardless of whether it satisfies other evaluation criteria. As noted in the Recommendations provided by the NRC in the report Sediment Dredging at Superfund Megasites: Assessing the Effectiveness (2007), …"remedies should be designed to meet long-term risk-reduction goals (as opposed to metrics not strictly related to risk, such as mass removal targets)." EPA notes that language is used in the CMS in the discussion of more advanced/costly remediation alternatives describing the positive aspects as "relatively small additional reductions," even when such incremental reductions are more successful in achieving IMPGs.*

In addition, particular arguments or themes asserted by GE throughout the CMS do not represent a balanced assessment of the General Standards and Selection Decision Factors. Examples include:

- *GE's assertion that quicker and smaller remedies are better.*
- *GE's assertion that longer remedies are more disruptive and more likely to encounter problems.*

- *GE's assertion that advective PCB loads and reductions in fish concentration are more important than attaining IMPGs or concentrations at which advisories can be modified to allow consumption of fish by humans[1].*

An objective comparison of metrics such as percent of area attaining IMPGs or risk levels would provide a more balanced assessment of the alternatives. Examples of additional metrics include but are not limited to: PCB mass exported (gross or net), reach-average residual PCB concentrations, concentrations in water and a comparison to the Ambient Water Quality Criteria (AWQC), time to reach particular IMPGs or relaxing of consumption advisories, as well as PCB mass removed/remaining. GE shall include a presentation of additional metrics including those listed above which are constructed in a way such that the performance of all alternatives can be compared directly by subreach and for CT.

GE Response: Attached is a series of tables summarizing and comparing numerous quantitative metrics presented throughout the CMS Report, including those mentioned by EPA in this comment, as well as certain additional metrics identified by EPA in other comments. These tables compare the metrics across all sediment and floodplain remedial alternatives evaluated and for all Massachusetts subreaches and Connecticut where applicable. Below is a brief description of the tables provided:

<u>*SED Alternatives*</u>

- Table GC13-1: Summary of removal volumes, areas, cost, and PCB load reductions under all SED alternatives.

- Table GC13-2: Summary of various reach-specific metrics for evaluating all sediment alternatives, including (a) remediation summary, (b) model-predicted endpoint PCB concentrations, (c) attainment of ambient water quality criteria at end of model projections, and (d) percent reduction in fish tissue PCB concentration at the end of model projections and PCB mass removed.

- Table GC13-3: Summary of adverse impacts on (a) habitat for all SED alternatives and (b) habitat of state-listed rare species for all SED alternatives.

- Table GC13-4: Attainment of sediment IMPGs for human direct contact, including the time to achieve

- Table GC13-5: Attainment of fish tissue IMPGs for human fish consumption, including the time to achieve

- Table GC13-6: Attainment of IMPGs for amphibians in backwater sediments, including the time to achieve

- Table GC13-7: Attainment of sediment IMPGs for benthic invertebrates, including the time to achieve

- Table GC13-8: Attainment of fish tissue IMPGs for fish protection and for consumption of fish by ecological receptors (piscivorous birds and threatened and endangered species), including the time to achieve

- Table GC13-9: Summary of percent of averaging areas attaining IMPGs for all sediment alternatives

- Table GC13-10: Adverse impacts of sediment remedial alternatives on workers and local communities

<u>*FP Alternatives*</u>

- Table GC13-11: Summary of removal volumes, areas, and costs for all FP alternatives.

- Table GC13-12: Summary of adverse impacts on (a) habitat for all FP alternatives and (b) state-listed rare species for all FP alternatives.

- Table GC13-13a: Attainment of floodplain soil IMPGs, based on Reasonable Maximum Exposure (RME) assumptions, for human direct contact

- Table GC13-13b: Attainment of floodplain soil IMPGs, based on Central Tendency Exposure (CTE) assumptions, for human direct contact.

- Table GC13-14: Attainment of floodplain soil IMPGs for agricultural products consumption

- Table GC13-15: Attainment of floodplain soil IMPGs for amphibians in vernal pools

- Table GC13-16: Attainment of floodplain soil IMPGs for omnivorous/carnivorous mammals

- Table GC13-17: Summary of exposure/averaging area acreage attaining IMPGs for all floodplain alternatives

- Table GC13-18: Adverse impacts of floodplain remedial alternatives on workers and local communities

The above-listed tables that summarize evaluations of the sediment alternatives reflect (where relevant) new model simulations of SED 6, SED 7, and SED 8 under the downstream model, which has been re-run since the CMS Report with an assumed remediation of more grid cells in Reaches 7B and 7C, as discussed in the Response to Specific Comment 44. The tables summarizing evaluations of the floodplain alternatives (other than Table GC13-18) reflect revisions to the removal volumes, exposure point concentrations (EPCs), and certain IMPG comparisons presented in the CMS Report due to changes made in response to EPA's Specific Comments 95, 98, 112, 113, and 115, as discussed in the responses to those comments. In addition, the cost estimates presented in these tables for both sediment and floodplain alternatives incorporate revisions made in response to EPA's comments on the cost estimates presented in the CMS Report.

It should be noted that above tables do not include an evaluation of the attainment of the IMPGs for insectivorous birds and piscivorous mammals, because the attainment of those IMPGs depends on both sediment and floodplain soil PCB concentrations, and thus cannot be evaluated independently for the sediment and floodplain alternatives. The achievement of the IMPGs for these receptor groups for all combinations of sediment and floodplain alternatives is discussed in the Response to General Comment 24.

It should also be noted that other EPA comments have also identified the need for comparisons of certain other specific metrics used in the CMS across remedial alternatives (e.g., General Comment 22 requesting a comparison of certain net risk reduction metrics). Responses to those comments refer back to the complete set of metrics provided here.

General Comment 14 (Page 5): *Specific Condition 48 in the April 13, 2007 Conditional Approval Letter for the CMS-P directed GE to recognize in the CMS that the vast majority of institutional controls are not effective for ecological exposures and may in some cases have limitations for humans. EPA was not able to locate such an acknowledgement in the text of the CMS. GE shall include a discussion of the effectiveness and limitations of institutional controls in minimizing ecological and human exposure to contaminants in the context of a Rest of River remedy. On Page 2-2, it is stated in the CMS text that "since human health may be protected through means other than achievement of the IMPGs (e.g., through biota consumption advisories), such other means have been considered in applying the standard." GE shall provide in the Supplement a discussion of how such other means were considered, the consideration if active measures are determined not to be practicable,* *based on the balancing of tradeoffs among alternatives, and the difficulties that can be associated with institutional controls (e.g. enforceability, reliability, and effectiveness) as discussed in EPA's Superfund Contaminated Sediment Remediation Guidance (EPA 2005) and OSWER Directive 9355.0-7FS-P, Institutional Controls: A Site Manger's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Correction Action Cleanups (EPA 2000).*

GE Response: GE recognizes that the use of institutional controls has limitations, especially in regard to ecological exposures. As indicated in EPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA, 2005b), "some people will disregard advisories despite best efforts to communicate risk, and advisories have no ability to reduce ecological exposures." Within the CMS Report, references to the use of institutional controls were made specifically in regard to providing human health protection, not ecological protection. EPA's guidance document notes that "institutional controls are frequently evaluated as part of sediment alternatives to prevent or reduce human exposure to contaminants" and that "institutional controls such as fish consumption advisories, fishing bans, ship draft/anchoring/wake controls, or structural maintenance requirements (e.g., dam or breakwater maintenance) are frequently a part of sediment alternatives, especially where contaminated sediment is left in place, or where remedial goals in fish tissue cannot be met for some time" (EPA, 2005b).

The Overall Protection of Human Health and the Environment criterion (as defined on page 2-2 of the CMS Report) includes an evaluation of how each alternative "would provide human health and environmental protection, taking into account EPA's Human Health and Ecological Risk Assessments." In evaluating the human health protection prong of this criterion, GE has considered not only a comparison of estimated PCB concentrations predicted to result from implementation of the alternatives to levels considered protective of human health, but also other components, such as institutional controls, that contribute to the protection of human health. Specifically, since none of the sediment alternatives is predicted to result in fish PCB levels that EPA considers protective for unrestricted human consumption, institutional controls in the form of continued fish consumption advisories were included in all sediment alternatives. In these cases, there is no alternative to the use of such institutional controls to provide human health protection. In addition, for the floodplain alternatives, since it would not be practical to remediate all properties to standards considered protective of all potential future uses (which would cause extensive unnecessary damage to the floodplain), institutional controls were included in all the alternatives to address reasonably anticipated future use, as discussed in the Response to General Comment 23.

As indicated in EPA's guidance document (EPA, 2005b), "where advisories or bans are relied upon to reduce human health risk for long periods, public education, and where applicable, enforcement by the appropriate agency, are critical." GE has assisted both Massachusetts and Connecticut in warning and educating the public about the biota consumption advisories along the Housatonic River. Since the early 1980s, signs have been posted along the River warning of the advisories. Beginning in 1994, GE has undertaken periodic inspections of the signs posted along the Massachusetts portion of the River and worked with EPA, MDEP, and/or the Massachusetts Department of Public Health (MDPH) to maintain and replace those signs as necessary. GE has also periodically provided fishing and hunting license sales agents in Berkshire County with cards that describe the PCB biota consumption advisory, for distribution to those obtaining licenses. In Connecticut, GE has cooperated with CDEP in publicizing the biota consumption advisories by preparing signs (in English and other languages), flyers, and pamphlets describing the advisories and providing them to CDEP for posting and distribution. Under all the sediment alternatives, GE would plan to work with the relevant state agencies in continuing such efforts to disseminate information about the advisories as appropriate.

General Comment 15 (Page 5): *The discussion of thin-layer capping (TLC) in the CMS is confusing and at times contradictory. EPA and the Army Corps of Engineers regard TLC as a form of enhanced monitored natural recovery, not a means of isolating contaminants, yet in a number of locations in the CMS reference is made to the stability of a thin-layer cap. On Page 1-13, the definition of thin-layer capping (TLC) is consistent with EPA's Superfund Contaminated Sediment Remediation Guidance (EPA 2005), OU1 Design Supplement Lower Fox River Operable Unit 1, Project I.D.: 07G017, GW Partners, Neenah, Wisconsin, November 2007) and the Fox River White Paper 6B (Palermo et al. 2002) in describing TLC as a means of enhancing natural recovery via sediment mixing and dilution. TLC is typically considered appropriate only for situations where comparatively low levels of contamination are present in a relatively thin layer at the sediment surface. In later sections of the CMS, however (e.g. pp. 4-31, 4-32, 4-36, 4-40), TLC is variously discussed in terms of controlling releases, remaining stable, and/or providing a cover layer over PCB-contaminated sediments. None of the latter functions are considered by EPA or the Army Corps of Engineers to be goals of TLC, but are factors to be considered in designing an engineered cap.*

In addition, there was no recognition in the CMS of the potential effects of deeper mixing processes such as storm events, boat traffic, or megafauna, the full magnitude of which may not be simulated in the hydrodynamic and sediment transport model. An evaluation of the data, along with engineering considerations, must be considered in concert with model *output in assessing the effectiveness of any alternative because of processes not fully represented in the model, as well as uncertainties both with the model and model inputs. EPA recognizes however, that the model simulations used in the CMS did include an extreme storm event to evaluate the performance of alternatives under storm conditions. However, conditions influencing deeper mixing processes may change in the future, with the influence of currently unquantifiable factors such as global warming. GE shall include a discussion and literature review of the effect of megafauna on both TLC and engineered cap integrity and the potential influences of other deeper mixing processes or climatic change on the alternatives.*

In addition, cap material is at times referred to as sand and at other times (specifically in the descriptions of the modeling simulations), is described as being similar to the underlying sediment, which is not sand in most of the ROR.

GE often cites Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA 2005) when discussing MNR and TLC. With reference to SED 3 and other alternatives involving MNR, GE cites that EPA has stated that MNR should "receive detailed consideration" where site conditions are conducive to such a remedy (EPA, 2005, p 4-3). GE fails to mention that EPA lists the site conditions in Table 4-2 of the guidance document where MNR should be considered. Of the nine conditions described as especially conducive to MNR, it is questionable whether the following five conditions apply to the areas in Reaches 5 through 8 (with the general exception of the flowing subreaches in Reach 7) for which MNR and/or TLC are proposed:

- *Sediment is resistant to resuspension*
- *Contaminant concentration in biota and in the biologically active zone of sediment are moving towards risk-based goals on their own*
- *Contaminants already biodegrade or transform to lower toxicity forms*
- *Contaminant concentrations are low and cover diffuse areas*
- *Contaminants have low ability to bioaccumulate.*

GE shall provide a discussion of its understanding of the appropriate use and function of TLC, particularly in reference to the Rest of River, and justify any differences between that understanding and the generally accepted definition and function of TLC as used by EPA and the Corps of Engineers and the applicability of TLC to the areas selected by GE in the SED alternatives. GE shall also include a discussion of the purpose and application of MNR in specific areas selected by GE in Reaches 5 through 8 as it relates to the issues described above.

GE Response: This comment calls for the following: (1) discussion of GE's understanding of thin-layer capping and application of that remedial technology to the areas where it would be applied in the sediment alternatives: (2) discussion of the effects of deeper mixing processes, such as storm events, boat traffic, and megafauna, on the integrity of thin-layer and engineered caps; and (3) discussion of the purpose and application of monitored natural recovery (MNR) in Reaches 5 through 8 in light of the conditions listed in EPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (Contaminated Sediment Guidance; EPA, 2005b) as conducive to MNR. Each of these items is discussed below. The ecological impacts of engineered caps and thin-layer capping are discussed in the Response to General Comment 10.

<u>Discussion of Thin-Layer Capping</u>

Consistent with EPA's Contaminated Sediment Guidance, the CMS Report (p. 1-13) recognizes that thin-layer capping is a means to accelerate natural recovery through placement of a layer of clean material over PCB-containing sediment. As described in that report, areas targeted for thin-layer capping under SED 3 through SED 7 were selected through evaluation of site-specific conditions, including areas with deeper water depths that are less prone to scour or impacts from high erosional forces and/or backwater areas that are depositional in nature and likewise not prone to erosion. For each alternative, the specific areas that would subject to thin-layer capping were identified in the CMS Proposal and approved by EPA. For each of these areas, in addition to the purposes described above, it is also important to consider the effect of the thin-layer cap on other parameters, including controlling releases from underlying sediments and providing stability, although those may not be the goals of thin-layer capping.

Modeling conducted for each of these alternatives indicated that thin-layer cap materials would remain largely intact, with limited portions of these areas experiencing erosion during the extreme event in Year 26 (CMS Report, pp. 4-40, 4-75, 4-107, 4-141, and 4-175). Since these clean materials would largely remain in place, they would assist in controlling releases from the riverbed and provide a thin cover of protection to aid in further reducing human and ecological exposures to the PCB-containing sediments. Future natural sedimentation (even assuming low rates) would further enhance the ability of the thin layer of material to provide long-term reductions in surficial PCB concentrations beyond what might be provided if mixing of the underlying sediments with the thin layer cap occurred. As indicated in the CMS Report (p. 4-39), "very thin layers of new clean material placed on the sediment bed can result in a dramatic reduction in the interaction of sediment-associated contaminants with the overlying water (Talbert et al., 2001)."

<u>Discussion of Deeper Mixing Processes</u>

As noted in EPA's comment, there are a number of processes that could cause deeper mixing in areas subject to thin-layer caps and to a lesser degree engineered caps. Storm events are simulated by the model, and their effect was discussed in detail for each alternative in the CMS Report.[10] With respect to boat traffic (which is not simulated by the model), potential effects would include turbulence generated in the water as a result of propeller wash that has the potential to cause scour of the sediment bed and thus of any cap or thin-layer cap. This potential for sediment bed scour from propeller wash depends on such factors as boat motor horsepower, size of propeller, water depth, etc. However, GE has not observed engine-propelled boat traffic of any significance in areas where thin-layer capping would be applied under any alternative. If these boats were used on the River, it is anticipated that this traffic would be within deeper water areas, thereby lessening the effects of propeller wash on the sediment bed. While disturbances could also result from boat anchors and canoes, these effects are anticipated to be localized and minimal in severity.

In response to EPA's comment, GE has also evaluated the potential impacts to the thin-layer or engineered caps from "megafauna." For present purposes, this evaluation has focused on common fish species observed in the Housatonic River, most notably carp

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[10] In response to EPA's comment, it is noted that, the potential influence of global climate change on the model's predictions regarding the effects of storm events on cap stability is anticipated to be small. Shifts in seasonal temperature and precipitation patterns associated with climate change would be expected to increase the magnitude and frequency of extreme events such as floods, droughts, and heat waves over the next century. However, simulations of the extreme event in Year 26 of the CMS model projections indicate that this large magnitude event would not have a significant impact on cap stability. Given the large floodplain that is inundated during extreme events, caps placed in the river would likely experience higher velocities and erosional forces during smaller events when the river is largely within banks (e.g., at bank-full flow). The model simulations conducted as part of the CMS include many flow events of these smaller magnitudes, and it is thus unlikely that an increased frequency of such events would result in significant changes in model results. Thus, increases in flood frequency would also not be expected to materially affect the comparative evaluations conducted based on the modeling. It should also be noted that the potential effect of global climate change on other aspects of the evaluations (e.g., impacts of the alternatives on the environment) has not been considered.

(bottom feeder) and largemouth bass (nest-builder). Both of these fish species are abundant, and reach large sizes in the Housatonic River, and may be expected to impact sediments more than other fish species that perform a similar function (e.g., bottom feeding by bullhead; nest-building by bluegill).

Common carp typically prefer "relatively shallow, warm, sluggish, and well-vegetated waters with mud or silt substrate," with "feeding and spawning activities over silty bottoms" (Edwards and Twomey, 1982). Carp feed by drawing bottom material into their mouths, including sediments, and then expel the mixture to sort through and preferentially select food items for consumption, which typically consists of algae and benthic invertebrates (Werner, 2004). Foraging depths of up to 3 cm in pond sediments have been reported (Ritvo et al., 2004). They also can destroy large stands of aquatic vegetation during feeding by physically uprooting plants (Smith, 1985). Carp do not nest-build (i.e., excavate a depression in sediment), but broad-cast spawn (Werner, 2004) in vegetated areas with water depths up to six feet (Becker, 1983). Carp are not expected to impact the engineered cap during these activities due to the presence of the armor stone that would be designed to withstand effects from biota/bioturbation. In addition, based on GE's field observations, spawning has typically been observed in the backwater areas (i.e., areas not targeted for engineered capping). However, carp may have some influence on portions of the thin-layer cap due to foraging in sediments, uprooting of plants, and thrashing behavior during spawning.

Largemouth bass typically prefer "warm, weedy parts of lakes, ponds, and streams" (Smith, 1985). They are not often found in water that is too deep for rooted vegetation to grow (Becker, 1983). They initially feed on algae and small invertebrates, but when bigger (> 2 inches), feed primarily on fish and other large items, such as crayfish, amphibians, and large insects. Small mammals and birds have also been reported to be consumed (Becker, 1983). Largemouth bass interact with sediments primarily during spawning activities in the spring when males build nests in sand or other firm substrates by sweeping the bottom vigorously with their tail fin. The nests are often in 1 to 4 feet of water, 2 to 3 feet in diameter, up to 12 inches deep, and about 30 feet apart from other nests (Becker, 1983; Smith, 1985). During spawning activities, largemouth bass are not expected to impact the engineered cap due to the presence of the armor stone that would be designed to withstand effects from biota/bioturbation, but may have some influence on portions of the thin-layer cap by excavating nests.

Actual cap composition and thickness will be determined during design. For purposes of the CMS, the cap material was assumed to "contain 12 inches of sand (which may be amended with organic material to increase the TOC content) placed over the excavated riverbed," followed by armor stone to be placed over the sand (p. 4-27, and repeated throughout Section 4). As further discussed in the Response to Specific Comment 46, the cap would be designed/constructed considering physical stability (along with chemical isolation) to mitigate any potential effects associated with deeper mixing due to storm events, boat traffic, and/or megafauna. As outlined in the CMS Report (p. 4-29), monitoring activities will also be conducted to evaluate cap integrity over time, with a provision for maintenance activities if needed.

The thin-layer cap material was defined in the CMS Report as a "6-inch sand cover used to enhance natural recovery" (CMS Report, p. 4-1, and repeated throughout Section 4). While the potential exists for deeper mixing due to processes outlined above, the thin-layer cap would still serve to enhance natural recovery where placed, even with mixing.

Note that, for the purposes of modeling, as described in Section 5.2.2.4 of the CMS Proposal, the physical properties of thin-layer caps and backfill material (e.g., grain size distribution, bulk density, and TOC) were assumed to be the same as those of the current native surficial sediments. This modeling simplification was made to avoid the need to specify for each sediment alternative the various properties of backfill/cap material that are typically determined during design, as that was considered beyond the scope of the CMS. This approach was discussed with EPA during a technical team meeting held in January 2007.

<u>Discussion of Monitored Natural Recovery</u>

As defined in the CMS Report, MNR includes reliance on "ongoing, naturally occurring processes to contain, or otherwise reduce the bioavailability and/or toxicity of, PCBs in sediment, with monitoring to assess the rate of recovery or attenuation" (p. 1-13). This definition is consistent with EPA's Contaminated Sediment Guidance. As EPA's comment notes, the Contaminated Sediment Guidance does list some site conditions that are considered "especially conducive" to MNR (EPA, 2005b, p. 4-3). However, it does not indicate that these conditions all need to be present to consider these remedial approaches. In fact, the guidance document also states that "each of the three potential remedy approaches (MNR, *in situ* capping, and removal) should be considered at every site at which they might be appropriate" (EPA, 2005b, p. 4-3).

As with thin-layer capping, the areas identified for MNR under each sediment alternative were identified in the CMS Proposal and approved by EPA. Since MNR could be effective in both depositional and erosional areas, the CMS proposed the use of MNR as a remedy component over a broad range of river reaches (for SED 2 it included the entire river). The model was used to help evaluate the effectiveness of MNR for the range of sediment alternatives.

Many different processes may aid in natural recovery and reduce risk from contaminated sediment; one of these processes involves a reduction in exposure levels through "a decrease in contaminant concentration levels in the near-surface sediment zone through burial or mixing-in-place with cleaner sediment" (EPA, 2005b; p. 4-2). As discussed elsewhere in this Interim Response, there is evidence that this process is occurring in certain portions of the River, such as Woods Pond and Rising Pond; and there is also other evidence (notably recent fish sampling results) indicating that natural processes, together with source control and remediation efforts upstream of the Rest of River, are producing reductions in PCB concentrations in the River in the PSA. See Responses to Specific Comments 27, 63, and 68. Moreover, as noted in the CMS Report, the EPA model predicts that natural recovery processes will result in considerable additional reductions in PCB loading to the Rest of River and PCB concentrations within the Rest of River. In addition, at this site, MNR is supported on the basis that it would avoid the devastating adverse impacts from all the sediment removal alternatives in the CMS on the numerous habitats in the Rest of River ecosystem, which, once affected, may not be able to be restored to their condition, either at all or for many decades, as discussed in the Response to General Comment 10.

General Comment 16 (Page 7): *There are numerous references in the CMS to the detrimental effects of construction activities for the various alternatives, including specifically the effects of roads and staging areas in the floodplain, truck traffic related to removal of soil and sediment, and general disruption of local populations of biota. There is comparatively little discussion, however, of the numerous avoidance and minimization measures that should be implemented to lessen or eliminate these effects if a remedy were implemented.*

GE shall provide a detailed discussion of the procedures that will be followed to use existing infrastructure and minimize habitat loss or adverse effects to MESA species in the construction of staging areas and roads in coordination with the remediation to be performed in the alternative being evaluated. In addition, GE shall describe their process to avoid, minimize and mitigate the potential for detrimental effects of construction activities on the quality of life of affected communities as well as MESA species. As part of the discussion, GE shall provide a more detailed description of the decision process that will be used to balance considerations including but not limited to the following: the type of a removal action (e.g. dredge type), measures that can be taken to minimize the footprint of construction, requirements for supporting infrastructure such as roads, costs, and geomorphology of restored river. GE shall provide further discussion of the assumptions made in the CMS regarding staging areas, roads and infrastructure. The description shall include a graphic depicting the decision tree that will be followed during the decision process. Such decision trees have been used effectively to transparently outline these *thought processes at other contaminated sediment sites (e.g. Fox River). GE shall use the area(s) identified in Specific Comment 42 to illustrate the implementation of such a decision tree.*

GE Response: Several portions of this comment were addressed in the Response to General Comment 10, including discussions regarding the process for evaluating the use of existing infrastructure and other potential measures to minimize habitat loss or adverse effects to MESA species in the construction of staging areas and access roads, as well as other construction activities. That response also includes a graphic depicting an example decision tree (Figure GC10-3) that could be followed during the decision process. Other portions of this comment – i.e., mitigation of detrimental effects on the quality of life, balancing considerations for the removal action type, and the assumptions regarding staging areas, roads and infrastructure – are discussed below.[11]

Discussion of Quality of Life Impacts

GE would employ a number of steps in an effort to avoid, minimize, and mitigate any potential detrimental effects of construction activities on the quality of life of affected communities. First, GE would avoid working at nights and on weekends or holidays except where necessary. Further, in order to decrease the impact of transport/disposition operations, vehicles would be properly maintained and would avoid (to the extent practical) travel through densely populated areas. If circumstances necessitate travel through populated areas, appropriate measures would be taken to ensure the safety and well-being of the impacted communities (e.g., traffic control, consultation with local public officials). Routine air monitoring would be performed during construction activities in accordance with a project-specific community air monitoring plan. Dust and odors would be controlled via wetting and application of foaming agents as needed. Where construction would occur near structures and/or populated areas, vibration and noise monitoring would be carried out, as necessary. Prior to and throughout the construction process, information would be distributed to the public through appropriate avenues (e.g., flyers, newspaper ads, public information meetings). Should the need for additional actions to reduce detrimental effects of construction on the affected communities be identified, GE would consider these on an as-needed basis.

[11] As discussed in the Response to General Comment 10, this Interim Response does not include an in-depth discussion of how the process described therein would apply to six example areas identified by EPA on October 30, 2008 (per Specific Comment 42), because GE believes that it is critical that those in-depth area-specific evaluations consider the ecologically sensitive alternative under development, and because there has not been sufficient time to complete those area-specific evaluations. GE will provide such illustrative evaluations of those six example areas in the revised CMS Report that includes the ecologically sensitive alternative.

It should be recognized, however, that despite implementation of these steps, the remedial alternatives that involve on-site construction activities will inevitably cause adverse impacts on the local communities in terms of increased truck traffic, increased noise and dust emissions, disruption of recreational activities, and changes to the visual character of the River and floodplain, as described in the CMS Report.

Discussion of Balancing Considerations (Removal Action, Construction Footprint and Infrastructure Requirement)

The decision processes used to determine the type of removal action (dredge type) was primarily based on the differing conditions in particular areas of the River. For purposes of the CMS Report, selection of the particular sediment removal technique for each reach and alternative considered a number of factors including ease of access, channel geometry, hydraulic characteristics, and geography. The rationale for selection of the removal approach for each reach was described in Section 3.1.2 of the CMS Report.

Other approaches can be further evaluated during detailed design to minimize the construction footprint and requirements for supporting infrastructure. These approaches could involve maximizing the use of existing infrastructure (where feasible) and reducing the extent of new access roads and staging areas needed for implementation. For example, for sediments, they could include working only from one side of the River (using bridges as necessary to cross the river) or diverting the River to work in the dry from the river bed. In addition, numerous BMPs would be considered, in designing and implementing the selected remedial alternatives, in an effort to minimize or mitigate the construction impacts. These BMPs are discussed in Section II.C of the Response to General Comment 10 and the associated Table GC10-3.

Discussion of Staging Areas, Roads, and Infrastructure Assumptions

During development of the conceptual plans, the locations of the staging areas, access roads, and supporting infrastructure were selected considering site conditions such as topography and extent of vegetation as observed through site visits and aerial photographs. Areas were specifically selected based on accessibility, existing land use, and location relative to the floodplain. Further, in selecting conceptual locations for staging areas, access roads, and supporting infrastructure, an effort was made to avoid sensitive habitats (e.g., wooded areas, floodplains, and wetlands) where practical, and to utilize existing infrastructure where possible (e.g., October Mountain Road was assumed as a primary haul road along the east side of the river from New Lenox Road to Woods Pond). Further evaluations of the locations for staging areas, access roads, and other supporting infrastructure will be conducted during design in a more detailed effort to achieve the same objectives.

It should also be noted that the CMS Report (and this Interim Response) assume that the floodplain remedial alternatives would be conducted independently from the sediment remedial alternatives, and thus they include separate access roads and staging areas, even though those areas may overlap with those that would be needed for the sediment alternatives. In fact, it would be more effective and efficient to conduct remediation of sediment and floodplain areas simultaneously. As stated in the CMS Report (p. 6-2), conducting these remedial activities concurrently would likely result in "economies in the construction of access roads and establishment of staging areas." As further stated in that report, "[o]pportunities for improving the economy and efficiency of remedial work by coordinating sediment and floodplain remediation can be considered during remedial design, after selection of sediment and floodplain remedies."

General Comment 17 (Page 7): *The analysis of reductions in PCB concentrations in fish fillet compared with human health risk levels presented in the CMS used initial concentrations in biota at the end of the model validation simulation. At that time the East Branch had substantially higher PCB boundary loads than is currently the case following remediation, and therefore the initial concentrations used by GE are no longer applicable to the current PCB loading regime. As a result, PCB concentrations in biota presented in the CMS show a steep decline in the beginning of the simulations that is an artifact of the modeling, and GE's conclusion of large declines in the first ten years of the simulation is not consistent with current conditions and represents in part an artifact of the modeling. Such a decline exaggerates the benefit expected in SED 1/2 and the effectiveness of SED 3 relative to alternatives SED 4 and higher. When EPA calculated initial conditions in fish tissue by spinning up the first year of the simulation (i.e. using current boundary conditions to reflect the initial condition rather than historical boundary conditions), the results appear considerably different. This alternate presentation reduces the apparent desirability of SED 1/2 and SED 3 and more clearly illustrates the differences between different sediment alternatives. GE shall provide a recognition of this issue and a discussion of the effect of this issue on the assessment of the SED alternatives.*

GE Response: During a technical meeting on January 31, 2007, GE and EPA agreed that Year 1 of the model projection would begin immediately following the model validation period, and that simulated remediation in the Rest of River would also begin in Year 1 (to eliminate any unknowns regarding timing of Rest of River remediation efforts). It would be inconsistent with this approach to "reset" the initial conditions in the Food

Chain Model (FCM), thereby assuming that fish in the Rest of River have instantly achieved equilibrium with the current boundary condition.

Nonetheless, to evaluate this issue, initial conditions in the fish were calculated by "spinning up" the first year of the simulation using current water column and sediment conditions, as described by EPA in this comment. "Spinning-up" is the process whereby initial conditions in the fish are determined by running the FCM with constant water column and sediment exposures for a period of time that is sufficient for the fish to reach equilibrium with those exposures (approximately 10 years or more). Table GC17-1 compares, by subreach, the original end-of-validation PCB concentrations in fish (fillets) with the initial concentrations in fish calculated using EPA's "spinning up" method.

Table GC17-1. Comparison of End-of-Validation and Spun-up Initial PCB Concentrations in Fish.

	Reach 5A	Reach 5B	Reach 5C	Reach 5D	Woods Pond
End-of-Validation Fish PCBs (mg/kg)	18	17	14	22	15
Spun-up Initial Conditions (mg/kg)	12	13	10	17	12

Given the long projection simulation period used for the CMS (52 years or more), resetting the initial condition in the fish has no impact on predicted fish concentrations at the end of the simulation. This is because, at the end of the simulation period, fish will have gone through several growth cycles in the model, causing fish concentrations to reach a new equilibrium with post-remediation sediment and water column PCB levels; and these levels are substantially different from the initial condition. However, resetting the initial condition does affect the calculated percent reduction in fish over the projection period (as noted by EPA, because the initial PCB concentrations in the fish are lower). A comparison of the percent reductions in Reach 5/6 fish tissue resulting from the above-described EPA method for all sediment alternatives to the percent reductions included in the CMS Report is presented in Table GC17-2.

As shown in this table, percent reductions calculated using the alternate method described by EPA generally do not change significantly over those presented in the CMS, except for SED 1/2. For SED 4 through SED 8, percent reductions decrease by 1% or less. Under SED 3, percent reductions under the EPA method are lower than those presented in the CMS Report by as little as 1% in Reaches 5A and 6 and between 5 and 10% in Reaches 5B, C, and D. Under SED 1/2, changes in percent reduction are much greater, ranging between 10% and 20% lower under the EPA method. In any case, it should be noted that, even using EPA's alternate method, the greatest incremental reduction in fish PCB concentrations is still achieved by SED 3 in all reaches except Reach 5D.

Table GC17-2. Comparison of CMS and Recalculated Percent Reduction in Fish PCB Concentrations over the Projection Period in the PSA.

	Percent Reduction in Fish PCB Concentrations over the Projection Period in the PSA									
	Reach 5A		Reach 5B		Reach 5C		Reach 5D		Reach 6	
	CMS	EPA Method	CMS	EPA Method	CMS	EPA Method	CMS	EPA Method	CMS	EPA Method
SED 1/2	60%	41%	47%	28%	48%	29%	57%	45%	44%	27%
SED 3	99%	98%	83%	77%	87%	83%	72%	63%	95%	94%
SED 4	99%	98%	98%	97%	97%	96%	98%	98%	99%	98%
SED 5	99%	98%	99%	98%	99%	98%	98%	98%	99%	98%
SED 6	99%	98%	99%	98%	99%	98%	98%	98%	99%	99%
SED 7	98%	98%	99%	98%	99%	98%	98%	98%	99%	98%
SED 8	99%	99%	99%	99%	99%	99%	99%	98%	99%	99%

General Comment 18 (Page 8): *EPA notes that many of the figures presented in the CMS showing residual concentrations, particularly in fish tissue, relative to human health IMPGs include only the IMPGs associated with 10-6 incremental cancer risk and/or Hazard Index of 1. Because of the very low exposure concentrations associated with the low end of the EPA risk range, and the consequent difficulty that most alternatives have in achieving the 10-6 IMPGs during the model simulation period given the bioaccumulative nature of PCBs at very low concentrations in sediment and water, such presentations tend to obscure the* *differences in risk reduction between alternatives. For incremental cancer risk, the EPA risk range is from 10-4 to 10-6, and for noncancer risks a Hazard Index less than 1 is generally considered acceptable. GE shall revise these figures to include the IMPGs for the entire risk range.*

GE Response: This comment does not reference a specific figure from the CMS Report, although it appears to be in reference to Figures 4-16a through 4-16n, which show temporal profiles of fish fillet concentrations compared to the 10^{-6} cancer and the non-cancer IMPGs. In these figures, the upper bound of the RME and CTE ranges was represented by the non-cancer IMPG on the assumption that, even if fish PCB levels were within the cancer risk range, EPA would not regard fish as "safe" to eat if their PCB levels exceeded the non-cancer IMPG. In response to EPA's comment, these figures have been revised to include the IMPGs for the entire cancer risk range as well as the non-cancer IMPGs, using both RME and CTE assumptions. In addition, in Response to General Comment 21 (discussed below), results for the four Connecticut impoundments estimated with the CT 1-D Analysis have been added to this series of figures. These figures also reflect the revised downstream model runs for SED 6, SED 7, and SED 8 that have been conducted in response to EPA's Specific Comment 44 (which assume more remediation in Reaches 7B and 7C). The revised figures are provided as Figures GC18-1 through GC18-18.

General Comment 19 (Page 8): *The model output presented in the CMS shows a leveling off of sediment and/or fish concentrations at a particular concentration post-implementation of the alternatives. EPA notes that this is largely driven by the modeling assumptions regarding continued low concentrations of PCBs coming in upstream from the East and West Branches as well as from atmospheric loads from tributaries. In addition, the model simulations for some alternatives reflect assumptions that were made about resuspension and residuals associated with the type of technology being modeled (e.g. placement of an engineered cap, or dredging). EPA approved the assumptions in the CMS Proposal, but also directed GE to produce model output with alternative assumptions ("lower-bound" simulations). GE provided this output on a CD in the Appendix to the CMS. However the lower-bound simulations are not plotted on the same graph as the "upper-bound" simulations, and are often provided on physically different scales and very small scales. Therefore evaluation of the effect of the modeling assumptions (and the uncertainty associated with the assumptions) cannot be evaluated. GE shall reproduce the graphics depicting the model simulations of alternatives provided in Section 4 with both the upper-bound and lower bound simulations plotted on the same graph in a readable format in hard copy as well as on a CD. In addition, GE shall provide a table that clearly shows the upper bound and lower bound values for the assumptions of model input parameters.*

GE Response: The attached Figures GC19-1 through GC19-4 show temporal profiles of model-predicted water column, surface sediment (0- to 6-inch), fish (whole body), and fish (fillet) PCB concentrations, respectively.[12] These figures directly compare base case (referred to as "upper bound" by EPA) and lower bound model simulations by subreach, and for the four CT impoundments simulated using the CT 1-D Analysis, for all sediment alternatives. These figures (as previously discussed in the CMS Report) show relatively small differences between the base case and lower bound simulations, with the largest differences generally occurring in Reach 5C and Woods Pond. For example, surface sediment concentrations at the end of the simulation period differ by at most 0.1 to 0.2 mg/kg.

Table GC19-1 provides a summary of the base case and lower bound model input parameter assumptions approved by EPA.

Table GC19-1. Summary of Base Case and Lower Bound Model Input Parameter Assumptions.

Parameter	Base Case	Lower Bound
Percent reduction in particulate-phase PCB concentrations for "future" East Branch boundary condition, at flows ≥ 550 cubic feet per second (cfs)	50% reduction from "current" condition	75% reduction from "current" condition
PCB concentration in cap/backfill materials	0.021 mg/kg	0 mg/kg
Mixing between cap materials and native sediments (cap placement with no prior removal)	99% reduction efficiency	100% reduction efficiency

<u>**General Comment 20 (Page 8):**</u> *EPA believes that undue emphasis is assigned by GE in the CMS to the length of time required to implement a remedy. A shorter length of time for a remedial project only yields benefit if the three General Standards are addressed (protection of human health and the environment, controlling sources of releases, and achieving ARARs) with consideration given to the other Selection Decision Factors. Furthermore, it should be recognized that the "disruptions and impacts" discussed in the*

[12] These figures reflect the new model simulations of SED 6, SED 7, and SED 8 under the downstream model, which assume greater remediation in Reaches 7B and 7C, in response to EPA's Specific Comment 44.

CMS not only would be spread out over time and space as implementation of active alternatives generally proceeds from upstream to downstream, but can also be to a large extent avoided, minimized or restored with proper implementation of a remedy. Therefore, describing remediation in simple terms of length of time for implementation of an entire alternative, in the context in which it is discussed in the CMS, is misleading. In fact, any remedy selected other than SED 1/2 and FP 1 would impact a given area for only a portion of the duration of implementation of the entire alternative, a point which is not made in the CMS in any discussion of short-term effectiveness. Also, in general (with the exception of SED 8), each alternative builds on previous alternatives, therefore the length of time for remediation in a given reach is typically the same (e.g. the time to complete Reach 5A in SED 3 is the same as it is in SED 5). GE shall provide a timeline that shows the implementation of each sediment alternative and associated restoration on a reach level. Such a timeline shall assume that any floodplain actions are generally done concurrently with any sediment/bank remediation, depending on physical proximity to a sediment alternative, and that restoration of each affected area would be conducted as quickly as is feasible and advisable following remediation, including the restoration of areas of supporting infrastructure.

GE Response: GE continues to believe that the length of time required to implement a remedy is a key factor in evaluating remedial alternatives under the Permit criteria. While the adverse impacts and disruptions associated with implementing a given alternative would be spread out over the overall implementation period and area and thus would not affect all areas for that entire duration, it remains true that an alternative with a longer duration would cause greater impacts and disruption in the overall Rest of River area for a longer time. In other words, such an alternative would impact parts of the Rest of River area over a longer period.[13] Moreover, contrary to EPA's comment, GE does not believe that such impacts can "be to a large extent avoided, minimized or restored with proper implementation"; this is discussed in detail in Section II of the Response to General Comment 10. In addition, as explained in the CMS Report (e.g., p. 4-247), the duration of an alternative affects its implementability, since alternatives with very long durations would involve more uncertainties in contracting over time periods of multiple decades, in obtaining the necessary large quantities of capping and backfill material, and in the availability of landfill capacity, as well as a greater potential for releases during implementation and more

[13] EPA's comment accuses the CMS Report of being "misleading," claiming that the CMS Report did not make the point, in any discussion of short-term effectiveness, that any active remedy "would impact a given area for only a portion of implementation of the entire alternative." That assertion is incorrect and unfair. The CMS Report clearly recognized this point. For example, at the beginning of the discussion of short-term effectiveness for each sediment alternative (other than SED 1 and SED 2), the CMS Report set forth the specific durations of impacts in each reach or subreach.

uncertainties stemming from potential changes in equipment or technologies or in statutes, regulations, regulatory priorities, or property ownership. For these reasons, the length of time required to implement an alternative directly affects the General Standard of overall protection of the environment, as well as the Selection Decision Factors of long-term adverse effects, short-term effectiveness, and implementability. (With respect to EPA's comment that, except for SED 8, the length of time for remediation in a given reach is typically the same among alternatives, see Response to Specific Comment 25.)

In response to this EPA comment, GE has prepared construction timelines associated with the implementation of sediment alternatives SED 3 through SED 8. These timelines are provided as Figures GC20-1 through GC20-6. (As stated by EPA, it is assumed that any floodplain remediation could be performed within the time frames given for the sediment alternatives.) Each of these timelines presents a general representation of the main components of the reach- and alternative-specific remedial activities (i.e., removal, backfilling/capping/restoration, and where appropriate, bank stabilization/restoration).[14] They illustrate the respective contributions of each activity to the overall implementation timeline, as well as the extent of activities being performed concurrently. Note that although these timelines present the duration of each of the main components in the overall schedule, they may not represent the specific sequencing of repetitive shorter duration activities within each reach. For example, timelines associated with Reach 5A illustrate the overall timeframe when removal, backfilling/restoration, and bank stabilization activities are occurring in terms of construction years. However, there are 176 dry removal cells in Reach 5A and it would not be possible to illustrate removal in each of those cells sequentially on the attached charts. An example of the details related to the specific sequencing of these activities on a cell-specific basis is presented on the timelines as a blow-up inset.

General Comment 21 (Page 9): *EPA notes that environmental improvements (reduced PCB concentrations) in select river reaches are highlighted in the CMS as justification for lack of action in remaining reaches in the evaluation of some alternatives. There is a tendency for the discussion presented in the CMS to be dismissive of the risk reduction and control of sources of releases of more aggressive alternatives in Reaches 5B, 5C, and 5D. In addition, EPA notes that GE's statements regarding the net incremental reductions attributable to SED 3 in comparison to more aggressive SED alternatives obscures the fact*

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[14] These timelines show the length of time for implementation of the alternatives; they do not show the length of time that residual impacts from the remedial activities would last, which would be far longer.

that it is the latter alternatives that in many cases are the only ones involving remediation in Reaches 7 and 8. Even if an alternative achieves substantial reductions in PCB concentrations when averaged over large areas, it may not be the best suited alternative if contamination in other reaches is only minimally reduced or unchanged. Many of the summary figures also do not depict the response of all reaches (e.g. Figure ES-3 does not include the response in Reach 7). To allow a complete evaluation of the effectiveness of each alternative, GE shall ensure that all figures representing the comparative effects of the alternatives include all river reaches including CT and shall provide such modified figures.

GE Response: In the CMS Report, the comparative effects of the sediment alternatives on fish PCB concentrations were presented by reach on Figures 4-15, 4-16 (14 figures), and 4-19. In some cases, these figures presented only selected reaches in an attempt to present the general trends more concisely and to avoid plots having many lines. Nonetheless, in response to this comment, revised figures showing all reaches have been prepared, as described below:[15]

1. Figure 4-15 in the CMS Report showed the reduction in fish (fillet) PCB concentrations over the model projection period versus surface area addressed by subreach (also included in the Executive Summary). This figure has been updated to include all Reach 7 subreaches and CT impoundments and, as updated, is provided as Figure GC21-1.

2. Figure 4-16 in the CMS Report showed average fillet PCB concentrations in largemouth bass in all reaches; this figure (which actually comprises 14 figures) was addressed separately in Response to General Comment 18 and has been updated to include the four CT impoundments. The revised figures are provided as Figures GC18-1 through GC18-18.

3. Figure 4-19 in the CMS Report showed modeled fish PCB concentrations at the end of the model projection period versus total cost for each alternative. This figure has been updated to include Reach 5D, all Reach 7 subreaches, and all CT impoundments. The revised figure is provided as Figure GC21-2.

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[15] Again, these figures reflect the new model runs for SED 6, SED 7, and SED 8 under the downstream model, which have been conducted in response to EPA's Specific Comment 44.

General Comment 22 (Page 9): *GE shall provide a single table or matrix and revised figures which present a more organized and clear comparison of the overall net risk reduction (as discussed in the Sediment Dredging at Superfund Megasites: Assessing the Effectiveness (NRC 2007)) associated with each alternative. There is some discussion in the CMS of many of the risk trade-offs that might be expected, but evaluating these competing factors would be much easier if they were organized into a single table or matrix. In addition, this organizational approach would help to reduce the potential for some risks (e.g., those from dredging) being emphasized over others (e.g., risk from residual PCB concentrations). GE mentions net risk reduction and attempts to address this goal in its comparison of remedies in Sections 4 and 6, but this comparison could be made more clearly and in an understandable manner. For example, predicted reductions in fish tissue concentration are presented in separate tables for each alternative. If these results were summarized across remedies in one place, the reader could more easily compare remedies with respect to this exposure reduction (and indirectly risk reduction) metric along with other metrics (e.g., worker health risk, PCB concentration reductions, habitat restoration benefits, habitat loss, etc.) that are also of concern.*

GE Response: While not all of the quantitative metrics presented in the CMS Report were summarized across remedial alternatives, EPA incorrectly states in its example that predicted reductions in fish tissue PCB concentrations were only presented in separate tables for each alternative; the comparative assessment of reductions in fish tissue concentration among all alternatives that EPA is requesting was provided previously in Table 4-53 of the CMS Report. Nonetheless, the quantitative metrics used in the CMS, as well as certain other metrics identified by EPA in this comment, have been compared among alternatives and by subreach (where applicable) as part of GE's Response to General Comment 13.[16] These include the net risk reduction metrics requested here.

General Comment 23 (Page 10): *EPA notes that GE's evaluations of residual risk to humans in the floodplain are based only on current uses, not reasonably foreseeable future use as was included in the Human Health Risk Assessment. Residual risks could change for some alternatives if land use changes in the future, particularly with regard to farming practices or development of new residential properties. In addition to the consideration of current uses, GE shall present a discussion of the actions and/or institutional controls that may be required if land uses change.*

[16] The tables provided as part of GE's Response to General Comment 13 do not include comparisons of "habitat restoration benefits," because GE does not believe that any of the remedial alternatives will provide any such benefits. See Response to General Comment 10.

EPA notes that in the Human Health Risk Assessment (WESTON 2005), portions of individual residential properties were evaluated as not having current residential exposure due to the definition of actual or potential lawns in the Consent Decree. GE shall submit a conceptual approach for obtaining restrictions on use of these portions of the properties, or for providing for unrestricted use.

In this context, GE shall include additional discussion of the implementation of institutional controls, including but not limited to the following:

- *Requirements for inspection, maintenance and monitoring for institutional controls,*
- *Requirements for expanded activities associated with biota advisories,*
- *Revised costs which include the implementation of such institutional controls.*

GE Response: The CMS Report did address residual risks to humans in the floodplain based on reasonably foreseeable future use resulting from land use changes. Specifically, the CMS Report stated that each floodplain remedial alternative other than FP 1 (no action) would include the use of deed restrictions and Conditional Solutions as necessary to address reasonably anticipated future uses and activities for which the alternative would not meet applicable cleanup criteria (e.g., residential use standards, where that use is reasonably anticipated and remediation would not meet those standards) (see pp. 6-12, 6-32, 6-55, 6-76. 6-96, 6-120). In response to EPA's comment, GE is providing an additional discussion of actions and/or institutional controls to address future changes in land use. In addition to deed restrictions and Conditional Solutions, such mechanisms include periodic inspections and reviews of floodplain properties to assess any changes in use, followed by additional remediation if necessary to be protective for the new use.

For certain types of properties, deed restrictions could be implemented to prohibit future uses or activities that are inconsistent with, and would involve greater exposure potential than, the current uses that are addressed by the cleanup. Deed restrictions include, for example, Grants of Environmental Restrictions and Easements (EREs), as provided for in the CD. They also include other types of restrictions such as Notices of Activity and Use Limitations (AULs), as provided for in the MCP, and conservation restrictions. Both GE and the City of Pittsfield agreed in the CD to provide EREs on their properties where restrictions on future use are necessary (CD Paragraphs 54 and 66). Similarly, the State of Massachusetts agreed in the CD that, where EREs are necessary, it will "not unreasonably withhold consent" to the placement of EREs on State-owned properties in the Rest of River without compensation, so long as the EREs do not interfere with recreational use of the properties or other uses that were made of the properties at the time of lodging of the CD (CD Paragraph 60.b).

Deed restrictions would be appropriate at certain types of properties where a given future use is reasonably anticipated but which would not meet the applicable cleanup standards for that use. For example, for such properties owned by GE, the City of Pittsfield, or the State, EREs would be executed as provided in the CD. For other properties in this category, deed restrictions could be executed where the property owners agree to do so; and if they do not, Conditional Solutions may be implemented. As provided for in the CD, a Conditional Solution requires GE to agree to conduct additional remediation in the future, under certain conditions, to address changes in the property's use that would require such remediation, provided that the property owner has all necessary permits and approvals for such use and demonstrates a commitment to that use. For the Rest of River, however, it would not be practical to implement the ERE/Conditional Solution approach for all the many properties in the floodplain that could have possible uses with potentially greater exposure than current uses and that would not meet the most restrictive possible standards. For example, it would not be practical to request an ERE or implement a Conditional Solution at every property in the floodplain that does not meet residential or agricultural standards, simply to address the theoretical possibility that it may someday convert to residential or agricultural use. Rather, the deed restriction/Conditional Solution approach must necessarily be limited to those properties where a change to a use involving greater exposure potential (i.e., residential or agricultural use) is actually reasonably anticipated, based on some objective measure, and which (based on sampling data) would not meet the cleanup standards for that use.

The remaining properties in the floodplain – i.e., those where a change from current use was not reasonably anticipated at the time of remedy selection (and thus are not subject to deed restrictions or Conditional Solutions) – would be subject to EPA's periodic (e.g., 5-year) reviews of the Rest of River remedy in accordance with Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Paragraph 43.c of the CD. Such periodic reviews are designed to evaluate potential changes in circumstances and conditions that could affect the protectiveness of the remedy. As such, they can and should be used to evaluate whether there have in fact been any changes in land use that were not previously anticipated and for which the applicable cleanup standards are not met. In such cases, where necessary, EPA could select further response actions to address the situation pursuant to Paragraph 46 of the CD, and could take the position that GE should carry out or fund those response actions on the ground that, under Paragraph 162 or 163, the unanticipated change in use constitutes new information indicating that the prior remediation is not protective of human health. Such an approach would thus allow for the performance of additional response actions as necessary to meet applicable standards. This would be protective given that the assumed health risks are based on long-term exposures. Specifically, the assumed exposure durations used by EPA in its calculation of risks based on direct contact with floodplain soil in the Human Health Risk Assessment (HHRA) range from a minimum of 6 years for young children to 47 years for adults.

For institutional controls, such as those discussed above, to address changes in land use, the inspection, maintenance, and monitoring requirements would include annual inspections of properties where deed restrictions or Conditional Solutions have been implemented (similar to the inspections required by the CD for such properties) and the EPA periodic reviews as described above. GE would submit reports on its inspections to EPA and the State.

For biota consumption advisories, GE would plan to work with the relevant state agencies in disseminating information about those advisories as appropriate – e.g., through posting and maintenance of signs, printing of information pamphlets, and/or printing to notices to be handed out with fishing or hunting licenses. See Response to General Comment 14. These activities would be essentially the same for all alternatives.

The revised costs for the remedial alternatives, presented in Appendix D, have included costs of the implementation of biota consumption advisories. For the institutional controls addressing future changes in land use, a reliable cost estimate cannot be made, because: (a) the costs of deed restrictions depend on the number of private properties where deed restrictions would be executed, which is unknown; and (b) the costs of implementing Conditional Solutions or the annual inspection approach depend on the number of future situations where GE may have to perform additional response actions, as well as the type and extent of such response actions, all of which are likewise unknown.

General Comment 24 (Page 10): *The approach used in the CMS (i.e., simulation of sediment concentrations of 1, 3, and 5 mg/kg) to evaluate the effectiveness of the floodplain alternatives on ecological receptors exposed to both floodplain and sediment food sources for each floodplain alternative serves as a useful screening tool. However, for remedial alternatives that do not result in residual concentrations within the range of 1 to 5 mg/kg PCB in sediment, these scenarios do not provide sufficient information to determine whether the IMPGs can be attained. EPA believes that in several instances, the "not achievable" determinations made by GE for piscivorous mammals IMPGs are not valid in light of the actual sediment concentrations achieved by some SED alternatives. GE shall provide a more comprehensive evaluation of whether various combinations of sediment and* *floodplain remedial alternatives satisfy the IMPG values for insectivorous birds (wood duck) and piscivorous mammals (mink). In addition, the analysis shall include an explicit evaluation of both the upper-bound and lower-bound IMPGs, not simply whether the residual concentration is within the "range of IMPGs".*

GE Response: As discussed in detail in the CMS Report (Section 2.2.2.3), the IMPGs for insectivorous birds (represented by wood duck) and piscivorous mammals (represented by mink) apply to the prey of those receptors, which consist of both aquatic and terrestrial organisms. As such, attainment of those IMPGs depends on the PCB concentrations in both the sediment and the associated floodplain soil, and it is not possible to derive target levels corresponding to the IMPGs in one of those media without knowing the concentration in the other. In these circumstances, GE proposed, and EPA approved, an approach involving the use of pre-selected target sediment concentrations of 1, 3, and 5 mg/kg and then calculation of target floodplain soil concentrations associated with achieving the IMPGs at each of those selected sediment concentrations. GE applied that approach in the CMS Report.

Nevertheless, in response to this EPA comment, GE has conducted a comprehensive evaluation of the attainment of the IMPGs for insectivorous birds and piscivorous mammals for all combinations of sediment and floodplain alternatives considered in the CMS. The first step in this evaluation was to determine, for each sediment alternative, the sediment PCB concentrations predicted by the EPA model at the end of the model projection period in all relevant averaging areas in the PSA for the receptor group in question. (These averaging areas were described in Sections 3.3.1, 5.2.3.3, and 5.2.3.4 of the CMS Report.) Next, for each such sediment concentration, an associated target floodplain soil level was calculated for the same averaging area using the same methods described in the CMS Report for calculating target floodplain soil levels associated with the previously selected target sediment levels.[17] Thus, for insectivorous birds, the calculation of target floodplain soil levels associated with attaining the IMPG at the modeled sediment endpoint concentrations was performed using the method described in Appendix B to the CMS Report; and for piscivorous mammals, the calculation of target floodplain soil levels associated with attaining the upper- and lower-bound IMPGs at the modeled sediment endpoint concentrations was performed using the method described in Appendix C to the CMS Report. The model-predicted sediment concentrations and the associated target

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[17] As in the CMS, this evaluation has been conducted for the PSA. An assessment of attainment of the IMPGs for insectivorous birds and piscivorous mammals in reaches downstream of the PSA was presented in Sections 5.3.4 and 5.3.5 of the CMS Report. See also Response to Specific Comment 97.

floodplain soil levels calculated for the relevant averaging areas are presented in Table GC24-1 for insectivorous birds and Table GC24-3 for piscivorous mammals.

For each floodplain alternative, the post-remediation exposure point concentration (EPC) in each relevant averaging area (described in Section 6 of the CMS Report) was then compared to the target floodplain soil concentration calculated for that area under each sediment alternative, as presented in Tables GC24-1 and GC24-3. The results allow one to determine attainment of the IMPGs for every combination of sediment and floodplain alternatives. These paired results are presented in Table GC24-2 for insectivorous birds and Table GC24-4 for piscivorous mammals.[18]

For the insectivorous bird evaluation, it appears that IMPG attainment is more sensitive to the amount of remediation conducted under the sediment alternatives than to that under the floodplain alternatives. For example, with the sediment levels achieved under SED 4 through SED 8, the insectivorous bird IMPG would be met in 100% of the averaging areas for all floodplain alternatives (including no action [FP 1]). At sediment levels predicted under SED 3, the IMPG would be met in 100% of the averaging areas in Reaches 5A, 5C/D, and 6 for all seven floodplain alternatives (except for one averaging area in Reach 5A under FP 1); within Reach 5B, which contains three averaging areas, the IMPG would be met in no areas under FPs 1 and 2, one area under FPs 3 and 4, and two areas under FPs 5, 6, and 7.

For the piscivorous mammal evaluation, attainment of the upper-bound IMPG is likewise more sensitive to the sediment alternatives than the floodplain alternatives. With the sediment levels achieved under SED 4 through SED 8, the upper-bound piscivorous mammal IMPG would be met in both of the averaging areas for all floodplain alternatives (with the exception of FP 1 where the IMPG would not be met in one of the two averaging areas under SED 4 and SED 5). With the sediment levels achieved under SED 3, the upper-bound IMPG would not be achieved under FP 1 through FP 5, would be achieved in one averaging area under FP 6, and would be achieved in both averaging areas under FP 7. The lower-bound piscivorous mammal IMPG would not be met in either area under any combination of remedial alternatives except for the combinations of FP 6 or FP 7 with SED 4 through SED 8.

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[18] The post-remediation EPCs presented in these tables reflect revisions to those presented in the CMS Report due to changes made in response to EPA's Specific Comments 98, 112, 113, and 115.

<u>General Comment 25 (Page 10):</u> *GE refers to a list of "challenges" that it claims have not been encountered at other sites and cites them collectively as a reason to favor alternatives with "a more reasonable scale and shorter duration." EPA notes that although alternatives SED 7 and SED 8 are certainly large-scale projects that may pose challenges, the discussion of lack of precedence with similar large-scale projects is overstated given the expanding scope of contaminated sediment remediation projects in recent years. For example, dredging has been performed as part or all of the remedy at a large number of so-called sediment "megasites," resulting in an EPA-sponsored review of the effectiveness of dredging as an option at such sites (NRC 2007). EPA guidance (EPA 2005) also reflects lessons learned to date from remediation at sites of various sizes, including some very large projects. Based on this and other information, EPA rejects the conclusion that any of the evaluated alternatives should be eliminated based on technical implementability.*

GE Response: The CMS Report did not draw the conclusion that any of the alternatives should be eliminated based on technical implementability. Rather, it pointed out the limited precedent or lack of precedent for some of the larger sediment alternatives, and noted that, in these circumstances, those alternatives would involve complications and uncertainties that have not been faced at other sites to date, which "favor the alternatives with a more reasonable scale and a shorter duration" (p. 4-247).

EPA asserts that GE's discussion of the limited or lack of precedents for SED 7 and SED 8 is "overstated given the expanding scope of contaminated sediment remediation projects in recent years," and it cites the NRC (2007) report on sediment megasites. In fact, the NRC (2007) report fully supports GE's conclusion. That report provided a detailed evaluation of 26 environmental sediment dredging projects, each of which included at least 10,000 cy of sediment removal and had pre-dredging and post-dredging data and which collectively represented a wide variety of project types. That report confirms GE's statement in the CMS Report that dredging projects with a magnitude equivalent to that of SED 7 (760,000 cy of sediment removal) have very limited precedent, since only two of the 26 projects evaluated by the NRC included greater than 400,000 cy of removal, and that no precedents are known to exist for projects with a magnitude equivalent to that of SED 8 (2,217,000 cy of sediment). Indeed, the report shows that even SED 5 (410,000 cy of removal) and SED 6 (554,000 cy of removal) also have limited precedents in terms of completed projects.

The two dredging projects evaluated by the NRC (2007) which involved sediment removal volumes greater than 400,000 cy were dredging projects at Head of Hylebos and Sitcum in Commencement Bay in Washington. In addition to providing only limited precedents for a dredging project of that size, these projects were completed in very different settings from the Rest of River. The Head of Hylebos and Sitcum projects included removal of sediments from large shipping channels in highly industrialized areas (Figure GC25-1a, below). The areas targeted for removal were easily accessible, and removal activities were conducted over a relatively small area. Conversely, the Rest of River has different site characteristics that present some unique challenges not encountered during the Commencement Bay projects (Figure GC25-1b). These characteristics include the length of the River to be addressed, the presence of environmentally sensitive areas surrounding the River (including a large number of rare species), the sinuous nature of the River, and lack of navigability for large vessels. In addition, limited access and the presence of large tracts of undeveloped land, as well as some residential areas, along the River make the Rest of River very different from those other sites.

In addition to the sites discussed in the NRC (2007) report, other large removal projects have been completed (although not at the same magnitude as SED 8). Site conditions at these sites are also quite different than those found in the Rest of River. Examples of other large projects include the dredging projects conducted at the Grand Calumet River (Indiana) and the Ashtabula River (Ohio). The Grand Calumet River project included removal of approximately 786,000 cy of material from a 5-mile reach of the river located in an industrialized area adjacent to U.S. Steel's facility (U.S. Steel, 2004) (Figure GC25-1c). At the Ashtabula River, a total of approximately 630,000 cy of soft sediments were removed over approximately two miles of river in an industrialized area, with sediment removal depths ranging from approximately 16 to 21 feet (EPA, 2006b) (Figure GC25-1d). The Housatonic River in the PSA differs significantly from those rivers because it extends for 10 miles in a sinuous manner through a natural and biologically rich ecosystem (Figure GC25-1b).

Remedies selected for some other large sites include dredging and/or capping of more than 1,000,000 cy (e.g., Hudson River, Fox River), but these remedies have yet to be implemented. In any event, the Hudson and Fox Rivers are significantly different in environmental setting from the Rest of River, as they are large, wide navigable rivers generally accessible throughout their course without the same concerns over the impacts to natural communities bounding the rivers (Figures GC25-1e and GC25-1f). While there are concerns with impacting the shoreline communities in these rivers, the majority of the dredging in those rivers is to be done by working within the navigable river, with transport to a single processing facility, rather than working from the adjacent shoreline in many instances and utilizing numerous access roads and staging areas built in the floodplain adjoining the River.

As discussed above, given the differences in site characteristics between the Housatonic River and these other sites, it is reasonable to assume that implementation of the large-scale sediment remediation alternatives at the Rest of River would result in complications and uncertainties not encountered at other sites.

With respect to the smaller sediment removal alternatives considered in the CMS – i.e., SED 3 with a removal volumes of 167,000 cy and SED 4 with a removal volume of 295,000 cy – previously completed dredging projects of that size likewise involve different conditions and characteristics from the Rest of River. For example, the NRC (2007) report evaluated seven dredging projects with sediment removal volumes between 100,000 cy and 225,000 cy. These projects were conducted at Bayou Bonfouca (Louisiana), Puget Sound Naval Shipyard (Washington), Harbor-Island (Washington), Cumberland Bay (New York), Lake Jarnsjon (Sweden), Manistique Harbor (Michigan), and United Heckathorn (California). None of these projects involved sediment removal in a riverine system like that in the Rest of River. Rather, they involved bayous, estuaries, lakes, and harbors (NRC, 2007). More recently, sediment removal was the selected remedy for an estimated 270,000 cy of sediment containing PCBs, PAHs, and metals from a 5.6-mile stretch of the Ottawa River (EPA, 2009) (http://www.epa.gov/glla/ottawa/index.html). Unlike the Housatonic River, the Ottawa River is bordered by landfills and commercial/industrial properties, and is much more accessible from the water.

In summary, the landscape setting and types of habitats of the Housatonic River are substantially different from those of other sites at which dredging at the scale of the CMS alternatives has been planned or implemented. The Housatonic River proper is much smaller than many of the reported large rivers and harbors that were dredged of sediments. The Housatonic River is intimately connected with the surrounding riparian banks, floodplains, wetlands, and adjacent uplands, forming an integrated forested riparian corridor, that will be severely impacted if the remediation activities in most of the CMS alternatives are implemented. Those remediation activities would eliminate or severely degrade the habitats supporting dozens of species of concern, and in most cases, would cause substantial mortality to current populations as is discussed in the Response to General Comment 10 and Appendix B.

Figure GC25-1a
Aerial Image of Head of Hylebos and Sitcum at Commencement Bay: Hylebos Waterway is the left channel and Sitcum Waterway is the middle channel. The surrounding area is highly industrialized.

Figure GC25-1b
Aerial Image of Housatonic River Primary Study Area downstream of New Lenox Road: Shows the River's natural and undeveloped setting, sinuous nature, and lack of navigability for large vessels.

<u>Figure GC25-1c</u>

<u>Aerial Image of Grand Calumet River showing one of the typical dredged areas</u>: The surrounding area is industrialized, and the River is channelized and accessible.

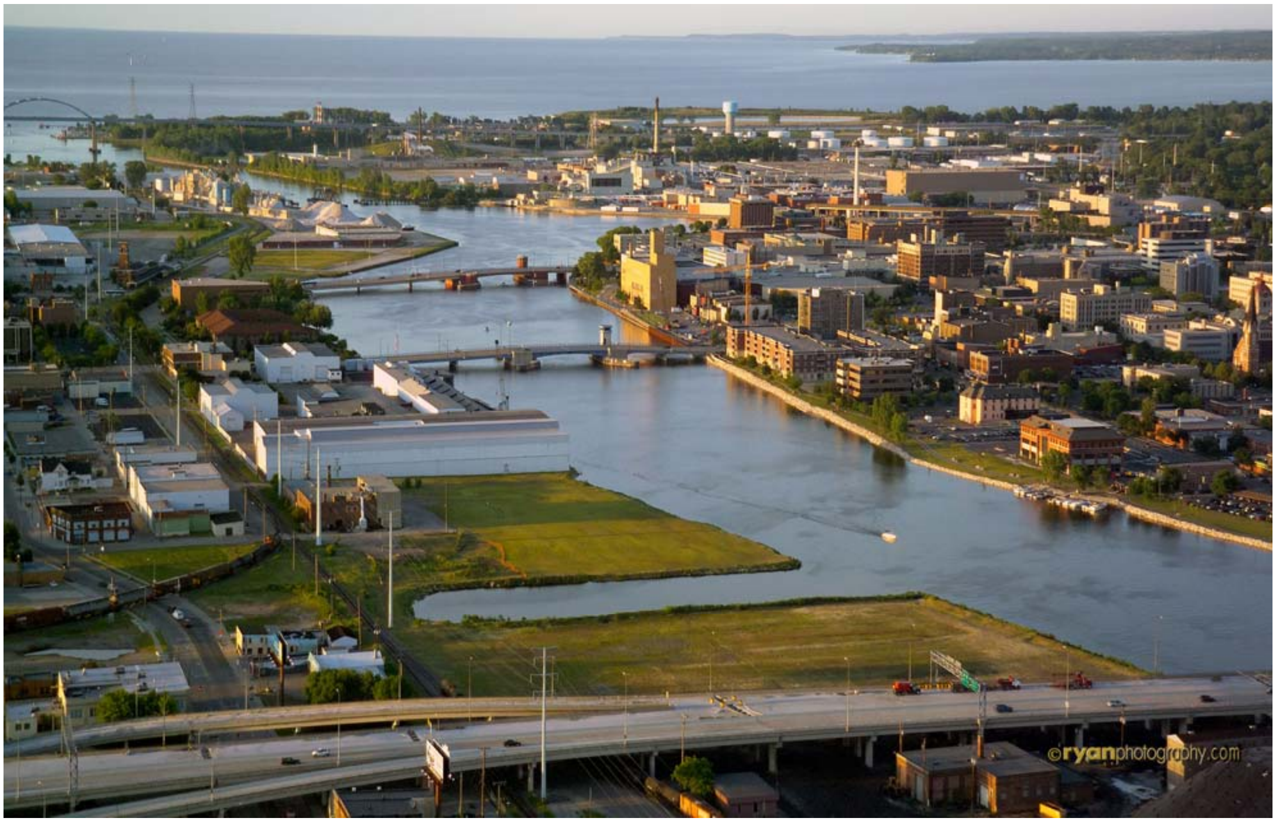
Note: Aerial photos obtained from http://www.ussteel.com/corp/rcra/Dredging_photo_archive.htm on February 12, 2009.

Figure GC25-1d

Aerial Image of Ashtabula River in Area of Concern: **Area of Concern includes approximately 2 miles of the lower river, the Ashtabula Harbor, and adjacent near-shore portion of Lake Erie in an industrialized area.**

<u>Figure GC25-1e</u>
<u>Aerial Image of Upper Hudson River (within area to be dredged)</u>: Shows the large, wide, navigable, and accessible nature of the River in the remediation area.

<u>Figure GC25-1f</u>
<u>Aerial Image of Fox River at mouth of river</u>: Shows the large, wide, navigable, and accessible nature of the River, as well as the urban setting, in the remediation area.



Note: Aerial photo © RyanPhotography.com. Used by permission.

General Comment 26 (Page 11): *EPA notes that in comparing the simulated performance of the various remedial alternatives to each other and/or to the IMPGs, the discussion in the CMS in many cases implies that the model results have greater precision than EPA believes is appropriate. Fate and transport modeling necessarily involves numerous simplifications of natural processes, assumptions of values for various parameters, use of data, and associated data gaps; accordingly, model results must be viewed as having some uncertainty and be interpreted in the context of data, observations, and engineering considerations. To ensure that the selected alternative is adequately protective of human health and the environment, EPA will consider the potential effects of model uncertainty in its review of all results presented in the CMS.*

GE Response: Comment noted.

General Comment 27 (Page 11): *GE shall, for all ARARs identified in the CMS Report, all additional ARARs identified in this letter, and any additional ARARs identified in response to this letter, provide a substantive analysis of each ARAR. GE's substantive analysis of each ARAR shall follow the five-column structure depicted below.*

Statute/ Regulation	*Citation*	*Requirement Synopsis*	*Status (Applicable or Relevant and Appropriate, or TBCs)*	*Action(s) to be taken to achieve ARAR*

GE Response: GE has prepared sets of ARARs tables, following this five-column format, for each of the eight sediment alternatives and each of the seven floodplain alternatives discussed in the CMS Report. These tables provide a substantive analysis of all potential ARARs identified in the CMS Report or in EPA's comments or in response to EPA's comments that pertain to these alternatives. At this time, GE has not prepared similar sets of ARARs tables for the treatment/disposition alternatives. As noted in the Responses to General Comments 1 and 3, given that, under the approach outlined in EPA's February 5, 2009 letter, this Interim Response will be followed by further evaluations and submission of a revised CMS Report, GE has not completed its evaluation of potential locations for an Upland Disposal Facility. Thus, GE has deferred preparation of detailed ARARs tables on the treatment/disposition alternatives until it can do so for all such alternatives (including all potential locations for an Upland Disposal Facility), so that comparisons can be made among those alternatives based on compliance with ARARs. Following completion of that evaluation, GE will include in the revised CMS Report a full set of ARARs tables for the treatment/disposition alternatives, including separate sets of ARARs tables for each potential location for an Upland Disposal Facility under alternative TD 3.

The ARARs tables for the sediment and floodplain alternatives discussed in the CMS Report are provided in Appendix E. Each set of ARARs tables includes separate tables for chemical-specific, location-specific, and action-specific ARARs. For requirements that GE believes would not be met by a given alternative or where attainment of the requirements is uncertain, that column notes that fact. Further, where appropriate, that column gives the basis for a waiver under CERCLA and the National Contingency Plan (NCP). For example, CERCLA and the NCP provide for such a waiver where compliance with the requirement "will result in greater risk to human health and the environment" than other alternatives or where compliance with the requirement is "technically impracticable from an engineering perspective" or where the alternative would "attain a standard of performance that is equivalent" to that required under the ARAR through a different method or approach (CERCLA § 121(d)(4)(B), (C), & (D); 40 CFR § 300.430(f)(1)(ii)(C)(*2*), (*3*), & (*4*)).

As can be seen by review of these tables, the sediment and floodplain soil alternatives that involve removal would not meet a number of the identified ARARs. A few examples are as follows:

- Those alternatives (except for FP 2) would not meet the requirements of EPA's regulations under § 404 of the Clean Water Act (40 CFR § 230.10) that there be no practical alternative with less adverse impact on the aquatic ecosystem (since there is a practical alternative with less adverse impact – i.e., the ecologically sensitive alternative under development), and that the project not cause significant adverse effects on aquatic life, the aquatic ecosystem, and recreational and aesthetic values.

- Those alternatives would not meet the requirements of the Massachusetts water quality certification regulations (314 CMS 9.06) and the Massachusetts Wetland Protection Act regulations (310 CMR 10.53(3)(q), 10.59) that there be no practical alternative with less adverse impacts on the aquatic ecosystem or wetland resource areas, and that the project have no adverse effect on Estimated Habitat of rare wildlife species listed by the State under MESA.

- Those alternatives would all affect the Priority Habitat of a number of animal and plant species that have been listed as threatened, endangered, or of special concern under MESA, and would implicate the MESA prohibition of any project involving a "take" of such a state-listed rare species that would impact a significant portion of the local population of that species (321 CMR 10.00). See also Appendix B to this Interim Response for a more detailed evaluation of these MESA issues.

- Assuming that the Upper Housatonic River is designated as an ACEC, alternatives SED 3 through SED 8 would not meet the requirement in the Massachusetts waterways regulations that there be no dredging in an ACEC except for the sole purpose of fisheries or wildlife enhancement (310 CMR 9.40(1)(b)); nor would they meet the requirements of the Massachusetts water quality certification regulations that dredging minimize and, to the maximum extent practicable, avoid affecting areas of ecological importance and that staging areas have no permanent adverse impact on state-listed rare species or an ACEC (314 CMR 9.07(3)(b), (4)(d)7).

- Based on prior experience and sampling at other portions of the Housatonic River and floodplain (e.g., the 1½-Mile Reach and associated floodplain) it is not anticipated that the sediments and soils that would be removed from the River, riverbanks, and floodplain in the Rest of River area would constitute characteristic hazardous waste under RCRA or the Massachusetts hazardous waste regulations. However, in the unlikely event that some removed materials should be found through sampling to constitute such hazardous waste, the temporary staging areas used for that waste could not practicably meet some of the federal and state design requirements that have been established for hazardous waste storage units (which were developed for permanent storage facilities, not short-term temporary staging areas), as well as some state siting requirements (e.g., prohibiting hazardous waste storage piles within the 500-year floodplain).

Accordingly, a waiver of these ARARs and the others listed in the ARARs tables that could not be met would be necessary in order for the alternatives to be implemented.

General Comment 28 (Page 11): *GE shall produce one set of ARAR charts for each of the eight sediment alternatives, each of the seven floodplain alternatives, and each of the five treatment and disposition alternatives evaluated in the CMS Report as well as any alternatives identified in response to the this letter. Each set of ARAR charts is to include evaluations of Chemical-specific, Location-Specific, and Action-specific ARARs.*

GE Response: See Response to General Comment 27 and the ARARs tables provided in Appendix E.

General Comment 29 (Page 11): *For requirements for which no permit is needed because the work is being conducted "on site", pursuant to CERCLA Section 121(e)(1), GE shall specify that GE remains required to comply with substantive requirements of a provision.*

GE Response: CERCLA provides, in Section 121(d), that, for activities for which no permit is needed because the work would be conducted "onsite" pursuant to CERCLA Section 121(e)(1), compliance with the substantive requirements of the provisions identified as ARARs is required, unless the conditions for a waiver of such requirements under CERCLA and the NCP are met. In this case, however, GE believes, as a legal matter, that certain substantive requirements relating to restoration of affected resources and/or compensatory mitigation for effects on such resources would exceed EPA's remedial authority under CERCLA, the CD, and the RCRA Permit, and would actually amount to actions to address natural resource damages, for which GE has a full covenant under the CD. GE reserves the right to take the position, based on that ground, that it cannot be required to perform such activities.

Responses to Specific Comments

Specific Comments for ARARs

Specific Comments 1 through 23 (Pages 12-14) contain EPA's comments relating to the ARARs that were identified in the CMS Report, additional ARARs that need to be identified, and the types of analyses that EPA would like to be included in the evaluations of particular ARARs. These comments are all addressed in the ARARs tables provided in Appendix E except insofar as they relate to the treatment/disposition alternatives. As noted above in the Responses to General Comments 3 and 27, GE has deferred preparation of detailed ARARs tables on the treatment/disposition alternatives until it completes its evaluation of potential locations for an Upland Disposal Facility and can thus develop ARARs tables for all TD alternatives (including all potential locations for an Upland Disposal Facility) to allow comparisons among them. A full set of ARARs tables for the treatment/disposition alternatives will be included in the revised CMS Report and will address EPA's comments that relate to such alternatives.

It should be noted that, for the extensive evaluations requested by EPA in Specific Comment 21, relating to compliance with the specific substantive requirements of MESA, summary information is provided in the ARARs tables, and detailed backup assessments of the MESA issues for each state-listed rare species (i.e., threatened, endangered, or special concern species) identified by the NHESP to be present in the PSA are provided in the document entitled "Assessment of MESA Issues for Rare Species Under Remedial Alternatives," which is Appendix B to this Interim Response. That document is based on Priority Habitat mapping provided by NHESP for the PSA, combined with information about the remedial alternatives. It presents, for each state-listed rare species, a discussion of the life cycle and habitat requirements of that species, the presence of that species within the PSA, the impacts of all of the sediment and floodplain remedial alternatives on that species, and a detailed assessment of the MESA issues for each alternative. These MESA issues are: (a) whether the alternative would result in a take of the species under the MESA regulations: (b) whether a take could be avoided; (c) whether the take would affect a significant portion of the local population of the species within the PSA; and (d) for those species where the alternative would not be expected to affect a significant portion of the local population, whether a long-term Net Benefit plan could feasibly be developed (and, if so, what it might involve).[19]

Executive Summary

<u>Specific Comment 24 (Page 15):</u> *<u>Page ES-2 to ES-3</u>: EPA notes that the discussion of the area between the Confluence and Woods Pond is incomplete. This habitat is correctly described in terms of the wide floodplains, extensive wetlands, and large backwaters that are present. However, potential impacts to these areas are described only in terms of the effects of remediation ("unavoidably impacting flora, fauna, and aesthetics"), but without recognition of the current impacts from risks posed by PCBs. Neither is the strategy to avoid, minimize or mitigate for impacts from remediation discussed.*

GE Response: The referenced paragraph did recognize the PCB levels in this area, noting that "this area contains the highest PCB concentrations." Moreover, the last sentence in the paragraph states that "the goal of the evaluation of alternatives presented in this CMS Report is to select a remedial approach that achieves overall protection of human health and the environment with the least amount of adverse impacts and in the most cost-effective way" (CMS Report, p. ES-3). This statement acknowledges the need to protect human health and balance the goal of achieving the ecological IMPGs established by EPA for the Rest of River against the permanent adverse effects of the remedial actions that would be necessary to achieve those IMPGs. Indeed, throughout the CMS Report, the evaluation of alternatives considered both the potential risks from PCBs and the potential impacts of the remediation. These were considered together under the standard of "Overall Protection of Human Health and the Environment." Finally, the discussion of remediation impacts in the CMS Report did consider the avoidance, minimization, or mitigation of such impacts.

It is critical that the concerns of the public, the Commonwealth, and EPA about the irreparable damage that the sediment and soil removal alternatives evaluated in the CMS would cause to the PSA and its diverse and abundant wildlife be fully explored. This damage is discussed in greater detail in the Response to General Comment 10 in this Interim Response, as is the fact that, in many cases, much of this damage cannot be avoided, minimized, or mitigated through restoration activities.

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19 GE also acknowledges, as noted in EPA's Specific Comment 21, that compliance with MESA is not restricted to areas formally designated as Priority Habitats, but also includes other areas, if any, where information on the occurrence of a state-listed threatened, endangered, or special concern species has been received by NHESP (321 CMR 10.13). However, apart from the Priority Habitat information provided by NHESP and the rare species observations reported by Woodlot Alternatives (2002) – both of which are discussed in Appendix B – GE knows of no other specific information on the occurrence of rare species in this area.

<u>Specific Comment 25 (Page 15):</u> *<u>Page ES-3, ES-15</u>: It is stated in the CMS that "the less time that it takes to implement the remedy, the faster any potential benefits will be realized." The statement fails to recognize that, in general, alternatives involving greater amounts of remediation generally include additions to remediation already specified in the simpler alternatives. Thus, the benefits of the simpler alternatives and the benefits of the same remediation conducted as part of a more complex alternative are realized in approximately the same amount of time. It just may take longer in its entirety to implement a remedy that involves a greater area, or potential larger volumes of material. In addition, this comment, and the text that follows it, is biased toward consideration of only the negative consequences of remediation. The remedial alternatives that take 25-50 years to implement in their entirety are described as "extreme," whereas the presence of PCBs in the Housatonic River since the 1930's and associated risks (in the past, now, and/or in the future) is understated.*

GE Response: It is true that where two alternatives involve the same remediation over the same time period in a given reach of the River, they would realize the benefits for that reach in the same amount of time, regardless of whether they would also address other reaches later. However, for the River as a whole, the extent and duration of remediation in a given alternative affect both the extent of adverse impacts from implementation and the time for achievement of benefits in more downstream reaches. Thus, the larger sediment alternatives, such as those that would take 25 to 50 years, would adversely impact the overall Rest of River area for a much longer time; and since they would involve more extensive remediation, they would take longer to reach certain areas of the river, which would delay any potential benefits in those areas. See also Response to General Comment 20.

GE believes that it is fair to characterize a remedy that would have adverse impacts on the Rest of River ecosystem for 25 to 50 years as "extreme." By contrast, while PCBs have been present in the Rest of River ecosystem for over 70 years, any adverse impacts of those PCBs, as determined in EPA's risk assessments, are theoretical. See also Response to Specific Comment 26 below.

<u>Specific Comment 26 (Page 15):</u> *<u>Page ES-5</u>: EPA notes that the statement that "abundant, diverse, and thriving fish and wildlife population and communities" have been documented in the Rest of River is inconsistent with the findings of the Peer Review Panel for the ERA for some species in the ecosystem (e.g. benthic invertebrates, amphibians, mink/otter).*

GE Response: EPA's Ecological Characterization of the Housatonic River (Woodlot Alternatives, 2002) showed diverse communities with abundant wildlife in the PSA – including 12 mussel species, 38 dragonfly species, 41 fish species, 5 reptile species, 14 amphibian species, 139 bird species, and 42 mammal species. In addition, the EPA and GE field studies discussed in EPA's Ecological Risk Assessment (ERA) showed the presence of populations of various species that were subject to the studies. The peer reviewers of the ERA did not dispute that, in fact, these field surveys/studies showed numerous and diverse fish and wildlife populations in the Rest of River, although they expressed a range of views on the weight that should be given to field studies and on the degree to which the ERA's conclusions regarding risks from PCBs to such local populations of the selected receptor groups were supported. In any event, as stated in the CMS Report and numerous other prior submissions to EPA, GE believes that many of the exposure assumptions, inputs, and data interpretations in EPA's ERA overstate PCB exposures and risks to fish and wildlife receptors in the Rest of River area. These points are summarized in the referenced sentence on page ES-5 of the CMS Report, which reads: "Further, GE does not believe that the evidence reveals significant adverse effects of PCBs on the Rest of River ecosystem; indeed, field surveys by both EPA and GE contractors have demonstrated abundant, diverse, and thriving fish and wildlife populations and communities in the Rest of River area despite decades of exposure to PCBs."

In addition, since that time, the August 2008 Nomination of the Upper Housatonic River as an ACEC (Save The Housatonic, 2008) provided additional information showing the diverse, abundant, and reproducing populations of fish and wildlife present within and downstream of the PSA, including an extraordinary number of state-listed rare species. As previously discussed, the NHESP of the MDFW has designated virtually the entire PSA as Priority Habitat for state-listed rare species (i.e., threatened or endangered species or species of special concern), including 28 separate listed species with Priority Habitat within the PSA. These developments provide additional support for GE's statement in the CMS Report.

Specific Comment 27 (Page 15): *Page ES-6: The CMS mentions that "upstream remediation/source control activities, along with natural recovery processes, have significantly reduced the PCB loads in the Rest of River and those improvements are continuing." EPA notes that this comment should not be interpreted to mean that monitored natural recovery will result in rapid improvement of environmental conditions in all reaches. GE's fish tissue sampling program over the last decade shows no discernible reduction in PCB concentrations in young of the year fish at the sampling locations in the MA portion of Rest of River, even in light of the upstream remediation and source control activities and* *improvements measured in the remediated reaches. This is due to the large inventory of PCBs which exists in Rest of River and the exposure concentrations which result from this inventory being proportionally greater than the reductions made in loadings from sources located upstream.*

GE Response: GE's statement was based on the analyses summarized in Section 4.1.3 of the CMS Report. That section stated:

> "For example, water column PCB sampling data collected from the station located immediately upstream of the Confluence (Dawes/Pomeroy Avenue) indicate that the in-river and upland remediation has reduced the East Branch PCB concentrations by a factor of three to five under both base flow and storm conditions . . . . Likewise, the annual average PCB loads entering the Rest of River from the East Branch from the model simulations exhibit a marked reduction from the upstream remediation. For example, the East Branch PCB load over the first 5 years of the model projections . . . is 90% lower than the load over the last 5 years of the model validation (i.e., 1999-2004 . . .). Some additional decreases in this PCB load would also be anticipated based on the planned future [remediation] activities . . .."

With respect to fish tissue PCB levels, it should be noted that, since the CMS Report was submitted, GE has conducted an additional round of sampling of adult largemouth bass at three locations in the Rest of River – Reach 5B/5C, Woods Pond, and Rising Pond. This sampling was conducted on September 3-5, 2008, and involved the collection of 15 bass at Reach 5B/5C, 15 bass at Woods Pond, and 10 bass at Rising Pond, which are comparable to the numbers of largemouth bass previously sampled at these locations by EPA in 1998 and by GE in 2002. All of these fish collection efforts were conducted at the same time of year. These samples were submitted for analyses of the fillets and the offal for PCBs and lipids. The results are presented in Table SC27-1. Comparisons of these results with the results of the samples collected in 1998 and 2002 are shown, for both fillets and reconstituted whole bodies (fillets plus offal) and on both a wet-weight and lipid-normalized basis, on Figures SC27-1 through SC27-4. As shown by those figures, the 2008 samples show a substantial reduction in PCB concentrations in the fish in Reach 5B/5C and Woods Pond compared to those measured in 1998 and 2002. This reduction is particularly pronounced in the fillets, but is also evident in the reconstituted whole body data, and can be observed for both wet-weight concentrations (Figures SC27-1 and SC27-2) and lipid-normalized concentrations (Figures SC27-3 and SC27-4).

The statistical significance of the observed declines in PCB concentrations in the adult PSA fish was confirmed through a 3-way (reach, tissue preparation, and year) analysis of variance (ANOVA) performed on log-transformed lipid-normalized concentrations.[20] For both the Reach 5B/5C and Woods Pond locations, this analysis shows a significant difference in PCB concentrations, with the 2008 data being significantly lower than both the 1998 and 2002 data ($p < 0.05$). In addition, the 1998 and 2002 data were not significantly different from one another. For the Rising Pond data, based on a one-tailed Student's t-test, there is no statistically significant difference in concentrations between the 1998 and 2008 fish data.

In addition, GE has recently completed another round of biennial sampling of young-of-year fish. This sampling, conducted between September 29 and October 2, 2008, involved the collection of composite samples of largemouth bass, yellow perch, and bluegill/pumpkinseed at four locations in Massachusetts – New Lenox Road (HR 2), Woods Pond, Glendale Dam, and the Connecticut border (HR 6) – for analysis of PCBs and lipid content. The resulting data are presented in Table SC27-2. In addition, the mean concentrations for each species and location for 2008 are shown in relation to those from prior years (1994-2006), on both wet-weight and lipid-normalized bases, in Table SC27-3 and Figures SC27-5 and SC27-6. The recent young-of-year data are generally consistent with the recent adult largemouth bass data from the PSA. While trends in young-of-year fish data can be confounded by year-to-year variability arising from several sources (e.g., hydrologic conditions, water temperature), the samples collected in 2008 generally show a decline in PCB concentrations from prior years and PCB levels that are among the lowest observed since the start of this program in 1994.

These data provide further support for the conclusion that source control and remediation efforts upstream of the Confluence, together with natural recovery processes within the Rest of River, have resulted in a significant reduction in PCB concentrations in the portion of the Rest of River between the Confluence and Woods Pond Dam.

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[20] Data were lipid-normalized in order to remove variability in concentrations due to differences in lipid content; data were log-transformed since ANOVA assumes that the distributions in each of the groups are normally distributed and previous statistical analyses of the fish data from the system indicated that the data were generally lognormally distributed (e.g., Figure D-2.1 of the RFI Report).

<u>Specific Comment 28 (Page 15):</u> *<u>Page ES-13</u>: EPA disagrees with the statement that "all the sediment alternatives that would involve removal would meet the General Standards in the Permit." For example, this claim is not supported by the Risk Assessment findings, which indicate that components of the General Standard of "Overall Protection of Human Health and the Environment" would not be achieved for several receptor groups (including humans) in many of the sediment alternatives at various reaches.*

GE Response: GE does not agree with this comment. To begin with, as discussed in Section 2.1.1 of the CMS Report, achievement of the IMPGs based on EPA's risk assessments is not necessary to meet the General Standard of "Overall Protection of Human Health and the Environment." Attainment of IMPGs is just one of several Selection Decision Factors to be balanced against other such factors, including the permanent adverse effects of the remedial actions that would be necessary to achieve those IMPGs. The assessment of overall human health and environmental protection requires consideration of a variety of factors, as discussed in Section 2.1.1.

In terms of human health protection, all the sediment removal alternatives would provide such protection from direct contact with sediments, since they would all achieve levels within EPA's cancer risk range, as well as the non-cancer-based levels, for direct contact in all sediment exposure areas. Further, since none of the alternatives would achieve the levels that EPA considers protective for human consumption of fish (at least in Massachusetts), they would all use fish consumption advisories to provide human health protection from fish consumption.

In terms of environmental protection, the fact that a given alternative may not achieve the IMPGs for some ecological receptors in some areas does not make that alternative not protective of the environment. Evaluating the overall protectiveness of the environment of any alternative requires both consideration of the objective of protecting local populations and communities of receptors (not individual animals) and balancing the goal of achieving the IMPGs (based on the inputs required by EPA) against the short-term and long-term, and even permanent, ecological damage that would be caused by the remedial actions that would be necessary to achieve those IMPGs. EPA's September 9, 2008 correspondence to GE shared a concern previously expressed by the public and the Commonwealth that the CMS Report did not provide sufficient information to support such an evaluation.

Since EPA's September 9, 2008 correspondence to GE, GE has further evaluated the ecological impacts of the alternatives evaluated in the CMS Report. Based on those additional evaluations, GE agrees with those who had concluded that any combination of the sediment and floodplain soil removal alternatives evaluated in the CMS Report would be inappropriate. Based on that conclusion, GE began work on the development of a more ecologically sensitive alternative, and is currently discussing that alternative with EPA and the Commonwealth. EPA's February 5, 2009 correspondence to GE agreed that this ecologically sensitive alternative "should be further developed and analyzed and compared to the existing suite of alternatives on an equal footing under the CMS process provided for by the Consent Decree." In the meantime, the results of GE's additional evaluations of the ecological impacts of the alternatives evaluated in the CMS Report are presented in this Interim Response, primarily in the Responses to General Comments 6 and 10 and Appendix B.

GE will evaluate and compare the overall protectiveness of the environment of all of the remedial alternatives, including the ecologically sensitive alternative, in the revised CMS report, as proposed by EPA in its February 5, 2009 correspondence to GE.

Specific Comment 29 (Page 16): *Page ES-14: EPA notes that lack of feasibility of achieving thresholds for unlimited human consumption of fish is not a valid justification for not attempting to reduce risks for this pathway. This argument is invalid because it does not consider the value of risk reduction in either a limited consumption scenario (i.e., inability to achieve risk levels allowing unlimited consumption does not necessarily prevent regulators from changing total restrictions to partial restrictions), a scenario in which fishing restrictions are ignored, or a scenario where consumption could occur, but after a longer duration than the model simulations suggest.*

GE Response: The cited page simply points out that none of the sediment alternatives would achieve, in Massachusetts, the PCB levels in fish that EPA considers to be protective for unrestricted consumption of Housatonic River fish (i.e., the RME IMPGs) within the model period, and that thus fish consumption advisories would have to remain in place indefinitely no matter the extent of remediation. With respect to the potential for achieving levels considered suitable for limited fish consumption (e.g., the CTE IMPGs), the modeling results indicate that all of the sediment removal alternatives would achieve some CTE levels in some Massachusetts reaches, with greater attainment under a probabilistic analysis (see Table 4-55 of the CMS Report; Tables GC13-5 and GC13-9 in this Interim Response). In any event, achieving the CTE IMPGs in some reaches would not avoid the need for fish consumption advisories. The Massachusetts Department of Health bases consumption advisories on general conservative assumptions about a given waterbody and is unlikely to make fine distinctions based on achievement of the CTE IMPGs in some reaches of the River.

With respect to the potential for achieving unrestricted fish consumption levels after the end of the model simulation period, the extrapolation of the model results beyond the end of that period indicates that the time to achieve such levels for both cancer and non-cancer effects in Massachusetts under the various sediment alternatives would extend to well over 100 years in nearly all cases and over 250 years in many cases (see CMS Report, Table 4-56, and Table GC13-5 in this Interim Response). As explained in the CMS Report (Section 3.2.1), this extrapolation procedure is highly uncertain. Given that uncertainty, use of this extrapolation procedure to project differences among alternatives, especially at a time scale of centuries, is too speculative to serve as a basis for a major remedial decision.

Specific Comment 30 (Page 16): *Page ES-14: EPA notes that the discussion of short-term and long-term effectiveness must also recognize the existing impacts from PCB contamination, the length of time it will take for the system to be unaffected by PCBs via natural recovery, and the manner in which remediation is implemented. A well-crafted and carefully implemented remediation and restoration strategy will allow the plant and animal communities to recover rapidly. Arguments presented in the CMS inappropriately question the ability of a properly implemented environmental restoration program to recreate fully functional ecological habitats and communities.*

GE Response: Short-term and long-term effectiveness of the remedial alternatives were discussed in the CMS Report in a manner consistent with the description of those factors in the Permit and the EPA-approved CMS Proposal (ARCADIS BBL and QEA, 2007a). In general, the short-term and long-term impacts of the alternatives were described in terms of the impacts from implementation of those alternatives, as provided in the CMS Proposal (pp. 5-40, 5-41). The potential impacts from PCBs were considered under other factors, including magnitude of residual risk and attainment of IMPGs, and were considered together with the impacts of implementation under the General Standard of "Overall Protection of Human Health and the Environment."

As noted above, GE does not agree with EPA's conclusions regarding "the existing impacts from PCB contamination." Moreover, GE does not agree with EPA's assertions that "[a] well-crafted and carefully implemented remediation and restoration strategy will allow the plant and animal communities to recover rapidly" and will "recreate fully functional ecological habitats and communities." See Responses to General Comments 6 and 10 and Appendix B.

<u>Specific Comment 31 (Page 16):</u> *<u>Page ES-14</u>: EPA disagrees with the statement that all sediment removal alternatives would address ecological risks identified in the ERA and would provide overall protection of the environment. The term "address ecological risks" is misleading because many receptors and areas of the river would continue to have ecological impairment following implementation of some of the sediment alternatives.*

GE Response: With respect to whether the sediment removal alternatives would provide overall protection of the environment, see Response to Specific Comment 28. Moreover, GE disagrees with EPA's assertion that there would be "ecological impairment" following implementation of the sediment alternatives other than as a result of the implementation of those alternatives themselves.

<u>Specific Comment 32 (Page 16):</u> *<u>Page ES-14</u>: EPA disagrees with GE's application of a dilution-based argument in their claim that "maintenance of healthy local populations" of mobile receptors would be achieved. This argument implicitly, but incorrectly, assumes that the contaminated area within the area of IMPG exceedances has no inherent ecological value to wildlife, and that there would only be a concern if the broader wildlife population outside the Rest of River area were threatened. The area affected by PCB concentrations exceeding IMPGs is sufficiently large that significant numbers of individual organisms would be affected in the Rest of River area, and as such cumulatively have implications for local subpopulations. In addition, the home ranges for some receptors fall entirely within the areas of IMPG exceedances. GE's implied definition of local population is so broad as to be a regional population.*

GE Response: GE does not assume that the area of IMPG exceedances has no inherent ecological value to wildlife, and in fact believes that it has unique ecological value. On this page, GE was simply pointing out that, for each of the receptor groups involved (amphibians, piscivorous birds, insectivorous birds, and piscivorous mammals), the local populations extend beyond the areas of the IMPG exceedances to other areas of the Rest of River where PCB levels are lower and/or to nearby areas outside the site. For instance, the local amphibian populations include the amphibians inhabiting the floodplain vernal pools and backwaters in the PSA that have suitable amphibian habitat.[21] For birds, given their high mobility, it is not realistic to assume that disconnections between areas of suitable habitat in the PSA would create boundaries between distinct local populations; rather, the

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[21] For example, EPA's own ERA defined the local wood frog breeding population in the PSA as those wood frogs breeding within the vernal pools in the PSA that have suitable wood frog breeding habitat (EPA, 2004, Vol. 5, App. E, Att. E.4, p. 2).

local populations appear to extend through the PSA without biologically discrete population segments (see CMS Report, p. 5-13 n.121; see also Response to Specific Comment 56). For mink, given their large foraging ranges, the PSA could support, at most, only a subset of the local population; the overall local population would extend to areas near the shoreline but outside the 1 mg/kg PCB isopleths, areas along tributaries, and other riverine areas in the vicinity (see CMS Report, p. 4-62 n.58, p. 5-16 n.124).

In these circumstances, even if exceedances of the IMPGs might suggest that there may some effects (e.g., malformations, non-survival, lower weights) in some percentage of the offspring of individual animals within the areas with such exceedances, those effects would not be expected to prevent the maintenance of healthy local populations of these animals. GE does not agree that, in the cases discussed in this portion of the CMS Report, the IMPG exceedances indicate that a sufficient number of animals would be affected to adversely affect the local populations. Moreover, the fact that the home ranges for some individual animals may be entirely within the areas of IMPG exceedances does not change the fact that, even if some portion of those animals' offspring may be affected, that would not necessarily have population-level consequences. This is supported by the fact that EPA's and GE's field surveys documented the presence of numerous and diverse species in the PSA, including the areas with IMPG exceedances, thus showing that despite the exceedances, those areas ***do*** have ecological value to wildlife.

By contrast, as discussed in the Response to General Comment 10, the more intrusive remedial alternatives (i.e., SED 3 through SED 8 and FP 3 through FP 7), at the spatial and temporal scales involves, would have far more negative consequence to the existing local populations of these receptors through loss and severe disturbances of their current habitats.

Specific Comment 33 (Page 16): *Page ES-18: EPA disagrees with the implication that, in making determinations of net negative impact, restoration scenarios of many years or decades are inherently unacceptable. Because the effects of PCB contamination have been present for many decades already, and would be expected to remain present for many more decades if not centuries if not remediated, long-term adverse effects are present even for the no-action and MNR alternatives. In addition, EPA notes that adverse impacts are not simply a function "of the area impacted by remediation" but are also a function of the residual PCB risks. Such statements are also made in the context of no defined plan to avoid, minimize, or mitigate such impacts where possible, a defined plan to optimize restoration opportunities, or the recognition that restoration will follow on the heels of* *remediation for any given area, such that the entire area affected by an alternative is not impacted for the entire duration of implementation of the alternative.*

GE Response: GE did not conclude that remediation/restoration scenarios of many years or decades are inherently unacceptable. Rather, GE pointed out on the cited page that the largest floodplain alternatives would cause significant short-term and long-term ecological damage; and it also considered the potential effects of PCBs that would be addressed by those alternatives and weighed those potential effects against the ecological damage that would be caused by the remedial actions that would be necessary to remove those PCBs from the environment. In addition, points regarding avoidance, minimization, or mitigation of impacts and restoration of affected habitats were included throughout the CMS Report text.

GE has further evaluated the ecological impacts of the all of the remedial alternatives evaluated in the CMS Report, as well as the ability to avoid, minimize, or mitigate those impacts. The results of those additional evaluations are presented in the Responses to General Comments 6 and 10 and Appendix B to this Interim Response. Those responses describe the adverse ecological impacts of the active remediation alternatives and the reasons that it is unlikely that many of the affected habitats could recover from those impacts for decades, if ever. As discussed above, given the concerns reflected in those responses, GE is currently discussing with EPA and the Commonwealth an ecologically sensitive alternative that would minimize those negative impacts. As noted in the Response to Specific Comment 27, following the development and evaluation of that alternative, GE will evaluate and compare the overall protectiveness of the environment of all of the remedial alternatives, including the ecologically sensitive alternative, in the revised CMS Report.

Section 2: Description of Evaluation Criteria

<u>Specific Comment 34 (Page 17):</u> *<u>Page 2-2</u>: EPA notes that it is important to understand that the observation of one or more individuals of a given species does not in itself provide proof of suitable health of such ecological communities or subpopulations. In evaluating alternatives on the ability to reduce "ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota," GE states that it has considered "the extent to which the alternatives would achieve that population- or community-level goal." EPA believes that GE has incorrectly interpreted the term "healthy local populations and communities" to be synonymous with simple occurrence of individuals. The latter does not, in isolation, achieve the narrative remedial action objective.*

GE Response: The CMS Report did not indicate that the simple occurrence of individuals is synonymous with the term "healthy local populations and communities of biota." The referenced paragraph states that, in assessing whether remedial alternatives would achieve the goal of recovery and maintenance of healthy local populations and communities, GE considered, as one factor, the attainment of the ecological IMPGs and also considered, where relevant, "the potential implications of th[e] estimated PCB concentrations for the local populations and communities of the receptor in question, given the habitat and characteristics of the receptor population, including the home range of animals within that population" (CMS Report, pp. 2-2 to 2-3). It is worth noting, however, that the field surveys finding numerous and diverse species in the Rest of River area despite decades of PCB exposure throughout that area do provide evidence of healthy and reproducing populations and communities of wildlife. This is further supported by the nomination of the Upper Housatonic River as an ACEC, as discussed in the Response to Specific Comment 27.

Specific Comment 35 (Page 17): *Page 2-2: EPA notes that it is important not to extend the definitions of populations and communities to include a spatial scale that is inconsistent with the Ecological Risk Assessment (ERA). The ROR between the Confluence and Woods Pond Dam contains more than 10 miles of high-quality wetland habitat for aquatic and terrestrial organisms. It is inappropriate to conclude that observation of organisms (e.g. mink) elsewhere in the Berkshires provides evidence of a lack of ecological harm in the ROR area.*

GE Response: GE agrees that the Rest of River contains more than 10 miles of high quality wetland habitat that is unique in several respects, including the presence of numerous rare, threatened, and endangered species and its proximity to other sensitive habitat, including upland forests. However, GE believes that, in some cases, the local populations of receptors extend beyond the PSA. For example, as noted in the CMS Report (p. 4-62 n.58, p. 5-16 n.124) and discussed in greater detail in GE's July 25, 2007 Statement of Position in its dispute of EPA's July 11, 2007 conditional approval of the CMS Proposal Supplement, GE believes that: (a) given the fairly large foraging and home ranges of mink, the PSA could support, at most, only relatively few mink; (b) it is reasonable to expect that mink utilizing the PSA would also use areas outside the 1 mg/kg isopleth (e.g., areas near the shoreline but outside that isopleth and areas along tributaries) as part of their foraging range; and (c) in any case, the mink using the PSA would make up only part of the local mink population.

<u>Specific Comment 36 (Page 17):</u> *<u>Page 2-3</u>: EPA recognizes that a remedial alternative that does not uniformly achieve all ecological IMPGs at all locations may be acceptable based on a balancing of other factors such as short- and long-term ecological impacts of implementation. However, EPA does not agree that an alternative that fails to achieve ecological IMPGs should be characterized without qualification as "protective of the environment."*

GE Response: As noted above (Responses to Specific Comments 28 and 34) and as EPA appears to recognize here, it is not necessary for a given remedial alternative to achieve all the ecological IMPGs in order to meet the General Standard of overall protection of the environment. Rather, the assessment of that standard involves consideration of various other factors as well, including the implications of the IMPG exceedances for the local populations and communities of the biota and the long- and short-term ecological impacts of the alternatives. Thus, an alternative that does not achieve certain ecological IMPGs can be characterized as providing "overall protection of the environment"; otherwise, the attainment of IMPGs would be a General Standard, rather than a Selection Decision Factor.

<u>Specific Comment 37 (Page 17):</u> *<u>Page 2-8</u>: GE shall confirm if the PCB concentration in the top 6 inches of sediment was consistently used in estimating exposure to receptors other than those simulated in FCM, or if the depth evaluated was varied to be consistent with the food-chain model exposure depth.*

GE Response: The 0- to 6-inch depth increment was used for assessing attainment of all sediment-based IMPGs.

<u>Specific Comment 38 (Page 17):</u> *<u>Page 2-11</u>: Here and elsewhere in the CMS, the "blended fish" calculations used for human health risk comparisons rely exclusively on concentrations in largemouth bass. Changes in fillet concentrations, therefore, show more sensitivity to changes in water column PCB concentrations than would have been the case if additional species, which derive more exposure from sediment sources (e.g., brown bullhead) were included in the calculation as was done in the Human Health Risk Assessment. GE shall include a discussion of the sensitivity of the model to the use of solely largemouth bass.*

GE Response: To assess the sensitivity of the use of model outputs for largemouth bass to evaluate attainment of the human consumption IMPGs in the CMS, the method used by EPA in the HHRA to calculate a "blended" fish was adapted for use with the species simulated by EPA's FCM. The methodology used for calculating the "blended" fish concentrations was consistent with that provided by EPA to GE in an email dated November 12, 2008 (included as Appendix F to this Interim Response). These "blended" fish results were then compared to the results using the fish concentrations used in the CMS Report.

Blended Fish Calculation Method

Application of the "blended" fish calculation consisted of averaging model outputs across different species and size classes, as shown by the equation below, which was developed by EPA (Appendix F) for the PSA and Reach 7/8:

$$\text{Blended Fish, PSA and R7/8} = [LMB_{(\text{fillet, Age 9+})}] * 0.75 + [BB_{(\text{fillet, age 5+})}] * 0.25$$

"Blended" fish assumptions for Connecticut were not provided by EPA in Appendix F. In the HHRA, the calculation of fish EPCs in the Connecticut reaches used smallmouth bass data, which were represented by the Reach 7/8 largemouth bass model in the CMS (e.g., see Appendix F of the CMS Report). Similar to largemouth bass, smallmouth bass also have a length limit of 12 inches; therefore, only age classes corresponding to lengths greater than 12 inches were used in the calculation. Thus, the "blended" fish concentration for Connecticut would be unchanged from what was used in the CMS; that is:

$$\text{Blended Fish, CT} = \text{Average}\ (LMB_{(\text{fillet, >=30.4 cm.})})$$

Results from Blended Fish Calculation

Application of the "blended" fish averaging methods described above to FCM outputs results in PCB concentrations that are on average 5% higher than those documented in the CMS Report, which were based on largemouth bass alone. The reason for this average increase is due to the exclusion of smaller sized largemouth bass (which would have lower concentrations) and the inclusion of brown bullhead (a bottom feeder) in the calculation.

To evaluate the impacts of the revised "blended" fish calculations on the prior comparative evaluations, the extent of human fish consumption IMPG attainment resulting from the use of this "blended" fish PCB concentration was compared to that resulting from the sole use of largemouth bass, as used in the CMS Report.[22] These results are summarized in Tables SC38-1 through SC38-7 for each of the sediment alternatives. These tables show that the slight average increase in PCB concentrations has a negligible effect on attainment of IMPGs and, overall, results in slightly less IMPG attainment. The reductions in IMPG attainment can be characterized by a few individual cases for each sediment alternative, with the majority of the changes to non-attainment occurring for the deterministic CTE IMPGs. In contrast, there are only three cases where additional IMPGs would be attained as result of the revised "blended" fish calculation, all of which are for SED 8 (probabilistic RME non-cancer (adult) in Reach 6, deterministic RME 10^{-4} cancer in Reach 7E, and deterministic CTE non-cancer (child) in Reach 7E).

Specific Comment 39 (Page 17): *Page 2-12: It is stated in the CMS that ecologically based IMPGs "are considered to be protective of the range of species within each of the broader receptor groups." EPA notes that it is incorrect to assume that the representative species selected are necessarily protective of all other species within the functional groups (assessment endpoints), as many factors go into the selection of a representative species for the purpose of the risk assessment. The Rest of River ERA risk characterizations for each group of receptors specifically assessed whether the risk assessment findings for the surrogate organism are expected to be protective of other species in the Housatonic River. Table 12.4-1 of the ERA summarizes these findings. Although many of the comparisons indicate a level of risk similar to or lower than the representative species, there are a number of cases for which higher risks are predicted for other species within an assessment endpoint (e.g. salamanders relative to wood frogs).*

GE Response: EPA selected certain representative species to represent each receptor group. The IMPGs for the various receptor groups were based on data for those representative species, but were developed to be protective of the receptor groups. As recognized in the Permit, the whole purpose of developing the ecological IMPGs was to have "preliminary goals that are shown to be protective of . . . the environment" (Special Condition II.C.1). Moreover, in its comments on GE's original IMPG Proposal submitted in September 2005 (GE, 2005), EPA directed GE to revise the IMPGs as specified by EPA "such that the discussion and assumptions used can be considered protective of all species of concern for the Assessment Endpoint, not just the representative species" (EPA December 9, 2005 comments, p. 8). GE did revise the IMPGs as specified by EPA in its

[22] Note that model endpoint concentrations from the CMS Report have been updated to reflect the revised Reach 7/8 model runs for SED 6, SED 7, and SED 8 that have been conducted in response to EPA's Specific Comment 44. These updated concentrations have been used in these comparisons.

comments and in subsequent discussions with GE; it submitted those revised IMPGs in a revised IMPG Proposal in March 2006, which stated that the IMPGs "are considered protective of the range of species within each of the broader groups" (GE, 2006, p. 46); and EPA approved that revised IMPG Proposal. Thus, while achievement of the IMPGs is not necessary for an alternative to be considered protective of the environment, it can be concluded that if an alternative meets the IMPGs for a given receptor group, it can be considered protective of that receptor group from the potential effects of PCBs. Of course, that does not mean that such an alternative would necessarily be, overall, protective of the environment, since that issue also requires consideration of the extent of adverse ecological effects from implementation of the alternative, which could cause greater harm than any failure to achieve IMPGs.

Specific Comment 40 (Page 18): *Page 2-17: It is not clear from the text whether the referenced "IMPG attainment factor" is a qualitative or quantitative metric. If quantitative, the basis for calculation of an IMPG attainment factor should be provided. GE shall provide additional detail on the "IMPG attainment factor", including the formula for its calculation, if appropriate.*

GE Response: The term "IMPG attainment factor" is not a quantitative metric, but is simply a short-hand name for the "Attainment of IMPGs" Selection Decision Factor.

Specific Comment 41 (Page 18): *Page 2-18: In addition to evaluating short-term impacts and risks to the environment, nearby communities, and workers, GE shall recognize the potential short-term impacts to cultural resources in and adjacent to the ROR.*

GE Response: Short-term effectiveness was evaluated in the CMS Report consistent with the definition of that factor in the EPA-approved CMS Proposal. This definition does not include short-term impacts to cultural resources. Nevertheless, GE agrees that, in the design of a remedy, impacts to cultural resources should be considered, and it has submitted a Phase 1 Cultural Resources Assessment describing the procedure to be used to consider such impacts.

Section 3: Approach to Evaluating Remedial Alternatives for Sediment/Erodible Riverbanks

<u>Specific Comment 42 (Page 18):</u> *<u>Page 3-1</u>: EPA recognizes that it was appropriate to evaluate remedy components on a reach-wide basis in the CMS but notes that it will be necessary and appropriate in the final design to implement different remedies for smaller sections of a floodplain area or reach with unique characteristics. In addition, EPA intends to consult with appropriate state and federal resource agencies to identify one or more smaller sections of a floodplain area or reach with unique characteristics for more in-depth evaluation consistent with General Comments 10 and 16. GE shall conduct such additional evaluation(s) as directed by EPA.*

GE Response: In a letter to GE dated October 30, 2008, EPA identified six specific areas for this in-depth evaluation. As discussed in the Response to General Comment 10, GE believes that it is critical that such in-depth evaluations should include the ecologically sensitive alternative that is being developed to avoid or minimize adverse impacts on unique and sensitive areas, such as those present in these six areas. In any event, as also discussed above, GE has not had sufficient time to complete an in-depth evaluation of the impacts of the existing alternatives on those six areas and the potential for restoring those areas under the existing alternatives, based on area-specific factors and considerations. GE will provide the in-depth evaluation of these six example areas, as requested by EPA, in the revised CMS Report that incorporates the ecologically sensitive alternative.

<u>Specific Comment 43 (Page 18):</u> *<u>Page 3-3</u>: General Condition 12 of EPA's Conditional Approval of the CMS-P directed that "GE shall include in the CMS a discussion of the process for evaluating how such features as natural erosion of banks, lateral movement of banks, and bedload movement will be affected by each of the corrective measure alternatives." SED 4 includes a combination of removal and thin-layer capping in Reach 5B. It is stated in the CMS that the split between these technologies would be based on "consideration of hydrological parameters." Given the importance of bank stabilization on those hydrological parameters, it is unclear whether in SED 4 and the other alternatives, the factors described in General Condition 12 for the CMS-P have been thoroughly evaluated. GE shall provide a thorough evaluation of how these factors are affected by the implementation of each alternative, and also the decision criteria that were used in specifying particular areas to implement various technologies (e.g. capping without removal) beyond those specified in the revised Table 5-1 of the CMS-P.*

GE Response: The decision criteria used to specify which technologies would be applied in a particular reach for the sediment alternatives were described in Section 3.1.1 of the CMS Report. Using EPA's example of Reach 5B under SED 4, the specific hydrologic parameters used to select areas for thin-layer capping versus removal were described on page 3-3 of the CMS Report:

> "Reach 5B: In this subreach, a combination of 2-foot removal and thin-layer capping would be applied under this alternative. The split between removal and thin-layer capping was specified based on both water depth and flow velocity, with the lower portion of the subreach (e.g., downstream of New Lenox Road) exhibiting generally greater water depths and lower flow velocities -- which result in lower potential for sediment resuspension. Based on these conditions, a thin-layer cap was judged suitable for the area corresponding to the last three spatial bins within the subreach (a distance of approximately 1 mile), and 2-foot removal was specified for the upper portion."

In this comment, EPA also states that it is unclear whether GE evaluated the effect of each of the CMS alternatives on features such as natural erosion of banks, lateral movement of banks, and bedload movement. In fact, the effect of each sediment alternative on these features was considered in the CMS Report. For example, the evaluation of SED 3 on p. 4-47 of the CMS Report states:

> "Stabilization of the banks would prevent additional erosion/lateral movement of the banks in these areas in the future. However, these actions could result in the need to stabilize other, currently non-erodible bank or riverbed areas to minimize the potential for future scour/movement of those areas. This is because stabilization of currently erosional bank areas may result in subsequent erosion of currently non-erosional bank areas (FISRWG, 1998). The potential need to stabilize non-erodible banks and/or nearby riverbed areas would be evaluated and addressed, as necessary, during design.
>
> "Stabilization of the erodible riverbanks would also eliminate a source of solids that are transported as bedload in Reaches 5A and 5B. To the extent that eroding banks slump into the River and subsequently contribute to the overall bedload in Reaches 5A and 5B, this process would be reduced following implementation of SED 3. The armor stone placed as a cap component would have an impact on bedload transport by capturing solids moving along the river bottom. Based on experience in the Upper ½-Mile Reach, once the armor stone is silted over, bedload movement should return to current conditions."

In response to EPA's comment, a more thorough evaluation of how natural erosion of banks, lateral movement of banks, and bedload movement would be affected by implementation of the alternatives has been performed and is described below. The evaluation focused on the impacts of alternatives SED 3 through SED 8 on Reaches 5A and 5B because the effects of remediation on river morphology are potentially more significant in these two upper reaches than in the downstream reaches. Both quantitative and qualitative approaches were used in this evaluation.

In Reaches 5A and 5B, alternatives SED 3 through SED 8 generally involve: (1) sediment removal followed by capping and armoring of the riverbed with largely non-mobile materials, which will maintain approximately the same channel dimensions and elevation; and/or (2) sediment removal with backfilling, using materials that are potentially mobile at higher flows. SED 4 also includes thin-layer capping in portions of Reach 5B. Each of these alternatives also includes stabilization of erodible banks by various means, which has the potential to impact river morphology.

Stabilization of the banks in Reaches 5A and 5B will reduce sediment supply to the river. To quantitatively evaluate the potential impact of bank stabilization on the hydrologic parameters used to develop the CMS alternatives (i.e., water depth, velocity), a diagnostic simulation was conducted using EPA's hydrodynamic and sediment transport (EFDC) model. For this diagnostic simulation, the EPA 26-year validation period was simulated with bank erosion turned off, which simulates the effect of bank stabilization alone and effectively removes a source of solids to the sediment bed. This simulation was compared to the results of the original validation simulation. For this comparison, differences in sediment bed elevation between the two simulations were used as a surrogate for changes in hydrologic parameters, such as water depth and velocity. Changes in bed elevation are a reasonable surrogate for water depth and velocity since, as bed elevation increases with respect to an initial datum, current velocity tends to increase as water depth decreases (and vice versa). The results of these two simulations are shown on Figure SC43-1. This comparison demonstrates that, overall, bank stabilization has a relatively small impact on the total bed elevation change over the 26-year simulation, even though there are some relatively large differences in bed elevation changes in some localized areas. As expected, removing sediment loading due to bank erosion is predicted to result in slight decreases in net deposition, relative to the simulation that included bank erosion, within several areas of the river (mainly in Reaches 5A and 5B). However, given the relatively small magnitude of such differences, it is reasonable to expect that changes in water depths and velocities would also be relatively small on average. Thus, a reduction in sediment load due to bank stabilization would likely result in slightly deeper, slower-moving water due to the decrease in deposition, with larger changes in some localized areas. These results indicate that bank stabilization during the remediation project will have a minimal effect on river morphology and bedload transport.

Bank stabilization will also reduce the extent of meandering and the rate of lateral migration of the river channel in Reaches 5A and 5B, since stabilizing the banks will significantly decrease bank erosion, which is the primary process that affects meandering and lateral migration of the river channel. As discussed in the Response to General Comment 6 and the Response to General Comment 10 (Section II.A.2), this effect is one of the principal contributors to the serious and irreversible ecological harm that would be caused by any bank stabilization method. However, stabilizing the banks should have a minor effect on hydraulics of the river channel since bank stabilization primarily affects channel meandering and lateral migration (which are morphological processes, not hydraulic processes), resulting in minimal changes in velocities or water surface elevations. The rate of bank erosion along a river channel has minimal effect on the hydraulic characteristics of the river (e.g., channel slope, channel width); generally, the cross-sectional area of a stream channel remains approximately constant as the channel migrates laterally. In addition, the extent and frequency of floodplain inundation during over-bank flood events will be minimally affected by bank stabilization since stabilizing the banks does not affect the hydrodynamic interactions between the channel and the floodplain.

In addition to bank stabilization, alternatives SED 3 through SED 8 include re-establishment of the existing channel dimensions after sediment removal by capping and armoring or backfilling. For those alternatives that include capping and armoring of the sediment bed, the armored bed will temporarily consist of sediment that is coarser than the native sediment. Increasing bed roughness (i.e., armoring the bed), without changes in other hydrologic and hydraulic factors, will result in a temporary reduction in bedload transport (and a negligible decrease in velocity) within Reaches 5A and 5B. However, bedload is not the dominant sediment transport mechanism within these two reaches (see RFI Report, BBL and QEA, 2003, Section 8.8.1.8). Transport of suspended sediment within these reaches will be minimally affected by the temporary increase in bed roughness due to bed armoring because changes in bed roughness have a minor effect on water column transport of suspended sediments (i.e., total suspended solids concentration). As previously observed in the Upper ½-Mile Reach, sediment transported into Reaches 5A and 5B will fill the void spaces between the armor stone (ARCADIS, 2008b). Eventually, the armor layer will be covered with a layer of sediment that has a composition (i.e., grain size distribution) similar to the native sediment bed.

Under the alternatives where backfill rather than armor stone would be placed after removal in Reaches 5A and 5B, the initial effects on reducing bedload transport would be significantly less and the adjustment period to reach a condition comparable to the native bed would be more rapid. The ecological harm of capping and armoring or backfilling is discussed in the Response to General Comment 10 and Appendix B.

<u>Specific Comment 44 (Page 18):</u> *<u>Pages 3-3 to 3-6</u>: In the review of computer files submitted to provide background detail on the model simulations conducted by GE as part of the CMS, EPA noted that GE's simulation of active remediation in Reach 7 & 8 impoundments did not include all of the grid cells in the impoundment reaches as defined by EPA. GE's more limited definition of the spatial extent of impoundments introduces an inconsistency between the spatial extent of elevated PCB concentrations (relative to the free-flowing reaches) and the spatial extent of elevated PCB concentrations affected by GE's simulation of active remediation in impoundments. The consequence of this inconsistency is that elevated PCB concentrations in the upstream ends of Reach 7B (Columbia Mill impoundment) and Reach 8 (Rising Pond), and all of Reach 7C (Former Lee/Eagle Mill impoundment) are not addressed by the simulated alternatives that include activities beyond MNR in Reaches 7 and 8. GE shall restart model simulations for Reach 7 & 8 for alternatives SED 6, SED 7, and SED 8, with remediation simulated in all of the grid cells of Reaches 7B, 7C, 7E, 7G, and Reach 8 as defined by EPA. For the SED 5 alternative, GE shall restart the simulation for Reach 7 & 8 for the portion of the simulation beginning when remediation commences in Rising Pond, with remediation simulated in all grid cells in Reach 8. EPA notes further that if this alternative were selected, the actual extent of remediation in these and other areas may be defined during the design of the remedy and is not necessarily constrained by the boundaries used in the CMS simulations, but that these changes are necessary for comparison of the relative performance of the alternatives.*

GE Response: As indicated in this comment, the model simulations provided in the CMS Report did not include remediation at the upstream end of Reach 7B. Rather, remediation in Reach 7B was limited to the southern-most portion of the reach, where mapping and bathymetry/elevation data indicate that the upstream limit of the impoundment is located (as shown on Figure 4-12b in the CMS Report). In addition, those model simulations did not include remediation of Reach 7C (the Former Lee/Eagle Mill impoundment), since the EPA-approved CMS Proposal did not include that former impoundment in the list of Reach 7 impoundments to be remediated (specific Reach 7 impoundments to be remediated were included in the description of SED 6 on page 5-10 of the CMS Proposal). For Reach 8, GE explained to EPA following receipt of this comment that the grid cells specified to define this reach in the model input files (previously provided to EPA) were indeed consistent with the Agency's definition of this impoundment; after further review, EPA advised GE that no further action was required for Reach 8.

In response to EPA's comment, the downstream model (Reach 7/8) simulations for alternatives SED 6, SED 7, and SED 8, were restarted with remediation simulated in all of the grid cells of Reaches 7B and 7C. The results of these revised simulations have been carried through to all other responses, tables, and figures in this Interim Response that present or compare model results that include Reaches 7 and 8. Further, all volumes, areas, costs, and durations have also been updated for SED 6, SED 7, and SED 8.

As expected, results from these revised simulations indicate, for SED 6, SED 7, and SED 8, lower post-remediation average PCB concentrations for all media in Reaches 7B and 7C than those presented previously in the CMS Report. Those lower concentrations, in turn, result, in an increase in IMPG attainment for these alternatives in these reaches. These revisions have been incorporated in the revised set of IMPG attainment tables provided in the Response to General Comment 13. Specifically, as shown in those tables, these revisions result in the attainment by these three alternatives of a number of IMPGs that were not attained under the prior modeling – namely, the sediment human direct contact IMPG in averaging area SA5 (i.e., former Eagle Mill Dam impoundment) at a 10^{-6} (RME) risk level; the lower-bound IMPG for benthic invertebrates (3 mg/kg) in Reach 7C; the piscivorous bird IMPG (3.2 mg/kg) in Reach 7B; and several additional IMPGs for human consumption of fish (primarily CTE IMPGs) in Reaches 7B and 7C, as well as in Reach 7E under SED 8.

Specific Comment 45 (Page 19): *Page 3-7: EPA notes that for backwaters in Reach 5D, the basis for determination of the sediment volume removed for some alternatives may be flawed. For areas where data exist, a 3-foot removal depth is assumed, whereas for less well defined areas the removal depth is assumed to be 2 feet. Where uncertainty exists with respect to the depth of remediation, it is appropriate to use a more conservative estimate of removal depth in order to estimate sediment volumes and remediate costs. GE shall provide a description of the rationale for assuming a 2-foot removal depth in areas with insufficient data for full characterization, and estimates of the alternative volumes, areas, and costs using the more conservative assumption of 3 feet.*

GE Response: For alternative SED 8, the CMS Report stated that a removal depth of 3 feet was estimated as the depth of the 1 mg/kg horizon for larger backwaters (> 2 acres) based on available data from those areas. For smaller backwaters (< 2 acres in size), the data were too limited to support estimation of the 1 mg/kg depth horizon, and a removal depth of 2 feet was specified for these areas. This shallower removal depth was selected for the small backwaters because, unlike the majority of large backwaters, these areas tend to be in poor hydraulic communication with the River, and backwater areas having poor hydraulic communication would be expected to have lower deposition rates and thus a shallower depth of contamination.

Specification of a 3-foot removal depth in the small backwaters would result in the removal of an additional 29,000 cy of sediment under SED 8 (i.e., increasing the total sediment removal in backwaters from 388,000 cy to 417,000 cy) at an additional cost of approximately $5M. Increasing the depth of removal by an additional 1 foot does not change the horizontal extent of the removal area.

Specific Comment 46 (Page 19): *Page 3-9: EPA notes that the thickness of an engineered cap (and associated depth of excavation, if required), whether placed with or without prior removal, should be determined in final design based on site-specific requirements using factors such as described in White Paper No. 6B – In-Situ Capping as a Remedy Component for the Lower Fox River (Palermo et al, 2002) and other applicable guidance. The design should consider the underlying sediment PCB profile and associated needs for chemical isolation as well as the need for physical stability. GE shall provide a description of the design process (such as that described in Palermo et al, 2002) that will be used to determine the appropriate cap materials and thickness of materials to be placed.*

GE Response: The cap design/construction for the Housatonic River will consider two main factors: chemical isolation and physical stability. The ecological impacts caused by an engineered cap are discussed in the Response to General Comment 10 and Appendix B. Design of the cap composition, dimensions, and thickness will conform to project specifications and will include plans to mitigate and monitor impacts during and after construction. Palermo et al. (2002), in their section on "*In-Situ* Cap Design and Construction," recommend that, in developing a model to assess the type of cap material and thickness of materials to be placed, six main parameters should be evaluated: (1) available capping material and its compatibility with contaminated sediment at the site; (2) potential for bioturbation of local benthic organisms; (3) potential for erosion at the capping site; (4) potential flux of sediment contaminants into the water column; (5) potential interactions and compatibility among cap components, including mixing and consolidation;

and (6) operational considerations. In accordance with this recommendation, GE will consider these parameters in designing caps for the Rest of River. In doing so, the general steps for cap design will include the following:

- Identify potential cap materials and assess their compatibility with contaminated sediment at the site.
- Evaluate existing available information on benthic organism communities (and, if necessary, perform a survey of such organisms) to assess the bioturbation potential of the local bottom-dwelling organisms, and design a cap that will physically isolate the sediment from them, to the extent practicable.
- Evaluate forces related to water velocities/currents, wave action, propeller wash (if applicable), and ice scour and design an armor system to protect the underlying cap components from potential erosion/scour due to those forces.
- Evaluate the potential flux of PCBs from the underlying sediments to the water column and design an isolation layer component to reduce the flux of dissolved PCBs into the water column.
- Perform an analysis of mixing, consolidation, and permeability to evaluate the potential interactions and compatibility among cap components.
- Evaluate the impacts of the cap on flood storage capacity and, if necessary, develop steps to avoid a significant reduction in flood storage capacity.
- Identify any operational considerations that may affect the ability to place the cap effectively or may require future restrictions on certain activities to ensure cap integrity.

The above design steps will be performed in conjunction with the design objectives to determine the cap composition for each area. Potential cap components could include a base stabilization layer/mixing zone, a base isolation layer, a bioturbation layer, a filter layer, and an armor layer. Certain materials provide multiple functions. For example, a 12-inch thick sand layer may provide a mixing zone, an isolation layer, and a bioturbation layer. Additionally, each of the layers may not be needed in all areas. For example, an armor layer may not be required in low energy areas such as backwaters. The final cap components, materials, and thickness will be determined during design using the process described above.

<u>Specific Comment 47 (Page 19):</u> *<u>Page 3-10</u>: EPA has questions concerning the projected construction schedule. GE shall provide a Gantt chart for each alternative. These charts shall include sufficient detail to determine the individual timeframes for activities such as mobilization, access road construction, staging area construction, sheetpile installation, excavation, backfill, and restoration. The sequence of these activities and their interdependencies should be presented in the Gantt chart to allow EPA to readily ascertain the assumptions that have been made regarding construction sequencing from reach to reach.*

GE Response: Based on the overall schedules prepared for the CMS Report, GE has prepared Gantt charts for each sediment alternative (Figures SC47-1 through SC47-6). These Gantt charts present reach- and activity-specific time estimates for the completion of the main components of each sediment alternative (such as removal, backfilling/capping, and bank stabilization/restoration) and for certain support activities (such as access road/staging area construction and restoration and sheetpile installation).[23] These Gantt charts maintain the overall reach- and alternative-specific schedules presented in the CMS Report, as estimated using the average production rates agreed to by EPA and GE.

<u>Specific Comment 48 (Page 19):</u> *<u>Page 3-10</u>: The basis for the assumption of an 8-hour work day is not clear. GE shall provide additional discussion of the selection of this assumption for the length of the work day for estimation of costing and construction duration, specifically addressing such issues as the whether the 8-hour day is based on consideration of quality of life issues and whether longer work days can be assumed for specific reaches or subreaches. Actual duration of the work days shall be determined in the design process.*

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[23] The restoration activities included in these charts are limited to the restoration activities that would be performed immediately upon the conclusion of the removal and backfilling/capping activities. They do not include any restoration activities that may have to be performed at a subsequent time, such as replanting activities that may depend on seasonal planting windows.

GE Response: The 8-hour work day was discussed and agreed to by GE and EPA. Section 3.1.4.1 (General Construction Schedule Assumptions) of the CMS Report states: "Based on EPA's conditional approval letters of April 13 and July 11, 2007, the construction season (i.e., the total available time each year for the implementation of the remedial alternatives) was defined, for purposes of the CMS, as consisting of 9 months/year, 22 days/month, and 8 hours/day, for a total of 198 working days per year." (CMS Report, p. 3-10).

Specific Comment 49 (Page 20): *Page 3-10 to 3-11: Daily average production rates are used to determine overall timeframes for the project, including mobilization, set-up, excavation, backfill, restoration, down time, etc. Based on this, EPA believes that the actual capacity of each work crew for excavation is higher than the stated average provided in the CMS. For example, the size of the excavation crew necessary to achieve the 110 cy/day may need to have a capacity closer to 300 to 400 cy/day to achieve the overall intended result of 110 cy/day assumption (agreed to by EPA in the CMS-P conditional approval) to account for all non-excavation activities. In addition to the overall productivities, GE shall include the capacity of the excavation crew expressed on a cy/day basis.*

GE Response: GE agrees that the excavation production rate will be higher than the daily average production rates since, as observed by EPA, the daily average production rates incorporate the performance of other, "non-excavation" activities. In response to EPA's comment, GE has estimated the excavation production rates as a stand-alone activity based on the exclusion of time for the performance of non-excavation activities (e.g., mobilization, sheetpile installation, restoration) as described below.

First, for each reach in each alternative, the amount of time (in days) associated with the following items was estimated:

- Mobilization of equipment and materials;
- Construction of staging areas/access roads, and establishment of supporting facilities (e.g., trailers, water treatment) prior to the initiation of excavation activities;
- Construction of steel sheetpile removal cells and related cell-dewatering activities (for reaches with mechanical removal in the dry);
- Completion of backfill/cap placement, as discussed in the response to Specific Comment 50, following the completion of excavation; and

- General restoration (e.g., of staging areas) and demobilization following completion of excavation and backfill/cap placement

In addition, 10% of the reach-specific construction duration was assumed to be "down-time" with no active remediation or associated productivity.

The Gantt charts prepared in response to Specific Comment 47 illustrate the sequencing as well as the estimated time associated with these activities. The sum of this time (i.e., the number of days estimated for the performance of non-excavation activities) plus the estimated "down-time" were subtracted from the respective reach-specific construction durations estimated using the daily average excavation production rate (see Response to Specific Comment 20). The remaining duration, considered to be excavation-related only, was then used in the calculation of daily excavation rates.

Table SC49-1 summarizes the maximum estimated rates for mechanical/hydraulic dredging in the wet and excavation in the dry. Note that because of the deeper excavations, increased volumes, and related greater marginal productivities associated with SED 7 and SED 8, maximum rates for these alternatives have been distinguished from those in the SED 3 through SED 6.

Table SC49-1. Maximum Estimated Rates for Mechanical/Hydraulic Dredging in the Wet and Excavation in the Dry.

Removal Technology	SED 3 – SED 6		SED 7 and SED 8	
	Daily Average Production Rate per Crew (cy/d)	Daily Excavation Rate per Crew (cy/d)	Daily Average Production Rate per Crew (cy/d)	Daily Excavation Rate per Crew (cy/d)
Mechanical/Hydraulic Dredging in the Wet	275	350	350	425
Mechanical Dredging in the Dry	110	180	140	200

Specific Comment 50 (Page 20): *Page 3-12: EPA disagrees that additional time should be added to the schedule to account for backfill activities. In general, the agreed-upon productivities were developed to be inclusive of backfill activities. Similarly, for Reaches 5A and 5B, stabilization of banks should also not add to the overall schedule, and is included in the overall timeframe as determined from the average productivity rate assumed and agreed to by EPA in the CMS-P conditional approval. These assumptions suggest that there will be no concurrent excavation downstream of ongoing backfill activities. If the excavation percent completes are correct as shown in Table 3-4, and backfill work cannot begin until at least those percentages of excavation have been completed, then a second crew working solely on backfill would be justified working upstream of the active excavation area. GE shall re-evaluate the excavation percent completes and the possibility of adding backfill crews to reduce the overall timeframes of the alternatives, and include the results of the assessment in the Supplement.*

GE Response: For the purposes of the CMS, the estimates of construction time were based on certain average production rates, assumptions related to the numbers of crews feasible in specific reaches, and conceptual schedule overlaps – all of which were established and agreed upon with EPA prior to submitting the CMS Report (or, in some cases, revised assumptions that would accelerate the schedule). Specifically, GE used technology-specific average daily production rates and crew size assumptions specified in the CMS Proposal Supplement, as modified in EPA's conditional approval letter dated July 11, 2007. Additionally, as discussed in an October 2007 meeting with EPA, GE proposed that all reaches would be addressed sequentially, with all remedial activities assumed to be complete in a particular reach before any activities were begun in the subsequent reaches. In the October 2007 meeting, GE also discussed using removal and backfill/capping production rates as the basis of the overall schedule, and presented the assumed overlap of excavation and backfill/capping activities. EPA approved this approach in a November 11, 2007 email to GE.

Following a January 2008 meeting with EPA, GE reconsidered the overlap between dry excavation and backfill/capping operations and decided to modify the schedule to increase the overlap and to assume that backfilling/capping would begin when excavation was approximately 60% complete. Additionally, the overlap for wet excavation in the river channel was increased so that backfilling/capping would begin when excavation was approximately 40% complete. Table SC50-1 below summarizes the overlaps that were originally presented in the October 2007 meeting and the actual overlaps used in the development of reach- and alternative-specific construction schedules in the CMS.

Table SC50-1. Originally Proposed Excavation-Backfill/Capping Overlaps versus Actual Overlaps Used in the Development of Reach- and Alternative-Specific Construction Schedules.

Removal Technology	Location	Originally Proposed Excavation Percent Complete Prior to Commencing Backfill/Capping	Actually Used Excavation Percent Complete Prior to Commencing Backfill/Capping
Dry Excavation	Channel	73%	60%
Wet Excavation	Channel	50%	40%
Wet Excavation	Pond/Impoundment	100%	100%

As previously discussed, GE included time for backfilling/capping and bank stabilization activities (where appropriate) to account for constructability issues (e.g., limited space in dry removal cells and potential recontamination in wet excavation areas). In each reach, GE estimated the start of backfilling/capping activities (i.e., the lag time following the start of excavation) to minimize the time added to the overall schedule. For example, within Reach 5A, when the schedule is broken down on a per cell basis, the average time to complete excavation and restoration within a removal cell is 8.5 days. Of this time, approximately 7 days are related to removal and 1.5 days are related to the additional time for backfill/capping and bank stabilization/restoration activities that occur after excavation is complete.[24] If it were assumed that backfilling/capping activities in the same cell were initiated much earlier, the backfilling/capping activities would finish before the completion of excavation activities.

GE also accounted for certain reach-specific limitations (such as space constraints) that required adding time into that reach's overall schedule. Where possible, GE incorporated the use of multiple crews working simultaneously (e.g., in Woods Pond) to expedite the completion of conceptual remedial activities; however, in some reaches (e.g., Reaches 5A and 5B), this was not a viable option given the removal methods and related space constraints. The addition of more crews in an attempt to increase concurrent excavation and backfilling/capping activities and thus expedite the overall schedule is not possible in

[24] As previously noted in the Response to Specific Comment 47, the restoration activities included in these schedules consist of the restoration activities that would be performed immediately upon the conclusion of the remediation activities. They do not include any restoration activities that may have to be performed later (e.g., replanting).

some reaches. For example, given the available space and geography in Woods Pond, it was assumed that two crews would be used to perform removal activities, followed by two crews performing backfilling/capping operations. As discussed above, for all impoundments, it was assumed that removal and backfill/capping activities would be performed sequentially, such that removal activities would be complete before beginning backfill/capping. If this sequenced approach were changed so that excavation and backfill/capping occurred simultaneously, maintaining two crews for each activity would mean four crews would be operating simultaneously. Given the need for work space and staging areas associated with four active work crews and the potential for recontamination associated with simultaneous adjacent removal and backfill operations, the limited space within and adjacent to Woods Pond makes this an infeasible option.

Additional information illustrating how the removal and restoration activities interrelate and contribute to the overall construction schedule is presented in the Response to General Comment 20.

As discussed above, the estimates of construction time used in the CMS Report, which were based on assumptions that were agreed upon with EPA (or later revised to shorten the time), are reasonable for purposes of the CMS. However, during design of a given remedial action, consideration would be given to modifying the excavation percent completes further and/or adding backfill crews in some areas to reduce the overall timeframe. Such modifications could include the possibility of beginning excavation in a further downstream area while backfill was still being conducted in an upstream area. These and other efficiencies would be considered during design to the extent practical.

Specific Comment 51 (Page 20): *Page 3-14: GE shall provide a table summarizing the volume calculations, including the areas, depths, and calculated volume for each alternative and each reach.*

GE Response: Table SC51-1 provides, for each sediment alternative, a summary of the removal volumes and depths and remediation areas for each reach of the river. Specifically, this table lists, for each alternative and each reach, the depth and volume of removal, acres of replacement capping or backfill in removal areas, acres of capping without prior removal, acres of thin-layer capping, and acres subject to MNR. Note that total volumes for SED 6, SED 7, and SED 8 differ from those presented in the CMS Report as this table includes the additional removal volume and remediation area in Reaches 7B and 7C that have been added in response to Specific Comment 44.

Specific Comment 52 (Page 20): *Page 3-14: EPA notes the following differences between the simulation modeling as implemented by EPA and as implemented by GE and reported in the CMS:*

- *Remediation is assumed by GE to occur between Mar. 1st and Nov. 31st of each year, not continuously as assumed by EPA.*
- *Backfill/capping is assumed to begin at 80% completion in a cell, but in an earlier presentation to EPA 73% was assumed.*
- *The spatial extent of the "deep hole" in Woods Pond used by GE is larger than used by EPA.*
- *GE has simulated the remediation of more backwaters than those considered part of Reach 5D; EPA restricted the definition of backwaters to Reach 5D only. However it appears that those backwaters are represented in the model as floodplain cells.*
- *Wet removal techniques can differ in Reaches 5C, 5D, 6, 7 & 8 between EPA and GE simulations.*
- *Cap thickness in the case of an engineered cap without prior removal differs between the EPA and GE simulations.*
- *The 15-ppm criterion for Reach 5D in SED 5 is applied by GE as a area-weighted average for each backwater as opposed to a cell-by-cell basis assumed by EPA.*
- *In cases where the CMS Proposal (Revised Table 5-1) included removal followed by backfill/capping, GE assumed capping whereas EPA assumed backfill.*

GE shall propose a resolution to each of these differences for EPA's consideration prior to submittal of the Supplement with a discussion of these differences in model application, particularly as they relate to the evaluation of alternatives.

GE Response: In accordance with this comment, GE provided an evaluation of each of these model input differences, along with a potential resolution of the differences, in a separate memorandum transmitted to EPA on October 31, 2008. A copy of that memorandum is attached as Appendix G. After review of this memorandum, EPA advised GE that no further action was required to resolve these differences.

<u>Specific Comment 53 (Page 21):</u> *<u>Page 3-25</u>: EPA notes the assumption of 0.01 times the vertical average of the cut profile residual factor for alternatives with a 1.5-ft removal cut followed by cap or backfill is reasonable for comparative evaluation of alternatives in the CMS, however, it does not affect EPA's potential requirements for future OMM.*

GE Response: As stated in the EPA-approved Model Input Addendum to the CMS Proposal (ARCADIS BBL and QEA, 2007c, p. 4-3), the assumption referenced by EPA (which represents a "reduction efficiency" of 99% from the pre-remediation sediment concentration) was used in simulating sediment removal in the wet with subsequent cap or backfill placement (as well as for engineered capping without removal). Simulations of sediment removal in the dry with subsequent cap or backfill placement used a post-remediation sediment PCB concentration assumed to be typical of clean backfill, as explained in the CMS Report (p. 3-25).

<u>Specific Comment 54 (Page 21):</u> *<u>Page 3-26</u>: EPA agrees that the assumption of backfill material of similar physical properties as sediment currently in place was reasonable for conducting the simulations in the CMS, however notes that in the event backfill becomes part of the selected remedy it may not be desirable or possible to obtain or use backfill with the same properties as underlying sediment. The selection of backfill material properties, if applicable, would be a component of the final remedy design subject to similar criteria as the engineered cap design.*

GE Response: Comment noted. However, given that the intended purpose of the backfill would be different from that of an engineered cap depending upon its use, not all criteria applicable to an engineered cap design would apply to placement of backfill. For example, an armor erosion protection layer would not be required as a component of backfill.

<u>Specific Comment 55 (Page 21):</u> *<u>Pages 3-28 through 3-33</u>: EPA notes that there is a link between representation of the extreme storm event in the CMS model, the time required to implement an alternative, and method by which alternatives are evaluated, that can potentially lead to inconsistent evaluation of alternatives. For simplicity in model set-up, the extreme event was treated in a deterministic fashion and was inserted into year 26 of the hydrograph. Consequently, the extreme event is expected to have less impact on alternatives that are completed (or that are substantially complete) before year 26 of the simulation and to potentially have a larger impact on alternatives that take longer than 26 years to complete. However, despite any assumption regarding the timing of such an event,* *it is important to recognize that the occurrence of the extreme event is stochastic and that the probability of an event occurring in any given year is constant (e.g. there is a 1% probability of that a 1-in-100-year event will occur in any year). Thus, EPA notes that it is just as likely that an extreme event could occur in year 1 of the simulation before any alternative is completed or in year 53 after any alternative is completed. In addition, with the influence of factors such as global warming, it is possible that such storm events may increase in frequency and this will need to be considered in selection of a final remedy and final design.*

GE Response: Simulation of the extreme event in the model is consistent with that described in Section 2 of the EPA-approved Model Input Addendum to the CMS Proposal. Further, the hydrograph used to simulate the extreme event (including its insertion into Year 26 of the model projection) was developed in conjunction with EPA's modeling team.

Specific Comment 56 (Page 21): *Page 3-31: EPA disagrees with characterization of the assumed 1-km foraging range for wood ducks as "conservative;" this value reflects the home range information from the Peer-Reviewed ERA, which was based on an evaluation of the literature. In Section 5.2.3.3, the CMS suggests that wood ducks would not be expected to be broken into distinct local populations, and therefore averaging of exposures across the entire PSA is appropriate. However, this rationale reflects a lack of consideration of the important difference between a home range (or feeding range) and the local subpopulation range. The local subpopulation range of wood ducks (and many other animals) extends beyond the ROR, or the Berkshires. The home range, on the other hand, reflects the feeding radius of animals within the local subpopulation range during their residence in the Housatonic River. It is indicated in the ERA that, in productive areas, wood ducks stay within 1 km of their nesting areas (WESTON 2004, G-6 and G-43). This limited home range is applicable to pre-incubating females that forage close to their nest sites. During this period, wood ducks would expand their home ranges only if habitat requirements are dispersed. Discussion in the CMS implies that animals such as wood duck and mink will naturally expand their feeding range to equal the area of the local population range, even where the literature indicates that this is not the case. It is also implied that a population level response is only possible if all individuals within the PSA are adversely affected, whereas EPA believes that local subpopulation level responses may occur with only a subset of PSA individuals affected.*

GE Response: The 1-km averaging areas used in the CMS for wood ducks were based on the foraging range of an individual pre-incubating wood duck during its residence in the Housatonic River, as recommended in EPA's ERA. Although the ERA did not characterize the 1-km foraging range as conservative, independent evaluation of the available literature on the subject finds that most researchers report foraging ranges and home ranges for wood ducks that are larger than 1 km, as detailed in footnotes 122 and 123 of the CMS Report. None of the studies cited in those footnotes reflects local subpopulation ranges; all of the cited studies characterize home ranges or foraging ranges of individual wood ducks. Thus, even for representing the foraging range of an individual wood duck, the 1-km-based averaging areas used in the CMS were conservative.

More importantly, regardless of the size of the foraging or home range of an individual pre-incubating wood duck, the use of the 1-km averaging areas in the CMS was inherently highly conservative for estimating effects on the local population, because the local population necessarily includes numerous wood ducks, not just the individual pre-incubating wood ducks that forage within a 1-km range of their nests. The practice employed in the CMS of evaluating achievement of the IMPGs within 1-km segments of the PSA implies that adverse effects in any individual wood duck have the potential to translate to adverse impacts on the local population, which is clearly more conservative than assessing whether effects would occur in a sufficient number and proportion of ducks to affect the local population.

Furthermore, the CMS considered all areas of the PSA with suitable year-round wood duck habitat, not just the habitat associated with the pre-incubating portion of the breeding season. While it might have been more logical to pair the 1-km averaging areas with only those portions of the PSA with verified breeding habitat, the 1-km foraging ranges were also overlain on portions of the PSA with suitable year-round habitat, thereby adding a further layer of conservatism to the analysis.

Finally, GE takes issue with EPA's characterization of the CMS Report as implying that a population-level response is only possible if all individuals in the PSA are adversely affected. No such statement was made in the CMS Report. Population-level responses may be expected if adverse effects occur in a sufficient proportion of the local population that the natural compensatory mechanisms at work in that population cannot offset those effects, such that the local population itself is impaired. See also Response to Specific Comment 32.

Specific Comment 57 (Page 22): *EPA agrees that the use of largemouth bass alone represents a conservative assumption; however, use of largemouth bass of age classes 6 through 10 fails to recognize the importance of older, larger fish than are simulated by the model. EPA's analysis indicates that age 9+ fish are a better indicator of the average largemouth bass concentrations experienced by human consumers.*

GE Response: GE disagrees with EPA's statement that age 9+ fish are a better indicator of the average largemouth bass concentrations experienced by human consumers. The legal minimum size limit for largemouth bass in Massachusetts is 12 inches; analysis of age versus length data for adult largemouth bass collected by EPA in 1998/99 from the PSA and Rising Pond indicates that age 6+ largemouth bass are consistently greater than 12 inches in size, as shown in Figure SC57-1 (these are the same data shown by EPA in its Final Model Documentation Report, EPA, 2006c, Appendix C, Figure 3). Since the analysis cited by EPA in this comment was not provided, the basis for EPA's statement is unclear. However, GE believes that human consumers are opportunistic, and will generally consume largemouth bass equal to or greater than the legal size limit (regardless of age). In that case, EPA's 1998/99 data set that forms the basis for Figure SC57-1 demonstrates that age 6+ fish are representative of largemouth bass greater than or equal to 12 inches.

Specific Comment 58 (Page 22): *Page 3-32: EPA notes that the procedure used to evaluate the effect of the remedial alternatives on fish likely underestimates residual risk. The evaluation presented in the CMS is based on the average largemouth bass PCB concentration for all age classes (ages 0+ through 9+) as representative for warmwater fish species. The average modeled age class is an underestimate of expected PCB concentrations in the older modeled age classes (i.e., Age 6+ through 9+), and is also an underestimate of PCB concentrations in older fish (Ages 10+ to 14+) not explicitly simulated by the model.*

GE Response: GE does not agree that the procedure used in the CMS to evaluate the effect of the remedial alternatives on fish "likely underestimates residual risk," as EPA states. While EPA correctly notes that GE's use of the average largemouth bass PCB concentration for all age classes may underestimate the expected PCB concentrations in older fish, it fails to recognize that the average of all age classes conversely would overestimate the expected PCB concentrations in smaller fish. Based on this, GE believes the use of an average representing all age classes is appropriate for estimating residual risk.

<u>Specific Comment 59 (Page 22):</u> <u>*Page 3-32*</u>*: The wet weight equivalency factor applied between largemouth bass and trout is not the correct procedure for extrapolation of residual risk to cold water species. The analyses presented in EPA's Peer-Reviewed Validation of FCM (WESTON 2006) indicated that trout concentrations are underpredicted by the largemouth bass model (see Figure 6.3-7). The correct procedure is to use a scaling factor to account for lipid differences between largemouth bass (surrogate species) and coldwater fish. GE shall recalculate residual risk to coldwater species using the correct procedure and report the corrected results, including a discussion of the implications of any changes for the evaluation of the remedial alternatives.*

GE Response: In the CMS Report, largemouth bass were used to represent trout because EPA's model does not simulate trout and because both species are top predators. However, in response to EPA's comment, due to differences in lipid content between largemouth bass and trout, a scaling factor has been developed and used in the recalculation of residual risk to coldwater species.

In the Model Validation Report (MVR; EPA, 2006d), EPA concluded that the largemouth bass model could approximate trout PCB concentrations on a lipid-normalized basis. Based on this conclusion, estimation of wet-weight concentrations in trout could be made by multiplying model-predicted concentrations in largemouth bass by the ratio of lipids in these two species. However, this method of scaling concentrations by the lipid ratio would be only valid if a one-to-one relationship exists between whole body lipid and PCB concentrations for both largemouth bass and trout. There are no whole-body trout data from the River to assess this assumption, but available data on largemouth bass and other species from the system indicate that there is not a good correlation between PCBs and lipids for fish in this system. Figures included in the RFI Report show that PCB-lipid relationships vary by species and reach in the Housatonic River, and are generally not one-to-one (see RFI Report, BBL and QEA, 2003, Figure 6-2). Also, tests conducted with EPA's model do not produce one-to-one relationships for largemouth bass; the reason for this is that lipid differences do not fully explain PCB uptake in fish since bioenergetics and other factors also contribute to PCB uptake.

Due to the uncertainty in this assumption of a one-to-one PCB-lipid correlation, an alternate approach to define the scaling factor has been developed based on differences in PCB concentration between largemouth bass and trout. Given that available largemouth bass and trout data from the River are not co-located, largemouth bass could not be used to represent the relationship between PCB concentrations in each species. Instead, smallmouth bass data, which are co-located with the trout data at Cornwall, were used in place of largemouth bass data to derive this scaling factor. First, a comparison between co-located smallmouth and largemouth bass PCB concentrations in Connecticut (at Bulls

Bridge, Lake Lillinonah, and Lake Zoar, averaged by year) was made; this analysis indicated that the overall relationship of PCB concentrations between these two species is nearly one-to-one (see Figure SC59-1), indicating that smallmouth bass are a reasonable surrogate for largemouth bass. Next, data for smallmouth bass at Cornwall were plotted against trout data at Cornwall on an annual average basis (Figure SC59-2). This relationship indicates an approximate factor of 2 difference between these two species.

Therefore, this analysis suggests that wet-weight PCB concentrations in trout may be approximated by multiplying model predictions for largemouth bass by a factor of 2. While there is a fair amount of uncertainty in this analysis, this factor of 2 is consistent with a factor of 2 to 3 difference between lipids in whole-body trout (as reported in the literature; Niimi and Oliver, 1989) and largemouth bass lipids. In this situation, the coldwater fish concentration estimates provided in the CMS Report were first revised to reflect the revised downstream model runs for SED 6, SED 7, and SED 8, as discussed in the Response to EPA's Specific Comment 44; those estimates were then increased by a factor of 2 to re-assess the attainment of IMPGs. The effect of this 2X increase in model-predicted endpoint concentrations on attainment of the coldwater fish IMPG under all sediment alternatives is shown in Table SC59-1.

Table SC59-1. Summary of Averaging Areas Meeting Coldwater Fish Protection IMPG.

Alt.	# Averaging Areas Meeting Fish Protection (Coldwater) IMPG (CMS Approach)	# Averaging Areas Meeting Fish Protection (Coldwater) IMPG (Apply 2X Factor)	Comments
SED 1/2	3 of 8	0 of 8	Change to non-attainment in Reaches 7F/G/H
SED 3	8 of 8	7 of 8	Change to non-attainment in Reach 7B
SED 4	8 of 8	8 of 8	No change in IMPG attainment
SED 5	8 of 8	8 of 8	No change in IMPG attainment
SED 6	8 of 8	8 of 8	No change in IMPG attainment
SED 7	8 of 8	8 of 8	No change in IMPG attainment
SED 8	8 of 8	8 of 8	No change in IMPG attainment

In general, the 2X increase in fish PCB concentrations for coldwater fish has a relatively small impact on IMPG attainment in Reach 7. IMPG attainment decreases for SED 1/2 and SED 3, while there is no impact for the remaining alternatives.

Specific Comment 60 (Page 22): *Page 3-33: EPA disagrees with the assignment of feeding preferences for osprey. Based on information developed in the ERA and calibration/validation of the food-chain model, EPA believes that an alternate parameterization is a better representation of the osprey diet:*

$$Blended_{raptor} = (0.6 \times \text{Age 4 Sucker}) + (0.15 \times \text{Age 5 Sunfish}) + (0.25 \times \text{Age 5 Bass})$$

The parameterization in the CMS was based on the assumption that all modeled fish species would be consumed equally by osprey (CMS Table 3-15), but provided no rationale for that assumption. The data from the fish biomass study (Woodlot, 2002) and Table H.2-11 of the ERA strongly suggest that the contribution of bottom fish to osprey diet would exceed that of forage fish, rather than be equal across modeled fish categories. EPA believes that the prey preference matrix used for eagles would provide a more technically sound basis for parameterizing the osprey diet.

In addition, based on the size range of fish consumed by osprey, EPA believes it is more appropriate to assume a diet consisting of age 4+ white sucker, age 5+ sunfish, and age 5+ bass as surrogate age classes most representative of this range. The CMS used the average of multiple age classes, including ages 1+ to 5+ for white sucker, 2+ to 5+ for sunfish, and 1+ to 9+ for largemouth bass.

Overall, the differences in methods result in CMS-simulated fish tissue concentrations that are approximately 16% less than calculated by EPA. These differences derive mainly from: (1) greater assumed proportion of forage fish in osprey diet in the CMS, and (2) inclusion of younger age classes (on average) of white sucker and sunfish in osprey diet in the CMS.

GE Response: With respect to species preference, the assumption that all modeled fish species would be consumed equally by osprey was based on GE's interpretation of the ERA. For example, while the ERA notes that fish represent the predominant prey of osprey (assumed to be 100% in the ERA), it makes no mention of the composition of diet by fish species (EPA, 2004b, Vol. 6, pp. H-25 – H-26); and the cited table on osprey diet (Table H.2-11) does not provide a clear basis for making that determination. This is particularly true since none of the studies listed in that table was conducted on a large Northeastern river comparable to the Housatonic River, an important consideration given the influence of fish species availability on the osprey's diet (Poole et al., 2002). Furthermore, the ERA's discussion of the assumed PCB concentrations in fish consumed by osprey focuses on the effect of the assumed length of fish, rather than the species or how they might be weighted (Vol. 6, p. H-26). Similarly, the summary table on PCB concentrations in such fish provides no indication of weighting by species. In contrast, for bald eagles, the ERA explicitly defines the weighting applied for different guilds of fish (Vol. 6, Table K.2-2). All of these elements of the ERA indicate that EPA did not weight fish by species when calculating the dietary concentration of osprey. GE followed that approach in the CMS.

In any event, contrary to EPA's suggestion that the bald eagle's weighting scheme be applied to osprey, prey preferences of bald eagles and osprey likely differ, as would be expected based on Gause's Law of Competitive Exclusion (i.e., species competing for the same resources cannot stably exist). In contrast with the bald eagle's preference of sucker>bass>sunfish, Van Daele and Van Daele (1982) reported that osprey target bullheads and salmonids disproportionately when compared to netted samples and that yellow perch and suckers were underrepresented in the diet. Edwards and Collopy (1988) reported that adult ospreys took bass in proportion to their abundance but took sunfish and shad disproportionately relative to their abundance. Although these two studies do not provide an adequate basis for quantitatively defining weights, they suggest that preferences among osprey follow a trend of bullhead=sunfish>bass>sucker (i.e., almost opposite to the preferences of bald eagles).

With respect to the age ranges used in the CMS, the assignment of model age classes that correspond to the preferred size range (130 to 400 millimeters [mm]) for osprey used in the ERA (i.e., the age classes shown in Table 3-14 of the CMS Report) was based on analysis of site data and EPA's model inputs, as follows:

- As the EPA FCM does not include length as a parameter, it was necessary to correlate the preferred length range to weight, a parameter used in the model. Log-log plots of length and weight data from the EPA and GE datasets were generated for each of the modeled species, and regressions from the data were used to convert the length range to a weight range.

- The resulting weight ranges were then compared to the weights input in the EPA FCM for each fish age class to establish the age classes that fall within the preferred osprey size range.

The attached Figure SC60-1 contains an example for Cyprinids. Based on the length-weight relationship shown in this figure, the 130 to 400 mm size range corresponds to a weight range of 20 to 600 grams. This weight range was then compared against the age-weight inputs in EPA's FCM for Cyprinids (summarized in Table SC60-1 below; also shown in Table 2 of Appendix C2 of EPA's Final Model Documentation Report [EPA, 2006c]):

Table SC60-1. Cyprinid Age versus Weight.

Cyprinid Age Class	1	2	3	4	5	6
Cyprinid Weight Range (grams)	0.2 – 3.0	3.0 – 5.0	5.0 – 8.0	8.0 – 12.0	12.0 – 20.0	20.0 – 25.0

From the EPA FCM inputs, the only age class for cyprinids having weights within the range of 20 to 600 grams is age 6, the last modeled age class. Thus, this is the age class listed for cyprinids in Table 3-14 of the CMS Report. The same approach was employed for all of the species listed in Table 3-14. GE believes that this approach for determining the age classes for osprey prey was appropriate. In fact, use of the ERA's size range extending up to 400 mm was already conservative, given that that range is greater than ranges reported in several studies (e.g., Cramp and Simmons, 1980; Van Daele and Van Daele, 1982; Prevost, 1982).

While GE does not agree with EPA's alternate parameterization of osprey feeding preferences, the significance of the method proposed by EPA was evaluated by: (a) increasing the endpoint PCB concentrations predicted by the model for fish consumed by osprey for all alternatives, using the CMS approach regarding prey consumed by osprey,[25] by the 16% cited by EPA in this comment; and then (b) comparing those increased concentrations again to the osprey IMPG. Table SC60-2 below illustrates the impact of this alternate approach on the number of averaging areas achieving the osprey IMPG for each of the sediment alternatives.

[25] The model endpoint concentrations determined using the CMS approach have been updated for this comparison to reflect the revised Reach 7/8 model runs for SED 6, SED 7, and SED 8 (assuming additional remediation in Reaches 7B and 7C) that were conducted in response to EPA's Specific Comment 44.

Table SC60-2. Number of Averaging Areas Meeting Osprey IMPG.

Alternative	Number of Averaging Areas Meeting Osprey IMPG using CMS Approach [26]	Number of Averaging Areas Meeting Osprey IMPG After Applying 16% Increase to Model-Predicted Concentration	Comments
SED 1/2	0 of 14	0 of 14	No changes in IMPG attainment
SED 3	6 of 14	6 of 14	No changes in IMPG attainment
SED 4	11 of 14	10 of 14	Change from attaining IMPG to non-attainment in Reach 7G
SED 5	13 of 14	11 of 14	Change from attaining IMPG to non-attainment in Reach 7C and 7G
SED 6	14 of 14	14 of 14	No changes in IMPG attainment
SED 7	14 of 14	14 of 14	No changes in IMPG attainment
SED 8	14 of 14	14 of 14	No changes in IMPG attainment

As shown in the above table, the method proposed by EPA would not have a large impact on attainment of the osprey IMPG or on the comparison among alternatives in terms of achieving this IMPG.

Section 4: Analysis of Remedial Alternatives for Sediments and Erodible Riverbanks

Alternative SED 1

Specific Comment 61 (Page 23): *Page 4-5: EPA notes that land use in the watershed can change over time and that changes in land use may result in changes in river transport processes. In contrast, the CMS assumes that all dams will be maintained but does not account for the influence that potential changes in land use may have on sediment delivery to the river or changes in the sediment trapping efficiency of impoundments over time.*

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[26] As noted above, this column is based on the model endpoint concentrations that were updated to reflect the revised Reach 7/8 model runs for SEDs 6, 7, and 8.

GE Response: This comment relates to text under Section 4.1.3 - Control of Sources of Releases (CMS Report, p. 4-5). This section describes how the dams would continue to limit movement of sediments to downstream reaches. While changes in land use may alter river transport processes and the amount of sediment transported to the River, the dams would still serve to reduce the potential for downstream transport of PCB-containing sediments. See also Response to General Comment 7.

Specific Comment 62 (Page 23): *Page 4-7: In this and similar sections for other SED alternatives (e.g., Pages 4-32, 4-70), annual average water column PCB concentrations are compared to the AWQC to evaluate compliance with the applicable ARAR. EPA notes that AWQCs are based on 4-day averages, not annual averages, and consequently these comparisons are invalid. GE shall include a section in the Supplement making the correct comparisons of simulated water column PCB concentrations vs. applicable AWQCs.*

GE Response: The PCB ambient water quality criterion for freshwater chronic aquatic life of 0.014 micrograms per liter (µg/L) (or 14 nanograms per liter [ng/L]), like other CCC (criteria continuous concentration) values for aquatic life protection, is based on a 4-day average not to be exceeded more than once every 3 years (see 40 CFR § 131.36(c)(2)(ii)).[27] However, it is unclear whether the 4-day averages to be used in comparing water quality data to this criterion are to be calculated as rolling averages (i.e., starting a new 4-day average each day) or 4-day "block" averages. In this situation, to evaluate whether the sediment alternatives would achieve this water quality criterion, 4-day averages have been computed both ways over the last 3 years of the model projection, and then compared to the freshwater aquatic life criterion to estimate the number of exceedances during this period. Table SC62-1 provides a summary of the number of exceedances estimated using both methods for all sediment alternatives.[28] (Note that, using rolling averages, there are 1,095 4-day averages within this three-year period, while using block averages, there are 274 4-day averages within this period.)

[27] By contrast, the ambient water quality criteria for human health protection are based on lifetime exposure and thus are appropriately evaluated by comparing annual average water column concentrations to those criteria.

[28] The model projections used in these calculations include the revised downstream Reach 7/8 model runs for SED 6, SED 7, and SED 8 that were conducted in response to EPA's Specific Comment 44.

Table SC62-1. Summary of Predicted Exceedances of Freshwater Chronic Aquatic Life Criterion for SED Alternatives.

Reach	Reach (Location)	Number of Predicted Exceedances in Last 3 Years of Model Projection (Rolling Average)						
		SED 1/2	SED 3	SED 4	SED 5	SED 6	SED 7	SED 8
PSA	5A (Holmes Road)	126	2	2	2	2	10	4
	5B (New Lenox Road)	1095	0	0	0	0	3	0
	5C (WP Headwaters)	1095	0	2	0	0	0	0
	6 (Woods Pond Dam)	1095	0	0	0	0	0	0
Reaches 7/8	7B (Columbia Mill Dam)	1095	0	2	0	0	0	0
	7E (Willow Mill Dam)	587	0	3	0	0	0	0
	7G (Glendale Dam)	284	2	3	3	0	0	0
	8 (Rising Pond Dam)	226	5	5	4	0	0	0
CT	Bulls Bridge	0	0	0	0	0	0	0
	Lake Lillinonah	0	0	0	0	0	0	0
	Lake Zoar	0	0	0	0	0	0	0
	Lake Housatonic	0	0	0	0	0	0	0
Reach	**Reach (Location)**	**Number of Predicted Exceedances in Last 3 Years of Model Projection (Block Average)**						
		SED 1/2	**SED 3**	**SED 4**	**SED 5**	**SED 6**	**SED 7**	**SED 8**
PSA	5A (Holmes Road)	29	0	0	0	0	2	1
	5B (New Lenox Road)	274	0	0	0	0	1	0
	5C (WP Headwaters)	274	0	1	0	0	0	0
	6 (Woods Pond Dam)	274	0	0	0	0	0	0
Reaches 7/8	7B (Columbia Mill Dam)	274	0	1	0	0	0	0
	7E (Willow Mill Dam)	150	0	1	0	0	0	0
	7G (Glendale Dam)	72	1	1	1	0	0	0
	8 (Rising Pond Dam)	60	1	1	1	0	0	0
CT	Bulls Bridge	0	0	0	0	0	0	0
	Lake Lillinonah	0	0	0	0	0	0	0
	Lake Zoar	0	0	0	0	0	0	0
	Lake Housatonic	0	0	0	0	0	0	0

Based on both averaging methods, predicted water column concentrations in the Massachusetts portion of the River under SED 1 and SED 2 exceed the water quality criterion 100% of the time in Reaches 5B, 5C, 6, and 7B, and on a considerable number of occasions in Reaches 5A, 7E, 7G, and 8. For the other alternatives, however, there are few or no predicted exceedances. Using 4-day rolling averages, 2 to 10 exceedances are predicted at one or two locations within the PSA and/or in Reaches 7 and 8, varying by alternative. However, all of the exceedances listed for SED 3 through SED 6 and SED 8 in both the PSA and Reaches 7 and 8 are exceedances of consecutive 4-day averages resulting from a single high-flow event, and thus could arguably be treated as a single exceedance (i.e., a prolonged exceedance that spans more than a single day resulting from the use of a rolling average during a single high-flow event). This is confirmed by the block averages that indicate only a single (or no) exceedance for these alternatives. Using rolling averages, SED 7 is the only alternative that results in exceedances during more than one high-flow event at Holmes Road over the three-year evaluation period. No exceedances were noted in Connecticut.

Using block averages, SED 3 through SED 8 all show one or no exceedance over the three-year period (with the exception of SED 7 which shows two exceedances in Reach 5A). Thus, using this averaging method, since application of the criterion allows one exceedance over a three-year period, all these alternatives except SED 7 would be considered to achieve the criterion, and SED 7 would have only one extra exceedance. In the present circumstances, under which the predicted exceedances for these alternatives using the rolling average method were all driven by a single high-flow event (except for SED 7), and given that the criterion permits one allowable exceedance, GE believes that use of block averages is more appropriate for assessing achievement of this criterion. Under that approach, all the sediment alternatives involving removal except SED 7 would attain the chronic aquatic life criterion.

Specific Comment 63 (Page 23): *Page 4-9: EPA notes that reference is made to natural recovery processes "documented to be occurring in the River," but this statement does not reflect a balanced consideration of all lines of evidence, some of which indicate lack of natural recovery. Reference should also have been made to studies that show little or no change in PCB concentrations in environmental site media (e.g., GE/BBL YOY fish tissue sampling since the 1990s).*

GE Response: First, it should be noted that the text cited in EPA's comment also references ahead to Section 4.2.5.2, Adequacy and Reliability of Alternative, and specifically the subsection on Use of Technologies under Similar Conditions. That subsection provides additional information regarding how "[c]ertain portions of the Rest of River, such as Woods Pond, Rising Pond, and the Connecticut impoundments, are currently demonstrating natural recovery" (CMS Report, p. 4-20). The text is supported by the analysis of finely sectioned cores from Woods Pond and Rising Pond that indicate deposition of cleaner sediments on the surface of the ponds and by long-term trends in fish and benthic insect PCB levels in the Connecticut impoundments, as discussed in the RCRA Facility Investigation Report (RFI Report) (BBL and QEA, 2003, Sections 4.6 and 6.6). See also Responses to Specific Comments 67 and 68.

A discussion of trends in the young-of-year (YOY) fish tissue sampling was not included in this section. As discussed in the RFI Report (BBL and QEA, 2003, Section 6.3), "from 1994 to 2002, no overall consistent trends can be discerned in average PCB concentrations in YOY fish from Massachusetts, either on a wet-weight or on a lipid-normalized basis. However, temporal trends are difficult to discern over such relatively short periods due to year-to-year variability in River conditions and changes in specific sampling areas due to the changing availability of fish for collection." Since completion of the RFI Report, GE has conducted three additional YOY sampling events (in 2004, 2006, and 2008), providing more data for developing a trend analysis. As described in the Response to Specific Comment 27, the 2008 YOY data generally show a decline in PCB concentrations from the previous sampling years and PCB levels that are among the lowest observed to date. As also discussed in Response to Specific Comment 27, the recent (September 2008) sampling of adult largemouth bass in the Massachusetts portion of the River shows a substantial reduction in PCB concentrations in the fish in Reach 5B/5C and Woods Pond compared to those measured in 1998 and 2002. This reduction is particularly pronounced in the fillets, but is also evident in the reconstituted whole body data (see Figures SC27-1 – SC27-4). These data provide further support for the conclusion that upstream source control and remediation efforts, together with natural recovery, have resulted in a significant reduction in PCB concentrations in the portion of the River between the Confluence and Woods Pond Dam.

Specific Comment 64 (Page 23): *Page 4-10: EPA notes that although it is true that SED 1, the no-action alternative, would not directly cause long-term impacts on human health or the environment, the demonstrated risks from the existing contamination would remain and only decrease slowly over time. This comment also applies to the similar statement on Page 4-21 with reference to SED 2.*

GE Response: This comment pertains to Section 4.1.5.3 - Potential Long-Term Impacts on Human Health or the Environment (CMS Report, p. 4-10). By definition, this criterion assessed "the potential long-term adverse impacts on human health and the environment from implementation of the alternative" (CMS Report, pp. 2-8 and 2-9). As such, this criterion considered only effects from implementation of remedial measures; and since SEDs 1 and 2 would involve no remediation in the River, there would be no long-term impacts under this criterion. The potential effects from the continued presence of PCBs were considered under other criteria, including magnitude of residual risk, attainment of IMPGs, and overall protection of human health and the environment. See also Response to Specific Comment 30.

Specific Comment 65 (Page 23): *Page 4-10: EPA notes that the discussion of IMPGs inappropriately emphasizes selected achievements of IMPGs without providing an appropriately balanced discussion of IMPGs that are not achieved. It is misleading to simply state (for SED 1) that "IMPGs would be achieved in some areas by the end of the 52-year simulation period." Some IMPGs for selected averaging areas and some endpoints would be achieved by SED 1, but the overall conclusion for most areas and most endpoints is that IMPGs would be exceeded even after 52 years. The exceedance of IMPGs for SED 1 is the rule, not the exception, and CMS language such as "certain IMPGs would not be achieved by the end of the model projection period" downplays the risks under the baseline scenario.*

GE Response: The cited summary statement, which appears in the introduction to the discussion of the attainment of IMPGs for SED 1 (CMS Report, Section 4.1.6), is a correct qualitative statement. Quantitative information regarding IMPG attainment is included in the CMS Report tables and Appendix G (as referenced in the text). More specific discussion of IMPG attainment for SED 1 is included in the subsections to Section 4.1.6 of the CMS Report.

Specific Comment 66 (Page 24): *Page 4-12: EPA notes that the discussion of target sediment levels for SED 1 inappropriately blurs the distinction between those concentrations and IMPGs. The CMS fails to clearly indicate that "target sediment levels" for insectivorous birds and piscivorous mammals do not equate with achievement of IMPGs. Later in the CMS, it becomes apparent that the 3 mg/kg and 5 mg/kg target levels do not generally achieve IMPGs, and in some cases even the lowest target level is inadequate to achieve select IMPGs without associated action in the floodplain.*

GE Response: This comment is incorrect. The CMS Report explained in detail, prior to this discussion of SED 1, that the achievement of the target sediment levels for insectivorous birds and piscivorous mammals is not equivalent to achievement of the IMPGs for those receptors, which depend on both the sediment and associated floodplain soil levels (CMS Report, Section 2.2.2.3). This point was noted again in comparing the sediment alternatives (CMS Report, p. 4-241). The achievement of the IMPGs for these receptors for all combinations of sediment and floodplain alternatives is discussed in Response to General Comment 24.

Alternative SED 2

Specific Comment 67 (Page 24): *Page 4-20: EPA notes that under SED 2, due to the extremely site-specific nature of MNR, the fact that MNR has been successful in reducing contaminant concentrations and risks at some other sites has limited relevance to the ROR site without an analysis of the specific conditions present in Reaches 5 through 8 against the considerations described in Chapter 4 of Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA 2005) as discussed in General Comment 15.*

GE Response: SED 2, which involves MNR in all reaches, was approved by EPA for evaluation in the CMS. The CMS Report section referenced in this EPA comment evaluated that alternative under the sub-factor of Use of Technologies Under Similar Conditions. That factor required consideration of whether the technology involved in the alternative, MNR, has been used at other sediment sites, either alone or in combination with other remedial approaches. Consistent with that requirement, the CMS Report explained that MNR has been selected as part of the overall remedial approach for numerous contaminated sediment Superfund sites (EPA, 2005b), including a portion of Twelvemile Creek and Lake Hartwell at the Sangamo-Weston Superfund Site in Pickens, SC (EPA, 1994a), Charleston Boat Yard, OR site (ORDEQ, 2001), the Fox River (EPA and WDNR, 2007), the Little Mississinewa River, IN (EPA, 2004c), and the Wycoff/Eagle Harbor Superfund Site East Harbor, WA (EPA, 1994b). MNR was selected for these sites (or portions of sites) as it was determined that there were "ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment" and those processes were contributing to risk reduction (EPA, 2005b, p. 4-1). As further noted in the CMS Report and discussed elsewhere in this Interim Response, natural recovery processes have likewise been shown in certain portions of the Rest of River. See Responses to Specific Comments 63 and 68.

With respect to EPA's comment regarding comparison of Rest of River conditions to the MNR-related considerations discussed in EPA's *Contaminated Sediment Remediation Guidance*, see Response to General Comment 15.

Specific Comment 68 (Page 24): *Page 4-20: EPA notes that reference is made to the analysis of finely sectioned cores in Woods Pond and Rising Pond indicating "deposition of cleaner sediments on the surface of the ponds." While true for some cores, this statement represents only a selected result of the analysis of some cores. High-resolution cores collected in both Reach 6 and 8 exhibited a wide range of sediment profiles, including some with no discernible vertical trend and some with higher contamination at the surface relative to deeper strata.*

GE Response: The entire sentence referenced in EPA's comment reads: "Certain portions of the Rest of River, such as Woods Pond, Rising Pond, and the Connecticut impoundments, are currently demonstrating natural recovery, as indicated by the analysis of finely sectioned cores in Woods Pond and Rising Pond that indicate deposition of cleaner sediments on the surface of the ponds and by trends in fish and benthic insect PCB levels in the Connecticut impoundments (BBL and QEA, 2003, Sections 4.6 and 6.6)." Note that the text refers to surface sediments and not vertical trends.

The quoted statement regarding surface sediment concentrations was based on text in Section 4.6 of the RFI Report (BBL and QEA, 2003). This text presents a summary of temporal trends in PCB transport and deposition in the River. In general, the temporal trends in surface sediment concentrations in Woods Pond and Rising Pond showed a downward sloping regression line. The text indicates that "the PCB concentration of particles that settled in depositional areas of Woods Pond and Rising Pond have significantly decreased since the 1960s. The results for these cores, however, cannot be used to conclude that reach-wide concentrations in these impoundments have significantly decreased during this period (BBL and QEA, 2003)." Given this analysis, the CMS Report text was qualified with "certain portions."

Specific Comment 69 (Page 24): *Page 4-21: EPA notes that the description of impacts of SED 2 is misleading as it implies that the current PCBs are not posing risk to human health and the environment. It would be correct to say that SED 2 does not pose any additional impacts beyond those already occurring.*

GE Response: As noted above, consistent with the Permit and the EPA-approved CMS Proposal, the discussion of impacts from the various alternatives in the CMS Report focused on the impacts from implementation of those alternatives. Potential impacts from PCBs were considered under other criteria. See Responses to Specific Comments 30 and 64.

Alternative SED 3

Specific Comment 70 (Page 24): *Page 4-26: No details regarding the proposed design of the sheetpile system are provided. GE shall include a description of the design process to be followed for the installation of the sheetpile including but not limited to the geotechnical data which would need to be collected, decision on sheet length, embddeness, and gage. (This comment applies to all alternatives.)*

GE Response: The design and construction of the sheetpile system that would be used for sediment removal in the dry will incorporate site-specific conditions to determine the appropriate sheet lengths, sheeting configuration, gauge, and depth of embedment. To obtain information on the necessary site- and reach-specific parameters to design the sheetpile system, the following steps would be followed:

- Perform pre-design investigations (i.e., sediment/soil borings), including laboratory soil testing in accordance with ASTM International standards, as needed to evaluate the geotechnical properties of the areas where sheetpiles would be installed (e.g., sub-surface stratigraphy, grain-size, blow counts, *in-situ* strength) so as to evaluate the feasibility of installation, drivability, and/or appropriate gauge of sheeting for the site. Data collected will provide information for the calculation of lateral earth pressures, estimated deflection of the sheeting, and the factor of safety against rotational failure.

- Evaluate the anticipated depths of water in the area of removal (and desired degree of flood protection), as well as the adjacent depth of the removal, to estimate length, embedment, and potential bracing requirements for sheeting, if necessary.

- Identify any obstructions that may require modifications to the designed location and/or gauge of the sheeting.

Upon completion of the pre-design investigation activities, the data collected will be compiled and the results will be evaluated using standard engineering practices, along with output from sheetpile software (e.g., ct-Shoring and ProSheet) for various sheeting systems and configurations that will provide a safe and secure method for sediment removal in the dry. Depending on the depth of removal and the strength of the underlying materials, both braced and unbraced sheeting systems may be considered. Where appropriate, the use of heavier gauge sheeting may be considered in order to reduce bracing requirements, if possible. In all cases, an appropriate factor of safety for these types of systems, in accordance with standard engineering practices, will be utilized as part of the design.

In addition, identification of potential subsurface obstructions during the pre-design investigation will be considered as part of the sheeting design configuration. In areas where obstructions are identified, alternative means of isolation may be considered in an effort to limit the impact of the obstructions on the overall sheeting system.

Specific Comment 71 (Page 24): *Page 4-27: GE shall provide in the Supplement the estimated capacity of the water treatment system which will be used to treat water from excavation and dewatering stockpile areas.*

GE Response: GE assumed for purposes of the CMS Report that the water treatment system would have a capacity of 450 gallons per minute (gpm).

Specific Comment 72 (Page 24): *Page 4-27: GE shall provide the assumptions used in the derivation of the 33,000 cy volume of erodible banks referenced in this section.*

GE Response: For the purposes of the CMS evaluations, a screening-level calculation was used to estimate the volume of bank soil to be removed within Reaches 5A and 5B for alternatives SED 3 through SED 8. The volume was estimated based on the assumption that all banks within Reaches 5A and 5B would require removal and stabilization and thus would be cut back to a nominally stable slope (an assumption that is most likely over-conservative, as discussed below). The volume calculation was based on an assumed vertical bank that would be cut back to a uniformly sloped bank. Thus, the volume was defined by a triangular prism; the dimensions of the prism varied by reach and were calculated as follows:

- The length of banks was calculated based on the total length of River shoreline within the reach, accounting for both sides of the River.

- Bank heights for each reach were based on the average difference between top of bank elevations (from the 1998 EPA cross-sectional elevation data) and water surface elevations under mean flow conditions predicted by the EPA hydrodynamic model.

- The base of the triangle (i.e., the horizontal distance from the top of the existing bank to the edge of the triangular cut) was calculated from the average bank height of each reach and an assumed horizontal to vertical slope of 3:2.

The calculation is summarized in Table SC72-1 below:

Table SC72-1. Estimated Volume of Bank Soil to be Removed within Reaches 5A and 5B under SED 3 through SED 8.

Reach	Length (feet)[29]	Height (feet)	Base (feet)	Volume (cy)
5A, upper 3.1 miles	32,700	4	6	15,000
5A, lower 1.9 miles	20,100	5	7.5	14,000
5B (2.1 miles)	22,200	2.5	3.75	4,000
Total				**33,000**

Although this volume estimate was based on the assumption that all banks in Reaches 5A and 5B would be remediated, it is unlikely that all banks in these reaches would require stabilization. For example, EPA conducted a visual survey of the banks in 2001, which identified specific locations of eroding banks. These areas covered approximately 22,100 linear feet of bank in Reaches 5A and 5B, which is much less than the total length used in the calculation described above. Specific banks in need of stabilization would ultimately be determined during design, as would the associated volume of bank soil to be removed. As discussed above in the Responses to General Comments 6 and 10, the bank stabilization activities called for by alternatives SED 3 through SED 8 would create serious and

[29] Note that the total length of remediated banks cited here (i.e., 75,000 feet, which represents total river miles of Reaches 5A/B converted to feet, times two banks), which was used to estimate the total bank removal volume in Reaches 5A and 5B during the CMS, is less precise than the more detailed estimate of riverbank length used elsewhere in this Interim Response (e.g., Response to General Comment 10), which is 84,000 linear feet.

irreparable ecological harm to the riverbanks and river. As a result, it is critical that the bank remediation and stabilization activities be reconsidered giving full consideration to that ecological harm.

Specific Comment 73 (Page 25): *Page 4-29: GE notes here that the post-construction monitoring program will include "visual observation in the thin-layer cap areas in Reach 5C and Woods Pond." It is unclear how a determination of cap thickness would be made given the influence of bioturbation over a 5-year period. GE shall provide a discussion describing how information from the "visual observation" program could be used to support a conclusion that the thin-layer cap is (or is not) effective, and the relationship of such monitoring to the definition of a TLC.*

GE Response: Visual observation of sediment cores collected from the thin-layer cap areas was included in the operation, maintenance, and monitoring (OMM) program to provide a method for assessing the presence of cap material (and potentially cap thickness). After a period of time, the difference between the cap material and native sediments may not be visually apparent; however, the visual observations would be supplemented/enhanced through monitoring that includes periodic core collection with PCB analysis. Effectiveness of the thin-layer cap would also be evaluated through fish and water column monitoring.

Specific Comment 74 (Page 25): *Page 4-31: EPA notes that the ability of dams to trap sediment may decline over time as sediment accumulates and those impoundments mature. Further, land use changes (urbanization) and other anthropogenic influences are expected to have long-term effects that are not necessarily quantifiable, but should be considered as uncertainties because such changes could increase sediment delivery to the system, or increase the potential for bank erosion. While increases in sediment loads may increase the rate of recovery by dilution to some extent, sediment accumulation also has the potential to reduce trap efficiency and slow the rate of recovery. Thus, the role of dams in limiting future PCB transport may depend on factors beyond the physical integrity of those structures.*

GE Response: In general, while the sedimentation rate will decrease as an impoundment behind a dam "fills up," the importance of this process is a matter of timescale. Reservoirs generally fill up slowly (on the order of a few centimeters per year). Thus, although sedimentation rates do decrease, the time over which such decreases occur is on the order of several decades. It is likely that the decreases in sedimentation rate would occur at a rate that is slower than that of natural recovery through silting-over, which means that natural recovery will continue to occur, although at a slower rate than it otherwise would. For example, for a reservoir that is a few meters deep having a sedimentation rate of 1 to 2 cm/yr, it could be on the order of 100 years before the rate slows down to 0.1 to 0.2 cm/yr.

Specific Comment 75 (Page 25): *Page 4-37: As discussed in General Comment 15, EPA considers thin-layer capping to be a component of monitored natural recovery and therefore does not recognize a thin-layer cap as providing any benefit in terms of isolation of contaminants. However, EPA notes that the claimed insignificant increase in exposure due to cap erosion following the storm event in fact represents a tripling in PCB concentrations in surficial sediment in Woods Pond (Figure G1.2-2A), and the comparison is misleading as it was made using original (pre-remediation) rather than pre-storm concentrations.*

GE Response: While EPA is correct in that the predicted increase in average surface sediment PCB concentrations in Woods Pond following a severe storm event represents a tripling in PCB concentrations, the CMS Report showed that that increase was less than 1 mg/kg (i.e., going from a pre-storm concentration of ~0.4 mg/kg to a post-storm concentration of ~1.2 mg/kg). The text later stated that, despite this increase, the post-storm surface sediment PCB concentration of 1.2 mg/kg in Woods Pond still represents a 96% reduction from pre-remediation conditions.

Specific Comment 76 (Page 25): *Page 4-42: EPA notes that in the discussion of GE's recommended alternative for sediment remediation, SED 3, it is mentioned that habitat alterations "may actually improve habitat conditions." However, for other sediment alternatives, remediation effects are described mainly in terms of negative consequences. GE shall provide a discussion of why positive effects of habitat alteration are not considered to be relevant for other remediation alternatives other than SED 3.*

GE Response: The sentence referenced by EPA in this comment occurred in the opening subsection under Potential Long-Term Adverse Impacts, titled "Potentially Affected Populations." It stated: "In some instances, the habitat alterations may actually improve habitat conditions. For example, placement of armor stone in excavated areas would increase the heterogeneity of the habitat for benthic invertebrates, particularly when portions of the dredged area are silted in over time." The CMS Report also stated in a subsequent subsection (p. 4-44) that thin-layer caps could change the habitat type in a negative or positive way depending on the existing water depth. Specifically, it noted that: (a) in areas where the water is less than 12 inches deep and consolidation of the underlying sediment is not anticipated, the thin-layer cap would have a long-term adverse effect by increasing the substrate elevation so as to change the vegetation of these riverine wetlands or cause it to be replaced with riparian or upland vegetation; and (b) in areas with water depths of 2 to 4 feet, placement of the thin-layer cap could have a beneficial effect by increasing the area of the littoral zone, thereby broadening the area available for colonization by emergent aquatic plants.

In the discussions of the subsequent sediment alternatives, the subsections on "Potentially Affected Populations" were much shorter and consisted of an introductory paragraph comparing the alternative under evaluation to those that had been discussed previously. Thus, they did not address specific impacts on habitat, such as the effects (positive or negative) of the placement of armor stone. However, with respect to the potential impacts of thin-layer caps, the discussions of long-term effects under the subsequent sediment alternatives that involved thin-layer caps did include the same point as in SED 3 about the potential beneficial effect of such caps in areas with water depths of 2 to 4 feet. They did so either explicitly (for SED 4 and SED 6; see CMS Report, pp. 4-78, 4-144) or by cross-reference to prior discussions (for SED 5 and SED 7, see CMS Report, pp. 4-111, 4-178 to 4-179).

In any event, as a general matter, although certain individual aspects of the sediment alternatives might have some beneficial effects in some areas, the overall impact on the environment of all the alternatives involving removal or capping, including SED 3, would be negative, producing substantial adverse effects on the river bottom, the river banks, and (due to the access roads and staging areas) the floodplain. These effects are discussed in the Responses to General Comments 6 and 10 and Appendix B to this Interim Response.

For this reason, as previously discussed, GE is currently discussing the development of an ecologically sensitive alternative with EPA and the Commonwealth, and will evaluate and compare the overall impact on the environment of all of the remedial alternatives, including the ecologically sensitive alternative, in the revised CMS Report.

Specific Comment 77 (Page 25): *Pages 4-42 and 4-43: The discussion here, and for other SED and FP alternatives, concerning Potentially Affected Populations and Adverse Impacts on Biota and Corresponding Habitat is not sufficient to provide a basis for conducting a relative evaluation of the alternatives because it fails to adequately discuss possible actions to mitigate adverse impacts. As currently prepared, the CMS assumes that any rare, threatened, or endangered species (including but not limited to MESA state-listed species, or "MESA species") in a work area may be permanently harmed. There are a number of actions that can be taken to avoid and minimize impacts to MESA species. For example, wood turtles (Clemmys insculpta) can be captured and then held in captivity until their habitat is restored, at which point they may be returned. Seeds or propagules can be collected from rare plants, stored, and then cultivated and replanted. Locations with rare plants can also be avoided. Vernal pools can be excavated and restored during the driest part of the summer, when amphibians are not in the pool but in the surrounding upland or wetland habitat. The non-pool amphibian habitats should be identified, mapped, and could then avoided to the maximum extent practicable.*

As described in General Comment 16, GE shall include a detailed description of how effects to MESA species will be avoided and minimized to the maximum extent practicable in the potential implementation of an alternative. Specifically, GE shall identify a full range of proposed siting criteria and other design, construction, and restoration measures that would apply to each alterative. Consistent with the requirement in that General Comment, GE shall include a graphic depiction of the decision tree process which underlies the objective of avoidance and minimization.

GE's analysis shall also include a discussion of how these assumptions modify GE's analysis regarding the short- and long-term effectiveness of the alternative and cost implications.

GE Response: Detailed evaluations of the adverse impacts of all of the sediment and floodplain soil removal alternatives on the Priority Habitats of the numerous state-listed threatened, endangered, and special concern species (jointly known as rare species) in the PSA are presented, on a species-by-species basis, in Appendix B, the "Assessment of MESA Issues for Rare Species Under Remedial Alternatives." Those assessments discuss, for each species that would be "taken" by a given remedial alternative, whether and the extent to which such a take could be avoided. In most cases where work would be conducted in the Priority Habitat of a rare species, there is no feasible way to avoid such a take. See also Responses to Specific Comments 102 and 105. For example, although it may be possible in some situations to avoid causing a certain kind of take (e.g., direct mortality) by working in the Priority Habitat at times of the year when the species in question is not present or by collecting and moving the animals out of the area during construction activities, such measures would not avoid a take due to the disruption of the nesting, breeding, feeding, and/or migratory habitat or patterns of these species. Similarly, the collection of seeds or propagules of rare plants would not avoid a take due to the killing of any such plants that may be in the construction area or the removal of the seed bank of the species.

Discussions of the potential to avoid, minimize, or mitigate adverse impacts of the remedial alternatives on the various types of habitat that would be adversely impacted, as well as the potential to successfully restore those habitats, are also provided in the Response to General Comment 10. As is shown in that response, for any combination of the more intrusive remedial alternatives evaluated in the CMS Report (i.e., SED 3 through SED 8 and FP 3 through FP 7), there is no feasible way to avoid or significantly minimize the long-term and even permanent ecological harm that would result from the implementation of those alternatives, nor is there any feasible way to return the overall ecosystem of the PSA to its current condition and level of function following the implementation of those alternatives.

Specific Comment 78 (Page 26): *Page 4-43: The discussion here, and for other SED alternatives, concerning Riverbank Restoration is not sufficient to provide a basis for conducting a relative evaluation of the alternatives. The river meander study and short- and long-term erosion studies indicated that the river channel is actively moving in the floodplain, and that movement is an integral part of the river. Sandy river banks, bars, and other soft river features provide habitat for a number of species that are obligate to the river. Exposed banks provide habitat for nesting belted kingfishers (Ceryle alcyon), several species of turtles, and dens for beaver (Castor canadensis). Intermediate spikerush (Eleocharis intermedia), which is rare, and a number of other wetland species grow on newly formed banks. Armoring the channel is expected to alter the erosion and accretion processes by stopping the river from moving. The short and long-term effects of armoring on river dynamics were not presented in the CMS. To provide the basis for evaluation of the SED alternatives, GE shall provide information on short and long-term bank habitat alteration and subsequent effect to obligate species, and on alternative approaches to river bank restoration that will eliminate or reduce negative impacts to these species.*

GE Response: The short-term and long-term effects of bank remediation/stabilization on the river and riverbanks and the obligate riverbank species are discussed in the Response to General Comment 6 and Section III.A.2 of the Response to General Comment 10. Further, the impacts on state-listed rare species that use the riverbanks are discussed in the "Assessment of MESA Issues for Rare Species Under Remedial Alternatives" in Appendix B As shown in those responses, the bank remediation/stabilization activities would cause serious and irreversible ecological harm regardless of the stabilization technique used. In particular, while General Comment 6 provides information on alternate approaches to riverbank remediation (namely, bioengineering), it also shows that those approaches would not avoid or significantly reduce the negative effects of that remediation.

Alternative SED 4

<u>Specific Comment 79 (Page 26):</u> *<u>Page 4-95</u>: In the evaluation of the SED 4 alternative, GE states that "this alternative would not achieve the ecological IMPGs for a couple of receptor groups in a few limited areas." EPA notes that this language is an understatement of the residual risks, because IMPGs for numerous receptor groups are exceeded, and some IMPGs (e.g., mink) are exceeded over large areas.*

GE Response: GE's statement was correct and not an understatement of PCB-related risks. As shown in Section 4.4.11 of the CMS Report, SED 4 would achieve the IMPGs for fish and threatened and endangered species in all reaches, levels within the IMPG range for amphibians in 27 of 29 backwaters (representing 99% of the backwater acreage), the IMPG for piscivorous birds in Reaches 5 and 6 and most of Reach 7, the target sediment levels of 3 and 5 mg/kg for insectivorous birds in all areas and 1 mg/kg in most areas, and all target levels for piscivorous mammals in both averaging areas. Thus, it is not true that, as EPA states, the "IMPGs for numerous receptors are exceeded," or that the IMPGs for mink "are exceeded over large areas." Rather, SED 4 would result in only very limited IMPG exceedances, and (except in combination with FP 1) would achieve levels within the mink IMPGs in all areas (see Response to General Comment 24 and Table GC24-4).

Alternative SED 5

<u>Specific Comment 80 (Page 26):</u> *<u>Page 4-110</u>: Mention is made in the CMS of the cumulative impacts of stressors to amphibian and wildlife populations. EPA notes that the stressors referred to by GE are described in terms of habitat alteration during remediation, however current and ongoing stresses due to the presence of PCBs are not discussed.*

GE Response: As noted above, consistent with the Permit and the EPA-approved CMS Proposal, the discussion of impacts from the various alternatives in the CMS Report focused on the impacts from implementation of those alternatives. Potential impacts from PCBs were considered under other criteria. See Responses to Specific Comments 30, 64, and 69.

Specific Comment 81 (Page 26): *Page 4-110: GE shall provide a discussion, supported by appropriate references from the technical literature, for the claim that re-establishment of benthic invertebrates and aquatic vegetation could require more time following implementation of SED 5 than for alternatives SED 1 through 4.*

GE Response: As discussed in the Response to General Comment 10 (Section III.A.3), the nature and rate of recolonization by benthic invertebrates and aquatic vegetation will be determined by many factors, including the scale, timing, and sequencing of the remedial alternative. Several factors, supported by the literature, indicate that the more extensive the disturbance, the longer it will take for re-establishment of benthic invertebrates and aquatic vegetation and the more uncertain it is how long that re-establishment will take, whether specific organisms will be re-established, and how abundant the organisms will be. These include the following:

- Studies have shown that invertebrate abundance and family richness decrease as the duration of the habitat disturbance increases (Shaw and Richardson, 2001), and conversely, that invertebrate population diversity increases with time after disturbance of the habitat (Death and Zimmermann, 2005). Even after a considerable period of time, however, benthic invertebrate communities that have been disturbed may differ from those of natural streams (Muotkaa et al., 2002), and the immigration of new species into restored areas can be limited (Spänhoff and Arle, 2007). One can conclude, therefore, that the greater the area of the initial disturbance, the longer it will take before the river biota ultimately resemble those in a natural, unaltered ecosystem.

- When greater areas of streams are disturbed, the speed and likelihood of recovery of benthic invertebrate populations are reduced compared to the recovery of smaller disturbed areas (Norkko et al., 2006). Less mobile species of invertebrate rely on refugia to survive natural and human disturbances, and then recolonize when conditions are again suitable. But the longer the length of disturbed or remediated stream, the less likely recolonization can take place in a timely manner, or at all. In addition, small populations of some species of concern (e.g., dragonfly larvae) may be eliminated during larger-scale remediation activities, threatening subpopulations of these already rare species.

- Similarly, disturbances to larger stream areas will reduce the speed and likelihood of re-colonization by native plants since they will: (a) increase the distance that seeds or other propagules would have to travel to re-colonize the area; and (b) increase the potential for, and extent of the area susceptible to, colonization by invasive species, which could dominate over native species.

- Disturbance of larger areas of a stream ecosystem interferes with hydrologic and habitat connectivity. Limited connectivity is associated with local extinctions, population fragmentation, and isolation. These factors have the potential to limit ecosystem recovery (Bolton and Shellberg, 2001; Cottingham et al., 2005). Intact areas of stream bed can improve recovery of invertebrate populations in nearby disturbed areas (Korsu, 2004).

- While the remediation work under the larger sediment alternatives would be sequenced over many years, thereby reducing amount of work in any construction season, the impacts of the work during a given construction season would last far beyond that season and extend for many decades or permanently, as discussed in the Response to General Comment 10. Thus, despite such sequencing, larger alternatives would have a greater adverse impact than smaller ones.

- The alternatives that take a longer time to implement would also mean that access roads, staging areas, and disturbed soils, substrates, and banks will remain unvegetated for longer periods, which will reduce sources for recolonization by native organisms and leave areas exposed longer for colonization by invasive species.

For all these reasons, remedial alternatives involving a greater extent of disturbance over a longer time period would significantly affect the nature and rate of recolonization by native invertebrates and aquatic plants. They would lengthen the time for such recolonization and make it more uncertain that recovery to pre-remediation conditions would occur at all. It is for that reason, among others, that GE is currently discussing with EPA and the Commonwealth the development of an ecologically sensitive alternative that would minimize the extent and time of any disturbance to the existing habitats. GE will fully evaluate and compare all the alternatives, including the ecologically sensitive alternative, in the revised CMS Report in accordance with EPA's February 5, 2009 letter.

<u>Specific Comment 82 (Page 27):</u> *<u>Page 4-119</u>: There is an inconsistency in the CMS regarding the nature of the material to be used for thin-layer capping, described here as "sand" and elsewhere in the document as being similar in properties to the underlying native material. EPA's understanding is that the latter definition was used for the model simulations involving TLC, but notes that, if TLC becomes a component of the remedy, it may be neither practicable nor advisable to duplicate the underlying native material. The specific nature of the TLC capping material, if appropriate, would be a component of the final design and subject to review by EPA at that time.*

GE Response: Comment noted.

<u>Specific Comment 83 (Page 27):</u> *<u>Pages 4-120 and 4-121</u>: EPA notes that the description of the number of truck trips, the disturbances they will generate, and the possible injuries and fatalities is lacking perspective (particularly for this and other more aggressive alternatives). The number of truck trips, expressed on a daily basis, would be 26 trucks per day. In addition, as the project progresses, the potential impact of these trucks will move from upstream areas to downstream areas, so that not all areas will be affected by the increased number of trucks over the entire duration of the alternative. The estimates of non-fatal and fatal injuries are also misleading because the timeframe over which these injuries would occur is omitted. GE shall provide a recalculation that expresses truck trips and injury estimates in terms of number of events per year to provide an alternative frame of reference with which to compare alternatives, rather than simply the total number of estimated events.*

GE Response: GE believes that the total number of truck trips and total number of fatal and non-fatal injuries estimated to result from a given alternative are meaningful and relevant to the evaluation of those alternatives. Nevertheless, in response to EPA's comment, GE has recalculated the truck trips and fatal and non-fatal injury estimates for each of the sediment, floodplain, and treatment/disposition alternatives to express those estimates on an average annual basis. In calculating these estimates on a per-year basis, the total numbers of truck trips and fatalities/injuries presented in the CMS Report for each alternative were divided by the estimated overall duration of that alternative. Since these estimates are provided for general illustrative and comparative purposes, GE has not revised the total number of truck trips and fatalities/injuries presented in the CMS Report to take account of revised information on total volumes of removal or implementation duration for the various alternatives, as presented elsewhere in this Interim Response. Nor has it attempted to make distinctions among the various years of implementation in terms of the number of truck trips or number of workers. Rather, it has simply calculated the average annual number of truck trips and of fatalities/injuries, based on the total numbers from the

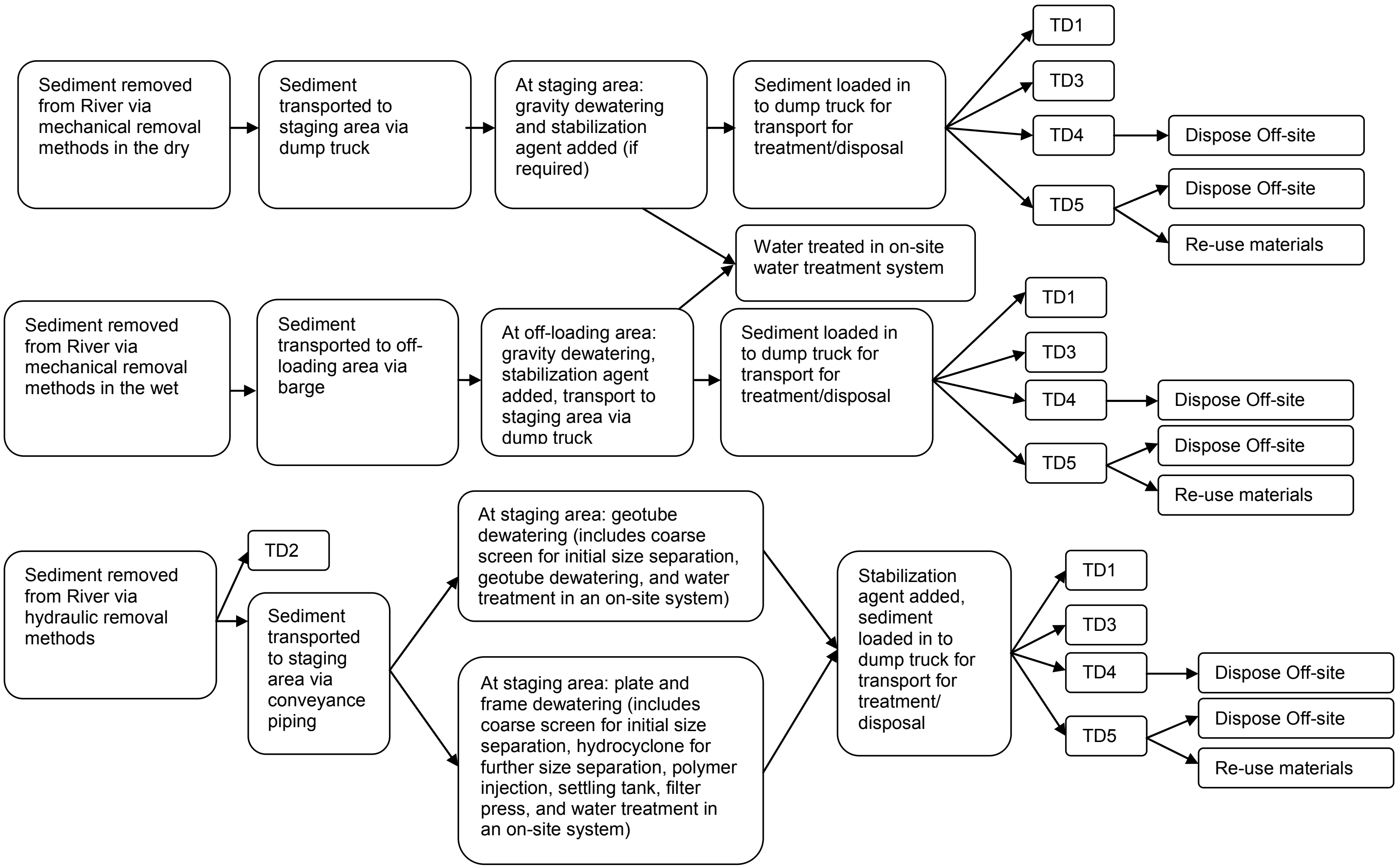
CMS Report (including the ranges of volumes for the treatment/disposition alternatives). Although not precise, the resulting estimates are sufficient to allow a general comparison among alternatives. The calculated estimates of truck trips per year, as well as injury and fatality estimates presented on an average per-year basis, are included in Tables SC83-1 through SC83-6.

Alternative SED 6

Specific Comment 84 (Page 27): *Page 4-131: GE shall provide additional details regarding the process for dewatering hydraulically dredged sediments that was assumed for cost estimating purposes. In addition, GE shall provide conceptual process flow diagrams for each alternative (i.e., the movement of material from the river to its ultimate disposal, including any treatment and dewatering steps used, should be shown graphically).*

GE Response: It was assumed that sediments removed from the River via hydraulic removal methods would generally be dewatered using a mechanical plate and frame dewatering system that includes a series of screens and a hydrocyclone for initial dewatering and particle size separation. Larger particles would be washed and dewatered via gravity dewatering, and would undergo waste characterization prior to disposal. The remaining fine-grained sediment would be mixed with a polymer to facilitate flocculation, and conveyed to settling tanks. Free liquids from this tank would be treated in an on-site water treatment system. Accumulated solids that settle out of the tank would be pumped to a filter press for further dewatering prior to waste characterization and transportation to the appropriate treatment and/or disposal facility.

The general conceptual sequences of materials handling and dewatering are summarized in the attached flow chart.


Sediment removed from River via mechanical removal methods in the dry
Sediment transported to staging area via dump truck
At staging area: gravity dewatering and stabilization agent added (if required)
Sediment loaded in to dump truck for transport for treatment/disposal
TD1
TD3
TD4
TD5
Dispose Off-site
Dispose Off-site
Re-use materials
Water treated in on-site water treatment system
Sediment removed from River via mechanical removal methods in the wet
Sediment transported to off-loading area via barge
At off-loading area: gravity dewatering, stabilization agent added, transport to staging area via dump truck
Sediment loaded in to dump truck for transport for treatment/disposal
TD1
TD3
TD4
TD5
Dispose Off-site
Dispose Off-site
Re-use materials
Sediment removed from River via hydraulic removal methods
TD2
Sediment transported to staging area via conveyance piping
At staging area: geotube dewatering (includes coarse screen for initial size separation, geotube dewatering, and water treatment in an on-site system)
At staging area: plate and frame dewatering (includes coarse screen for initial size separation, hydrocyclone for further size separation, polymer injection, settling tank, filter press, and water treatment in an on-site system)
Stabilization agent added, sediment loaded in to dump truck for transport for treatment/ disposal
TD1
TD3
TD4
TD5
Dispose Off-site
Dispose Off-site
Re-use materials

Alternative SED 7

<u>Specific Comment 85 (Page 27):</u> *<u>Page 4-164</u>: It is EPA's understanding that while it is specified that backfill will be used in Reaches 5A and 5B in the text, for costing purposes an engineered cap was assumed. GE shall clarify if SED 7 consists of removal with backfill or removal with an engineered cap.*

GE Response: As noted on p. 4-164 of the CMS Report and Table 5-1 of the CMS Proposal (revised and submitted on May 31, 2007), SED 7 assumed that backfill (sand and gravel) would be placed following removal in Reaches 5A and 5B. For cost estimation purposes, there was no distinction between the two options (i.e., engineered cap vs. backfill) as the material types and thicknesses were assumed to be the same.

Alternative SED 8

<u>Specific Comment 86 (Page 27):</u> *<u>Page 4-216</u>: GE shall include a discussion of the applicability of the referenced "one to three orders of magnitude" increase in releases of contaminated sediments during dredging to the site-specific conditions in the ROR. The discussion shall also provide the quantitative basis for the statement that implementation of SED 8 would result in the loss of 1,000 to 1,500 lbs of PCB to the water column, which appears to be inconsistent with the loss rate cited and the estimated PCB mass removed by reach (Page 4-215) when adjusted for operations to be performed in the dry.*

GE Response: According to *The Four Rs of Environmental Dredging: Resuspension, Release, Residual, and Risk* (Bridges et al., 2008), prepared for USACE:

> "Short-term releases directly to the water column (during dredging operations) may be one to three orders of magnitude greater than pre-dredging releases (Sanchez et al. 2002). Although 'short-term' in this context refers to the releases occurring during the immediate time frame of the dredging operation, since many environmental dredging projects can run 24/7 for 4-10 months seasonally and span multiple dredging seasons, it is important to evaluate the overall potential impact of the increased exposure attributable to releases, particularly in light of some of the earlier studies showing loss of 2-3 percent of the PCB mass dredged. For example, 3 percent of 10,000 lb of PCBs would be 300 lb of PCBs released." (Bridges et al., 2008, p. 19.)

That report also states that contaminant release is dependent on a number of factors, including "the duration of the dredging operation, composition of the sediment being dredged (e.g., grain size distribution), contaminants associated with the sediment, current velocities, and a range of other physical and chemical factors" (Bridges et al., 2008, p. 15). Considering the duration of removal activities for SED 8 (over 50 years), sediment composition including primarily sands and silts (with some gravel), and the varying current velocities throughout the River, considerable PCB releases would be expected during SED 8 activities.

The initial calculated loss of 1,000 to 1,500 lbs of PCBs was based on 2 to 3% (as noted by Bridges et al., 2008) of the 52,500 lbs of PCBs to be removed from Reach 8. As EPA notes, this mass loss needs to be adjusted to account for removal in the dry in Reaches 5A and 5B, which is assumed to involve no releases. After such adjustment, the estimated PCB loss for SED 8 would amount to a release of 600 to 1,000 lbs of PCBs.

Comparison of Sediment Alternatives

<u>Specific Comment 87 (Page 28):</u> *<u>Page 4-233</u>: It is stated in the CMS that "the most significant reductions in fish PCB concentrations" are achieved by SED 3. EPA notes, however, that this calculation was flawed (see General Comment 17) and the percent reductions associated with an alternative are only one aspect of its effectiveness. Of greater importance is the goal of reducing environmentally unacceptable concentrations to environmentally acceptable concentrations. It is the absolute concentrations that drive the residual risks, not the percent reductions.*

GE Response: The predicted concentrations that would be achieved by each of the sediment alternatives are included in the tables prepared in Response to General Comment 17. It should also be noted that, while percent reductions do not provide the actual concentrations, they do provide one acceptable way to compare effectiveness among alternatives.

Specific Comment 88 (Page 28): *Page 4-240: GE shall expand Table 4-56 to include the entire EPA risk range and reaches in Connecticut.*

GE Response: Times to achieve the IMPGs, including extrapolations of the model results, for all alternatives and risk levels are provided in the tables of metrics prepared in Response to General Comment 13 (i.e., Tables GC13-4 through GC13-8).

Specific Comment 89 (Page 28): *Page 4-241: CMS Figure 4-17 indicates the percentage of areas "meeting or within the range of IMPGs", and therefore, for IMPGs expressed as a range of concentrations, reflects meeting the upper IMPGs only, without any consideration of the point of departure, or lower IMPGs.*

GE Response: Percentage of areas meeting both the upper-bound IMPGs and the lower-bound IMPGs (points of departure), where applicable, have been included in the expanded tables of metrics prepared in Response to General Comment 13 (i.e., Table GC13-9 for the sediment alternatives, and Tables GC13-17 for the floodplain alternatives).

Specific Comment 90 (Page 28): *Page 4-242: Although the information on PCB mass removed under the various SED alternatives is valuable, EPA notes that mass removed per se is not necessarily correlated with risk reduction and should not be the focus of the efficacy of a particular alternative (NAS 2007).*

GE Response: EPA's April 13, 2007 conditional approval letter for the CMS Proposal directed that an estimate of the mass of PCBs removed should be included under the evaluation of the criterion of Reduction of Toxicity, Mobility, or Volume for each alternative. That letter stated (p. 17): "For each alternative evaluated, GE shall include an estimate of the mass of PCBs, and area and volume removed/treated." Contrary to EPA's assertion, GE made no correlation between mass removal and risk reduction in the CMS Report.

Specific Comment 91 (Page 28): *Page 4-243: Table 4-58 is incomplete and potentially misleading because it presents information suggesting diminishing returns in terms of the removal of lbs of PCBs per volume removed without presenting a sense of the additional effort necessary to achieve those removals. This effort can be expressed in total estimated cost per cy and cost per lb of PCBs removed. In addition, the incremental cost for each of* *these factors can be calculated. EPA calculates that the cost per cy of removal decreases from a high of $886/cy for SED 3 to a low of $273/cy for SED 8. This decrease is related to the increased depths of excavation and consequent increases in productivities. In addition, the cost per lb of PCBs is relatively insensitive to the number of pounds removed, ranging from $11,300 for SED 8 to $13,900 for SED 6. GE shall present other data, such as cost, to provide a relative sense of the level of effort associated with the stated reductions in Table 4-58.*

GE Response: Table 4-58 of the CMS Report was developed within the context of the Reduction of Toxicity, Mobility and Volume section to summarize the removal volume, estimated PCB mass removed, and the mass per unit volume removed for each alternative. The purpose of this table was to simply illustrate that the larger removal alternatives do not necessarily result in more efficient/effective removal of PCB mass, and that there is a diminishing return when considering these variables. The addition of cost to this table would not be appropriate here since this section focuses on the degree to which the alternatives reduce the toxicity, mobility, or volume of PCBs.

However, if costs were to be considered, the cost per cubic yard included in EPA's comment is potentially misleading because the calculations are based on the total cost of the alternative, which includes other items not necessarily related to the removal activities (e.g., thin-layer capping). Therefore, while there is a reduced unit cost when moving from SED 3 to SED 8, the magnitude of that unit cost is less than indicated in EPA's comment. Calculation of the estimated removal unit costs should include only the line items specific to removal activities – i.e., removal, transportation and disposal (staging/access). Using these specific line items, unit costs for each SED alternative are provided in Table SC91-1.

Table SC91-1. Estimated Removal Unit Costs for SED 3 through SED 8.

Alternative	Cost per Cubic Yard Removed	Cost per Pound (lb) of PCB Removed
SED 3	$303/cy	$4,396/lb
SED 4	$248/cy	$4,524/lb
SED 5	$223/cy	$4,963/lb
SED 6	$228/cy	$5,634/lb
SED 7	$185/cy	$4,661/lb
SED 8	$101/cy	$4,184/lb

While the above table indicates that there are economies of scale in moving from SED 3 to SED 8, that does not mean that the alternatives with lower unit costs are more cost-effective. As discussed in the next response, assessing cost-effectiveness involves an evaluation of the costs against a measure of effectiveness. Section 4.9.10 of the CMS Report included an evaluation of the total costs of the alternatives against model predictions of the reduction in PCB loading/transport and the average fish PCB concentrations resulting from those alternatives (i.e., comparison of costs relative to the remedial outcomes). This is a more appropriate way to assess cost-effectiveness.

Specific Comment 92 (Page 28): *Page 4-251: GE concludes that SED 3 is the "most cost-effective alternative." EPA notes, however, that to be considered cost-effective, an alternative has to be effective. Numerous IMPGs for human and ecological receptors in most reaches are not met with SED 3, even when the upper end of the IMPG range is considered.*

GE Response: GE recognizes that, to be cost-effective, an alternative must be effective. The CMS Report noted (p. 4-252 n.109) that, in accordance with the NCP, a selected remedial action "shall be cost-effective, provided that it first satisfies the threshold criteria," that cost-effectiveness includes consideration of "overall effectiveness" (which is determined by evaluating long-term effectiveness and permanence, reduction of toxicity, mobility, or volume, and short-term effectiveness), and that a "remedy shall be cost-effective if its costs are proportional to its overall effectiveness" (40 CFR § 300.430(f)(1)(ii)(D)). Based on these considerations, the CMS Report concluded that, among the sediment alternatives evaluated in that report, "SED 3 is the most cost-effective alternative, both in terms of achieving reductions in PCB loading and transport and in terms of reducing fish PCB concentrations" (CMS Report, pp. 4-251 to 4-252).

As previously noted, following receipt of EPA's comments on that report, GE has further evaluated the ecological impacts of the alternatives evaluated in the CMS Report, and is currently discussing with EPA and the Commonwealth an ecologically sensitive alternative. GE will re-evaluate and compare the cost-effectiveness of all of the remedial alternatives, including the ecologically sensitive alternative, in the revised CMS Report, as proposed by EPA in its February 5, 2009 correspondence to GE. As also previously discussed, it is not necessary for an alternative to achieve all the IMPGs in order to meet the threshold criteria and to be considered "overall effective"; otherwise, IMPG attainment would have been specified in the Permit as one of the threshold criteria.

<u>Specific Comment 93 (Page 28):</u> *<u>Page 4-255:</u> EPA notes that the "substantial environmental harm" that GE claims to be associated with alternatives SED 5 through SED 8 has not been clearly demonstrated in the evaluations presented in the CMS, particularly in the absence of detailed procedures to avoid or minimize harm as required in General Comments 10 and 16.*

GE Response: The CMS Report discussed the substantial environmental harm that would result from implementation of the active sediment remediation alternatives, including SED 5 through SED 8, in the sections on the long-term adverse impacts and short-term effectiveness of those alternatives. Since that time, GE has further evaluated the ecological harm that would result from implementation of all the removal alternatives evaluated in the CMS Report, as well as the ability to avoid or minimize that harm. The results of those evaluations are presented in the Responses to General Comments 6 and 10 and Appendix B to this Interim Response. As previously noted, GE will include in the revised CMS Report an evaluation and comparison of the overall protectiveness of the environment of all of the remedial alternatives, including the ecologically sensitive alternative currently being developed.

<u>Specific Comment 94 (Page 29):</u> *<u>Figures 4-16a through 4-16n:</u> EPA notes a number of issues with this series of figures, the net effect of which is to minimize residual risks and/or differences between the remedial alternatives:*

On reach-specific plots, the non-cancer IMPGs referenced are those for adults only, a concentration that is over twice that for children (0.43 vs. 0.19 mg/kg fillet). In addition, the range of IMPGs for "10-6 cancer to non-cancer range for 50 meals / yr (RME)" is shown incorrectly, making the bottom of the range appear to be 0.01. The bottom of the range is, in fact, 0.0019, nearly an order of magnitude less. GE shall revise the plots to include all IMPGs for consumption of fish.

GE Response: As discussed in the Response to General Comment 18, the reach-specific fish concentration plots previously presented as Figures 4-16a through 4-16n, have been revised to show all IMPGs for the entire risk cancer range as well as the non-cancer IMPGs for both adults and children, using both RME and CTE assumptions. These figures have been provided as Figures GC18-1 through GC18-18.

Section 5: Approach to Evaluating Remedial Alternatives for Floodplain Soils

Specific Comment 95 (Page 29): *Page 5-5: Regarding GE's delineation of the Heavily Used Subareas based on the Direct Contact figures presented in the Human Health Risk Assessment (HHRA) (WESTON 2005), GE did not delineate Heavily Used Subareas for EAs 35a, 37b, 57, 58, and 59. GE shall provide a discussion of the basis for not defining Heavily Used Subareas for these EAs, or alternatively define Heavily Used subareas for these EAs.*

GE Response: As discussed in the CMS Report, Frequent-Use EAs were intended to consist of areas containing trails, access points, and known recreational areas; and the Heavily Used Subareas within those EAs were defined as approximately 10-foot wide corridors down the center of the trails, as well as easily accessible portions of the remaining access points and recreational areas. These Heavily Used Subareas were defined based on observations from site reconnaissance and aerial photography. As noted by EPA, GE did not delineate Heavily Used Subareas within EAs 35a, 37b, 57, 58, and 59. In response to this comment, GE has further evaluated whether to do so.

Figures SC95-1 through SC95-5 show these five exposure areas, respectively, and include aerial photography as well as mapping of trails/roads within the vicinity of these EAs as identified by EPA in the HHRA. EA 35a includes portions of two separate utility corridors. While these utility corridors both have foot trails running through them, these trails remain outside the 1 ppm isopleth and thus outside the EA, so no Heavily Used Subarea was identified in EA 35a (see Figure SC95-1). Similar to EA 35a, EA 37b includes a utility corridor with a foot trail running through it. In this EA, however, the foot trail section is within the 1 ppm isopleth and thus within the EA boundary, and hence the section of the trail within EA 37b was defined as a Heavily Used Subarea (as shown in red on Figure SC95-2). EAs 57, 58 and 59 border Woods Pond to the east and south. A dirt road runs through and adjacent to these EAs. The sections of this road that fall with the 1 ppm isopleth include sections in EAs 58 and 59 but none in EA 57 (see Figures SC95-3 through SC95-5). As a result, new Heavily Used Subareas were defined for the sections of this road in EAs 58 and 59 (shown in red on Figures SC95-4 and -5), but not for EA 57.

The additional Heavily Used subareas within EAs 37b, 58, and 59 were included in the revised volume calculations discussed in the Response to Specific Comment 98 and in the revised IMPG attainment tables presented in the Response to General Comment 13.

<u>Specific Comment 96 (Page 29):</u> *<u>Page 5-15:</u> In the footnote, GE repeats arguments made concerning a "fairly large foraging range of mink" relative to the ROR floodplain. EPA notes that these comments are contradictory to the habitat assessment of mink provided in the ERA (WESTON 2004) (I.2.1.5.1) that (1) describes the importance of foraging within close proximity of the shoreline, and (2) describes the length and area of mink foraging ranges, such that several mink could have their entire foraging ranges located in the PSA and within the 1-ppm isopleth.*

GE Response: See Response to Specific Comment 35.

<u>Specific Comment 97 (Page 29):</u> *<u>Page 5-21:</u> EPA notes that the conclusion regarding the assessment of mink IMPGs for downstream areas is inconsistent with the data presented in Table 5-3b. The attainment of IMPGs presented in the CMS shows that half of the subreaches do not achieve the lower-bound IMPGs, with Subreach 7C not achieving either the upper- or lower-bound IMPG. The argument used by GE to discount this result is to consider the upper-bound IMPG only and to average together adjacent reaches, even where such results in aggregation of areas that exceed mink home ranges identified in the literature. EPA believes that both approaches are inappropriate and fail to properly identify risks to mink.*

GE Response: To clarify, the lack of attainment of the upper- and lower-bound IMPGs in Reach 7C was not justified in the CMS by averaging together adjacent reaches. The CMS simply noted that the area covered by Reach 7C is much smaller than the EPA-specified mink averaging areas used for assessing IMPG attainment in the PSA – i.e., Reach 7C only spans approximately 0.8 miles of River and covers an area of approximately 20 acres, whereas the mink averaging areas specified by EPA for the PSA span 4 to 7 miles of River and cover areas of 300 to 450 acres. Based on this, a qualitative argument was made that if averaging areas that were consistent in size with those used in the PSA were evaluated for Reach 7, the upper-bound IMPG in the area of Reach 7C would likely be met since that IMPG is met in the adjacent subreaches (i.e., 7B and 7D).

While this approach does indicate that there could be some exceedances of the lower-bound IMPG in four of the eight Reach 7 subreaches, GE does not believe that those exceedances would translate into adverse impacts on the local mink population. For reasons similar to those discussed in Response to Specific Comment 35, the local population of mink extends well beyond those Reach 7 subreaches. Even accepting EPA's interpretation of the mink feeding study in the ERA (which GE does not agree with), the lower-bound IMPG was based on a statistical analysis that yielded an assumed 20% effect level for kit survival in that study. Even if the exceedances of that IMPG value in four Reach 7 subreaches meant that the relatively few mink that may inhabit those subreaches would experience a 20% reduction in kit survival, it would not be expected that such a reduction would adversely impact the overall local mink population.

Specific Comment 98 (Page 29): *Page 5-21: In Appendix D of the CMS-P, GE proposed the use of Thiessen polygons (TP), rather than the IDW method used by EPA, to spatially interpolate PCB concentrations in the floodplain. GE proposed the TP method because it claimed that (1) determination of removal areas and volumes in the floodplain required spatial interpolation in areas with limited data, which can be difficult to achieve using IDW, and (2) the TP method readily accommodates new data, which would likely be collected prior to initiation of a remedy. In its conditional approval of the CMS-P, EPA accepted GE's proposal.*

In reviewing the calculated EA-specific area and volume of soil to be removed for each of the floodplain alternatives, EPA noticed that the projected removal volumes calculated by GE were considerably smaller for most of the EAs than the same volumes calculated by EPA, even when EPA used the TP methodology. Additional examination of this discrepancy indicated that the differences appeared to be due to two factors, as discussed below.

- *In developing the removal areas and volumes, GE did not use the same data set that was used for the HHRA. New data collected since the date of the HHRA were added to the data set, which is appropriate. However, GE excluded data from side channels and oxbows (SCOX), terraces, and aggrading bars. Because each of these sample types is representative of an area that could result in exposure, GE shall use the same procedure followed in the HHRA and include all such data in the recalculation of EA-specific removal areas and volumes for the floodplain alternatives.*

- *In determining the degrees of freedom applied in the calculation of the 95^{th} UCL EPC for an EA, GE used the number of polygons that intersect an EA as the degrees of freedom; EPA counted only the actual number of samples within an EA. The GE approach is statistically invalid and has the effect, when done for all EAs, of artifactually inflating the total number of degrees of freedom above the true sample size of PCB concentrations measured in the study area., thereby inappropriately underestimating the area and volume of soil necessary to meet risk-based IMPGs. The 95^{th} UCL concentration is specifically used in risk assessment to account for uncertainty in the data and basing the UCL calculation on an invalid statistical procedure defeats this important safeguard on the process. GE shall use the appropriately conservative* *approach used by EPA in the recalculation of removal areas and volumes for the floodplain alternatives.*

GE Response: EPA's comment states that differences between floodplain removal volumes presented in the CMS and those calculated by EPA (not provided with the Agency's comments) are due to two factors: (1) differences in the data sets used between GE and EPA; and (2) differences in the methods used to determine the degrees of freedom for each exposure area. In response to this comment, GE has recomputed floodplain removal volumes for alternatives FP 2 through FP 7 using: (1) the floodplain data set used by EPA in the HHRA with certain supplements discussed below (this data set was provided to GE by EPA on October 2, 2008); and (2) the degrees of freedom method used by EPA. The results of these recalculations are described below and have been carried through to all other relevant responses and tables in this Interim Response that present floodplain removal volumes or areas, costs, or floodplain IMPG attainment. The revised floodplain volume estimates provided here also include the corrections to IMPG values noted by EPA in Specific Comments 112, 113, and 115, and the additional Heavily Used Subareas described in the Response to Specific Comment 95.

While GE has recomputed the floodplain volumes using the EPA data set and degrees of freedom methodology as directed by EPA, GE notes the following:

- While the floodplain data set as defined by EPA is generally consistent with the data set used by GE in the CMS, it does include some additional data that were not used in the analyses presented in the CMS Report, but appear upon review to be appropriate for inclusion. However, there are also a number of samples included by EPA that GE feels are inappropriate for use in the floodplain volume calculations.

- GE disagrees with EPA's assertion that the degrees of freedom approach used in the CMS is statistically invalid and has the effect of artificially inflating the total number of degrees of freedom above the true sample size. The question of appropriate degrees of freedom is not a question of the overall statistical approach; rather it is one of sampling design.

Additional detail on these points is provided below.

<u>Data Coverage</u>

GE received the PCB data set used by EPA in its floodplain evaluation (which EPA stated was used in the HHRA) on October 2, 2008; GE had requested this data set from EPA because the data provided by EPA with the HHRA Report only included samples collected in the top 6 inches of floodplain soil and did not include samples collected by GE subsequent to the HHRA. The data set provided by EPA on October 2, 2008 consists of PCB data from samples collected in the top foot of floodplain soil (from the 0- to 6-inch or 6- to 12-inch depth increments), which is appropriate since floodplain soil removal was largely evaluated over the top foot in the CMS. Comparison of that data set with the data set used in the CMS Report indicates that the two are generally consistent, in that GE's data set included approximately 90% of the EPA sample locations in Reaches 5 and 6 and 99% of the EPA sample locations in Reaches 7 and 8. However, there are some differences, as described below:

- The top 6-inch data in the EPA-provided data set do not exactly match the top 6-inch data set provided in the HHRA Report. Since EPA directed GE to use the HHRA data set in the recalculation of removal areas and volumes, it is unclear why this portion of the data set provided by EPA does not match the HHRA Report data set.

- The EPA-provided data set includes samples from 222 locations (219 in Reaches 5/6 and 3 in Reaches 7/8) that were not included in the CMS Report. Most of these samples were designated as sediment samples in EPA's data set and therefore excluded from the CMS evaluation, but in fact have coordinates that would place them in the floodplain and thus appear to be appropriate for inclusion. However, GE believes that there are other samples included in the EPA-provided data set that should not be used in the floodplain evaluation. These include:

    - samples collected between 1975 and 1980 (approximately 15 locations); as described in the RFI Report, data collected after 1990 were considered to be most representative of contemporary conditions in the floodplain; and

    - several "shallow" core segments collected in the top 1 or 2 inches of floodplain soil (47 locations); these samples were excluded from the CMS since they are not representative of the top 6-inch soil PCB average. It is unclear how EPA treated these samples in its data set.

  Nevertheless, despite GE's disagreement with the inclusion of the above-described samples, the full EPA data set was used in the recalculation of floodplain volumes.

- The EPA-provided data set does not include a number of samples that were included in the CMS evaluation. These consisted of samples from 55 locations in Reaches 5/6 and 125 locations in Reaches 7/8. GE does not understand why the former were omitted, but they were not included in the recalculation of floodplain volumes. GE believes that the latter (i.e., the samples from 125 locations in Reaches 7 and 8) were inadvertently omitted by EPA; these consist of floodplain transect samples collected in 1995 and floodplain data collected by GE in 2005 in EAs 72, 73, and 80. These data were added to the EPA data set for the recalculation of floodplain volumes presented here.

- Since the EPA-provided data set is limited to the top foot of floodplain soil, additional data were needed to evaluate the need for and extent of removal to a depth of three feet in Heavily Used Subareas. Therefore, for depths below the top foot, the original CMS data set was used to supplement that provided by EPA.

Degrees of Freedom

Because of the need to calculate sample quantities to replace unknown population parameters, constraints are induced on the calculation of a statistic. The degrees of freedom (df) refers to the difference between the overall sample size and the number of these constraints (Box et al. 1978). Stated differently, the df can be defined as the number of independent pieces of information that are used in the estimation of a parameter. In the method used in the CMS for calculation of EPCs based on the 95% Upper Confidence Limit (UCL) (i.e., the modified Halls Bootstrap method, which is the same as the method used in the HHRA; see Appendix D of the CMS Proposal), df determines the size of the bootstrap data set (i.e., the number of times the data are randomly drawn with replacement from the spatially interpolated data set during bootstrapping). The df is important to the 95% UCL EPC calculation. For a given data distribution, increasing the df indicates more certainty in a data set, thereby resulting in a lower EPC for a given area.

As stated in the CMS Report, the df was calculated as the number of Thiessen polygons that intersect an EA, as each polygon represents one sampling effort (except that this approach excluded small, *de minimis* portions of polygons along the edge of an EA that may potentially bias the df).[30] Since the PCB Thiessen polygons were developed based on the EPA-developed floodplain "super-habitats" (i.e., independent of EA boundaries), a polygon within an EA (either wholly or partially) derived from a sample located outside the EA boundary is still used in defining the concentration distribution within the EA. As a result, each polygon intersecting an EA should be recognized as an independent piece of information, and should therefore be included in the number of df for the 95% UCL calculation.

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[30] Small portions of polygons that were excluded from the degrees of freedom were defined as polygons having an area that is less than 5% of the average area of all polygons within an EA.

In contrast, EPA's method of counting the actual number of samples within an EA as the df is inappropriate for a polygon-based spatially interpolated data set, as used in the CMS. This method likely results in an overestimation of removal areas and volumes, particularly in relatively small and/or narrow exposure areas or areas having relatively poor data coverage. As an example, Figure SC98-1 shows the top 6-inch PCB sampling locations and associated Thiessen polygons near EA 62, which is a utility corridor. Portions of Thiessen polygons associated with 28 sampling locations are contained within EA 62, but only 6 of the sample locations are actually located within that EA. As indicated in the figure, these 6 polygons based on samples located in the EA cover very little area of the EA, but 14 other samples located outside the EA boundary (excluding 8 *de minimis* polygons within EA 62) in fact have a significant influence on the average PCB concentration of EA 62 – more so than the 6 samples located within the EA. As shown, 30% of EA 62 is covered by the polygons associated with the 6 sample points within the EA, while 70% of the EA is covered by the remaining 14 polygons. Thus, these 14 sample locations outside the EA should be included in the df for this EA as they represent independent pieces of information used to define the average concentration in this EA. Based on this approach, EA 62 was characterized in the CMS Report by a df of 20, while EPA's method would only use a df of 6. As a result, the EPC calculated for this EA is approximately 280 mg/kg using EPA's df, while the EPC calculated using GE's df is approximately 138 mg/kg. Although GE believes the method used in the CMS Report is more appropriate, EPA's method has been used for the revised volumes presented here as directed by the Agency in its comment.

<u>Results</u>

As stated above, floodplain volumes were recomputed for CMS alternatives FP 2 through FP 7 using the revised data set and degrees of freedom method described above, and also using the corrected IMPGs noted by EPA in Specific Comments 112, 113, and 115, as well as the additional Heavily Used Subareas defined in the Response to Specific Comment 95. The revised volumes (compared to those originally presented in the CMS Report) are summarized in Table SC98-1 below, while the revised estimated removal areas are shown on Figures SC98-2 through SC98-7. Furthermore, the results of these revised calculations have been carried through to all other responses in this Interim Response that discuss floodplain removal volumes, areas, costs, durations, and IMPG attainment.

Table SC98-1. Comparison of Floodplain Removal Volumes from the CMS and Recomputed Volumes Calculated in Response to Specific Comments 95, 98, 112, 113, and 115.

Version	Alternative	Estimated Removal Volumes (cy) Based on:				Total Removal Volume (cy)
		Human Health	Amphibians	Piscivorous Mammals	Other	
CMS Report (Mar 08)	FP 2	17,000	---	---	---	17,000
	FP 3	19,000	23,000	18,000	0	60,000
	FP 4	77,000	22,000	0	0	99,000
	FP 5	Removal of soils with PCBs ≥ 50 mg/kg				100,000
	FP 6	Removal of soils with PCBs ≥ 25 mg/kg				316,000
	FP 7	520,000	22,000	28,000	0	570,000
CMS Interim Response	FP 2	22,000	---	---	---	22,000
	FP 3	34,000	24,000	16,000	0	74,000
	FP 4	97,000	24,000	0	0	121,000
	FP 5	Removal of soils with PCBs ≥ 50 mg/kg				104,000
	FP 6	Removal of soils with PCBs ≥ 25 mg/kg				320,000
	FP 7	599,000	21,000	11,000	0	631,000

In summary, for the IMPG-based alternatives (i.e., FPs 2, 3, 4, and 7), removal volumes have increased by approximately 10% to 30% over those presented in the CMS Report due to the changes in methodology discussed in this response, as well as the corrections of certain IMPG values (Specific Comments 112, 113, and 115) and additional Heavily Used Subareas (Specific Comment 95). For the threshold-based alternatives (i.e., FPs 5 and 6), removal volumes have increased by less than 5%, primarily as a result of using EPA's data set, since removal volumes for these alternatives are not based on attaining IMPGs in specific EAs and therefore do not make use of UCL calculations (as discussed in Section 5.4 of the CMS Report).

Section 6: Analysis of Remedial Alternatives for Floodplain Soils

Alternative FP1

Specific Comment 99 (Page 30): *Page 6-4: The discussion of residual risk for FP 1 here and on Page 6-7 claims that "residual risk presented by current floodplain conditions is limited." EPA disagrees with this conclusion given the ecological IMPGs that are not achieved (cf., Section 6.1.6.2), even assuming the lowest target sediment level of 1 mg/kg.*

GE Response: The basis for GE's conclusion that the residual risk presented by current floodplain conditions is "limited" (even accepting EPA's risk assessments) was set forth in detail in Section 6.1.6 of the CMS Report, which described the extent to which FP 1 would achieve the EPA-approved IMPGs. In fact, since GE believes that many of the exposure assumptions, toxicity values, and data interpretations in EPA's risk assessments (which formed the basis for those IMPGs) overstate actual PCB exposures and risks in the Rest of River area, GE believes that current floodplain conditions do not pose a significant risk to human health or the environment.

Alternative FP2

Specific Comment 100 (Page 30): *Page 6-21: Here, and in other locations in the CMS, GE claims that "there are several cases where the soil IMPG levels [for mink] could not be achieved at any floodplain soil concentration since the PCB concentrations in the aquatic food items at the target sediment level would be themselves exceed the IMPGs for mink prey." EPA notes that this statement is true only if the analysis is restricted to the three target sediment levels of 1, 3, and 5 mg/kg. Of interest is whether the soil IMPGs could be achieved if the sediment target level is reduced below 1 mg/kg, which occurs for several of the sediment remediation alternatives.*

GE Response: The extent to which all combinations of sediment and floodplain alternatives would achieve the IMPGs for piscivorous mammals is described in Response to General Comment 24 and shown in Table GC24-4.

Specific Comment 101 (Page 31): *Page 6-29: EPA disagrees with the implication that because amphibians are known to inhabit the floodplain it can be concluded that IMPG exceedances do not prevent maintenance of "healthy local populations." Controlled studies and evaluations conducted as part of the Ecological Risk Assessment (ERA) (WESTON 2004) clearly demonstrated that IMPG exceedances impact amphibians to a degree that is inconsistent with maintenance of a healthy local population. EPA also disagrees with the claim that field studies indicate that local populations of piscivorous mammals inhabit and reproduce in the floodplain. EPA studies have documented a lack of resident mink and otter in the area.*

GE Response: GE does not agree with this comment. As shown in prior submissions to EPA on the ERA and in GE's original IMPG Proposal (GE, 2005), the studies conducted on frogs as part of the ERA did not demonstrate that the effects reported to occur at the levels represented by the EPA-approved IMPGs for amphibians would have any appreciable impact on the local frog population in the PSA, particularly given the density-dependence of frog populations. With respect to piscivorous mammals, as also noted in those submissions, GE's field survey of mink and otter demonstrated, based on the spatial distribution of tracks and signs, that mink and otter use the PSA as part of their home ranges in estimated numbers that are within the range of densities that might be expected for such riverine habitat based on the literature. Additional discussion of the habitat functions currently provided by the PSA can be found in the Response to General Comment 10 and Appendix B to this Interim Response.

Alternative FP3

Specific Comment 102 (Page 31): *Pages 6-35 and 6-36: The study by Lichko and Calhoun 2003 on 15 vernal pool creations is cited in the CMS, with the observation that the projects were deficient due to failure of design and construction. EPA notes that these two factors are easily controlled with proper evaluation of existing conditions and implementation of appropriate restoration methods. GE shall include a discussion in the presentation of the restoration process specified in General Comment 10 of the design and construction practices that would be used to assure that vernal pools are constructed properly during any restoration activities.*

GE Response: GE disagrees that many factors responsible for the failure of vernal pool creation are "easily controlled." In fact, there is no support in the literature for the proposition that vernal pool recreation of the sort and scale that would accompany the implementation of most of the floodplain remedial alternatives would be successful. There are numerous complex constraints on the ability to restore the current function of the vernal pools that would be adversely affected by those remedial alternatives. These constraints are discussed in Section III.E of the Response to General Comment 10. As a result of these constraints, and given the magnitude of the vernal pool restoration program that would be required under most of the floodplain alternatives, successful restoration of the suite of vernal pools in the PSA is highly unlikely even if the design and construction practices described in Section III.E.4 of the Response to General Comment 10 are employed.

Specific Comment 103 (Page 31): *Page 6-38: GE shall provide the basis for, and citations for previous studies that support the statement that "the potential loss of these 3 rare plant locations would not likely result in a permanent loss of the population or species across the floodplain."*

GE Response: The CMS Report notes that three of 27 locations within the PSA floodplain where rare plant species were identified by Woodlot Alternatives (2002) are within the area targeted for soil removal under FP 3. The species of interest in these three locations are the matted spike-rush (also known as the mudflat spikesedge) (*Eleocharis intermedia*), eastern black currant (*Ribes americanum*), and wapato (*Sagittaria cuneata*). The statement referenced in EPA's comment was made based on the logical assumption that the loss of one specimen of each of these species from the floodplain, in which a number of other specimens have been identified, would not affect the other identified locations of these species or the local population. For the matted spike-rush and the wapato, which are listed as threatened species in Massachusetts, Woodlot Alternatives (2002) noted several other findings of these plants in the PSA. The more detailed evaluation of MESA issues that has been performed based on information provided by the NHESP, as set forth in Appendix B, likewise concluded that, while FP 3 would cause a "take" of matted spike-rush and might cause a "take" of wapato, that alternative would likely not impact a significant portion of the local populations of those species. The eastern black currant is only listed as a species on the watch list and is thus not discussed in Appendix B. In such a case, in which the population is not as greatly reduced as with a threatened or endangered species, it is very unlikely that the loss of one plant would be harmful to the population.

Specific Comment 104 (Page 31): *Page 6-39: GE observes in the CMS that the extent of vernal pool remediation in FP 3 "could have long-term adverse impacts on the amphibian subpopulations that inhabit those pools and potentially on the local amphibian population in the area." EPA notes that the while the potential subpopulation-level consequences of habitat alteration is highlighted in the CMS, GE's comments on the effects of PCBs on local subpopulations of amphibians emphasize compensatory mechanisms that would result in no impacts on the local subpopulation. In addition, because many of the species utilizing vernal pools spend a portion of their life in other habitats, EPA does not agree that properly conducted remediation and restoration will likely have long-term adverse impacts on the amphibian subpopulations that use those pools.*

GE Response: As noted earlier on the cited page of the CMS Report, remediation of vernal pools could reduce the subpopulations of amphibians inhabiting those pools, since many of these species are pool-specific and must return to their own pools to breed. GE's statement regarding the adverse impacts of FP 3 on the subpopulations of amphibians in individual pools and potentially on the overall local amphibian population was based on the fact that FP 3 would involve remediation in most of the vernal pools in the PSA (60 of 66 pools). In terms of PCB effects, the CMS Report concluded elsewhere that an alternative that would achieve levels within the amphibian IMPG range in about half the backwater areas (SED 3) would not be expected to adversely affect the local amphibian population in the PSA (p. 4-62), and that for alternatives that would achieve such levels in only 10% (FP 2), 30% (FP 5), or 40% (FP 6) of the floodplain vernal pools, the impact on the local amphibian population is uncertain (pp. 6-29, 6-93 n.152, 6-116 n.156). In these cases, GE was discussing the impact of the IMPG exceedances on the overall amphibian population (or meta-population) in the PSA, not the subpopulations in the individual pools with exceedances. Moreover, it is worth noting that the compensatory mechanisms in an amphibian population or subpopulation, such as density-dependence, are more likely to offset the impacts of malformations in offspring, which is the primary basis for the IMPGs, than the impacts of destroying the amphibians' habitat. This is because destroying the habitat reduces the carrying capacity of the floodplain (i.e., the number of frogs that the floodplain can support). Thus, GE's statements regarding the potential impacts of PCBs and vernal pool remediation, respectively, on the local amphibian population are consistent.

The impacts of vernal pool remediation on the amphibian subpopulations inhabiting those pools and the difficulties with restoration of vernal pools are discussed further in Section III.E of the Response to General Comment 10. As shown there, GE does not agree with EPA's assertion that, because many of the species utilizing vernal pools spend a portion of their life in other habitats, remediation and restoration are unlikely to have long-term adverse impacts on the amphibian subpopulations that use those pools. This is particularly true where the floodplain remediation would also result in the cutting of vegetation in the forested areas surrounding the vernal pools, which not only provide the necessary shade and leaf litter for the organisms in the vernal pools, but also provide habitat for adult amphibians when they leave the pools. In this situation, the remediation would adversely affect the species that inhabit vernal pools both during the period of their life cycle when they are within the pools and during the time when they are in surrounding habitats.

Specific Comment 105 (Page 31): *Page 6-44: In describing potential impacts to vernal pools, it is stated that the loss could include amphibian eggs or larval stages. GE shall describe how work in vernal pools could be conducted to avoid impacts to special habitats and their indigenous species, as required by applicable ARARs such as MESA. For example, work in vernal pools could be performed late in the growing season after amphibians have left the pools. In addition, at this time, the pools are typically dry and easier to work in.*

GE Response: GE disagrees that "work in vernal pools could be conducted to avoid impacts to special habitats and their indigenous species, as required by applicable ARARs such as MESA." There are no times during the year when vernal pool species are not using the pools or immediately adjacent areas. Section III.E.2 of the Response to General Comment 10 explains:

> "Working in the pools when the amphibians have left the pools for the season would avoid one set of impacts (i.e., to the breeding and larval stages), but would simply displace impacts to the terrestrial life stage of the vernal pool amphibians, as many vernal pool species spend a substantial portion of their annual life cycle in the surrounding woodlands. Even if the construction were to occur during the low-flow season, and after the spring breeding and migration period, this would not avoid direct mortalities to vernal pool animals that are occupying the surrounding terrestrial environments (e.g., the leaf litter and shallow root zone). These are slow-moving organisms that are especially vulnerable to ground disturbance. Further, the impacts of remediation in a given pool would last multiple years beyond the season in which that remediation takes place, thereby adversely affecting the breeding potential of the local population. Because vernal pool amphibians have strong site fidelities, they will unsuccessfully attempt to return to the disturbed vernal pool via routes rendered unsuitable by removal activities."

<u>Specific Comment 106 (Page 31):</u> *<u>Page 6-44:</u> GE shall provide a description of measures that will be taken during design and construction to insure that stormwater flows do not affect nearby wetlands. The discussion shall describe the Best Management Practices that will be implemented during construction to meet wetland-related ARARs, as well as a description of compensatory mitigation measures that will be implemented if there are impacts to neighbouring wetlands.*

GE Response: During the design of any of the floodplain removal alternatives, GE would develop appropriate BMPs to minimize, to the extent practicable, the effect of stormwater flows on nearby wetlands and to meet, to the extent practicable, the wetlands-related ARARs identified in the ARARs tables for those floodplain alternatives, provided in Appendix E. These BMPs would be designed to meet the Massachusetts Stormwater Management Standards (310 CMR 10.05(6)(k); 314 CMR 9.06(6)(a)) – including the requirement to provide a setback from receiving waters and wetlands where it is practicable to do so[31] – and would take into account the Massachusetts Stormwater Handbook (MDEP, 2008). Some potential stormwater management BMPs that may be implemented during construction include, but are not limited to, use of the following:

- Hay or straw bales;
- Silt fences;
- Grass channel with a pretreatment device (e.g., sediment forebay with a check dam); and/or
- Water quality swale with a pretreatment device (e.g., sediment forebay with a check dam).

Numerous other BMPs that would be considered during design to avoid or minimize impacts on wetlands were identified in Section II.C of the Response to General Comment 10 and the associated Table GC10-3.

Compensatory mitigation measures that could be considered if there were impacts to neighboring wetlands include restoration of affected wetlands and, where necessary, enhancement of existing wetland(s) and/or creation of new wetland areas in suitable

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[31] In many areas, where there is no alternative to conducting soil removal or siting temporary staging areas in or near wetlands, providing such a setback from wetlands would be not feasible. This is particularly true since, as shown in the Response to General Comment 10, the majority of the PSA (~ 85%) consists of wetland community types.

locations. However, as discussed in the Response to General Comment 10, for many affected habitats, implementation of on-site mitigation measures would not prevent adverse impacts on those habitats that could last for decades or, in some cases, permanently or indefinitely. In addition, as noted in the Response to General Comment 29, GE reserves the right to contend that, as a matter of law, it cannot be required to undertake particular compensatory mitigation measures at this site.

Alternative FP6

Specific Comment 107 (Page 32): *Page 6-102:* *EPA notes that here and elsewhere in the document, the size of the area to be remediated associated with a particular alternative and the time to fully implement that alternative are presented together with the implication that the entire area would be affected for the entire time period. In fact, construction activity would be taking place only in a limited area at any one time proceeding in general from upstream to downstream, so issues described in the CMS over, for example, wildlife being displaced due to the "widespread extent of the excavations," are overstated.*

GE Response: GE recognizes that the entire area affected by a given floodplain alternative would not be directly affected by construction work for the entire time period over which that alternative would be conducted. The CMS Report acknowledged this in stating that, "[f]or FPs 2 through 7, the short-term impacts would last, ***in portions of the floodplain***, for the duration of the remedial activities, which is estimated to range from 1 year (for FP 2) to 22 years (for FP 7)" (p. 6-155; emphasis added). Nevertheless, for the more intrusive floodplain alternatives (FP 3 through FP 7), the negative impacts of the construction/remediation work in a given area would last much longer than the season during which the work is being conducted in that area. As discussed in the Response to General Comment 10, for many of the natural communities that would be adversely impacted by these alternatives, restoration efforts are likely either to be unsuccessful in replicating existing habitats or to take a prolonged period (up to many decades) to do so. In short, while the remediation activities would proceed from upstream to downstream over multiple years, the effects of these remediation activities on the habitats in the PSA would continue for decades, at least, after those remediation activities are completed in a given area.

<u>Specific Comment 108 (Page 32):</u> *<u>Page 6-113:</u> With regard to availability of resources for providing plants for restoration efforts, EPA notes that it is possible to arrange for nurseries to undertake contract growing of plants ahead of when they are needed to provide greater certainty of availability of indigenous species needed for restoration.*

GE Response: Comment noted.

Alternative FP7

<u>Specific Comment 109 (Page 32):</u> *<u>Page 6-127:</u> EPA disagrees with the characterization of alternative FP 7 in terms of "the cumulative impact of the removal of 62 vernal pools." As discussed elsewhere in this letter, restoration of vernal pools is not only possible but feasible and has been demonstrated at other sites. In addition, not all vernal pools would be affected simultaneously, and there are a wide range of measures that can be implemented to lessen the impacts from work being done in a relatively small number of pools at any one time.*

GE Response: As discussed in Section III.E of the Response to General Comment 10, the implementation of vernal pool remediation, including the sequencing of such remediation over a number of years, would not avoid severe adverse impacts on the vernal pool animals. As also discussed in that response, the restoration of vernal pools on the scale that would be required under most of the floodplain alternatives (i.e., FP 3 through FP 7) has no known precedent in the Northeast and is unlikely to result in the return of many of those pools to their current condition and level of function for many years or not at all.

<u>Specific Comment 110 (Page 32):</u> *<u>Page 6-127:</u> EPA notes that GE's claim that the loss of even a single vernal pool could have serious effects on local amphibian subpopulations is inconsistent with GE's position in the CMS and other documents that EPA's determination of impacts to amphibians due to PCB contamination in the floodplain is overstated.*

GE Response: This comment misstates what GE said in the CMS Report. The CMS Report stated: "[T]he cumulative impacts of the removal of 62 [out of 66] vernal pools could pose a significant threat to the long-term viability of the amphibian population in the area. Given that amphibians are dedicated to specific pools and the loss of a given pool could have serious effects on the subpopulation of amphibians supported by that pool, ***the loss of a large number of pools over an expansive area could affect the whole population***

of amphibians in the region" (p. 6-121, emphasis added). This is not inconsistent with GE's position that exceedances of the amphibian IMPGs in a limited number of areas would not be expected to adversely affect the overall local amphibian population in the PSA. See Response to Specific Comment 104.

Comparative Evaluation of FP Alternatives

Specific Comment 111 (Page 32): *Page 6-153: EPA notes that the percentages of averaging area acreage in Table 6-49 are based on achieving the upper-bound IMPGs, with no distinction made if an alternative achieves the lower-bound point of departure IMPG. This type of presentation is not conservative, and also masks the potential differences among options FP 3, FP 4, and FP 5. GE shall revise the table to indicate acreage for both lower-and upper-bound IMPGs.*

GE Response: In Response to General Comment 13, GE has prepared a revised table (Table GC13-17) showing the percentages of exposure/averaging area acreage attaining both the upper-bound and lower-bound IMPGs for all floodplain alternatives (except for insectivorous birds and piscivorous mammals, which are addressed separately in Response to General Comment 24).

Specific Comment 112 (Page 32): *Table 6-13: GE shall make the following modifications to the IMPGs. For Exposure Areas 4, 12, 37b, 40, 57, and 59 the IMPG shall be changed to 14 mg/kg to account for the 10^{-5} exposure for the Adult High-use general recreation exposure in a "heavily used areas". GE shall recalculate the removal volume, where necessary, to achieve the IMPG.*

GE Response: This correction has been made in the revised table on attainment of the RME floodplain IMPGs based on direct human contact (Table GC13-13a) and the other summary comparative tables for the FP alternatives presented in the Response to General Comment 13. This correction results in an increase of about 11,000 cy in the estimated removal volume for alternative FP 3, which is designed to achieve the mid-range IMPGs (i.e., those based on a 10^{-5} cancer risk) in frequently used areas and the upper-bound IMPGs in other areas. The corrected volume has been included in the updated volume calculations for the floodplain alternatives, discussed in the Response to Specific Comment 98, and the figures and tables associated with that response. As discussed in that response, the full set of volume calculations has been updated to reflect several comments, including Specific Comment 112.

Specific Comment 113 (Page 32): *Table 6-19: GE shall make the following modifications to the IMPGs. For Exposure Areas 4, 12, 28, 40, 40b, 55, 57, 59, and 60 the IMPG shall be changed to 14 mg/kg to account for the 10^{-5} Adult High-use general recreation exposure. GE shall recalculate the removal volume, where necessary, to achieve the IMPG.*

GE Response: This correction has been made in the revised table on attainment of the RME floodplain IMPGs based on direct human contact (Table GC13-13a) and the other summary comparative tables for the FP alternatives presented in the Response to General Comment 13. This correction results in an increase of about 10,000 cy in the estimated removal volume for alternative FP 4, which is designed to achieve the mid-range IMPGs (i.e., those based on a 10^{-5} cancer risk). The corrected volume has been included in the updated volume calculations for the floodplain alternatives, discussed in the Response to Specific Comment 98, and the figures and tables associated with that response. As discussed in that response, the full set of volume calculations has been updated to reflect several comments, including Specific Comment 113.

Specific Comment 114 (Page 33): *Table 6-21: GE shall correct the table to include vernal pool 23B-VP-1.*

GE Response: This vernal pool was inadvertently excluded from Table 6-21 in the CMS Report (i.e., summary of attainment of amphibian IMPGs under alternative FP 4). It has been included in the revised summary table on attainment of the floodplain IMPGs for amphibians, presented in the Response to General Comment 13 (Table GC13-15).

Specific Comment 115 (Page 33): *Table 6-37: GE shall make the following modifications to the IMPGs. For Exposure Areas 4, 12, 28, 40, 40b, 55, 59, and 60 the IMPG shall be changed to 2 mg/kg to account for the 10^{-6} Adult High-use general recreation exposure. GE shall recalculate the removal volume, where necessary, to achieve the IMPG.*

GE Response: This correction has been made in the revised table on attainment of the RME floodplain IMPGs based on direct human contact (Table GC13-13a) and the other summary comparative tables for the FP alternatives presented in the Response to General Comment 13. This correction results in an increase of about 50,000 cy in the estimated removal volume for alternative FP 7, which is designed to achieve the lower-bound IMPGs or 2 mg/kg (whichever is higher). The corrected volume has been included in the updated volume calculations for the floodplain alternatives, discussed in the Response to Specific Comment 98, and the figures and tables associated with that response. As discussed in that response, the full set of volume calculations has been updated to reflect several comments, including Specific Comment 115.

Section 7: Analysis of Remedial Alternatives for Treatment/Disposal of Removed Sediments and Soils

Alternative TD2

Specific Comment 116 (Page 33): *Page 7-11: The citation (EPA 1992) is not related to the definition of CDFs. The intended citation is likely USACE/EPA 1992 (which was updated in 2004). The full reference is:*

> *USACE/EPA. 1992. Revised 2004. Evaluating Environmental Effects of Dredged Material Management Alternatives - A Technical Framework. EPA842-B-92-008, US Environmental Protection Agency and US Army Corps of Engineers, Washington, D.C. http://el.erdc.usace.army.mil/dots/pdfs/epa/tech-frame-rev04.pdf*

GE Response: Comment noted.

Specific Comment 117 (Page 33): *Page 7-11: The citations for various manuals related to CDFs should include the CDF Testing Manual/ Upland Testing Manual (USACE 2003). The full reference is:*

> *U.S. Army Corps of Engineers. 2003. Evaluation Of Dredged Material Proposed For Disposal At Island, Nearshore, Or Upland Confined Disposal Facilities - Testing Manual (Upland Testing Manual). Technical Report ERDC/EL TR-03-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS. http://el.erdc.usace.army.mil/dots/pdfs/trel03-1.pdf*

GE Response: Comment noted.

Specific Comment 118 (Page 33): *Pages 7-12 and 7-14: A berm height of 5 ft above mean water elevation is mentioned on page 7-12, but on page 7-14 a final fill height of 5 ft above mean water is mentioned (which is assumed to include 1.5 feet for a surface cover). Note that for a final sediment fill height of +3.5 ft (+5.0 ft less 1.5 ft for the cover thickness), the berms and sheets must be higher by about 2.5 ft to account for 2 ft for freeboard, plus 2 feet for ponding during filling. This does not account for an undetermined allowance for consolidation. Either the berm/sheet elevation must be described as higher by a minimum of 2.5 ft, or the final fill elevation should be described as lower by 2.5 ft. This adjustment in berm/sheet elevation would result in an adjustment in confined volume for the CDF. GE shall clarify the preliminary design considerations for the CDF elevation.*

GE Response: As indicated by EPA, the guidelines for CDF design presented in the U.S. Army Corps of Engineers Engineering Manual for the Engineering and Design of Confined Disposal of Dredged Material (USACE, 1987) specify that a minimum of 2 feet of height be assumed for freeboard and that a minimum average ponding depth of 2 feet be assumed during filling. Based on the assumed dredging production rates, coupled with the potential for consolidation of the bottom materials to occur during placement, a less conservative berm elevation height of 5 feet during filling (equivalent to the final fill/surface cover elevation) was assumed in the CMS Report. Without consideration of those factors, based on the USACE (1987) guidance, the CDF berm/sheet elevation would be set at 7.5 feet above mean water elevation (as suggested by EPA) for purposes of filling, and ultimately reduced to a final elevation of 5 feet to match the final fill/surface cover elevation.

Alternative TD3

Specific Comment 119 (Page 33): *Page 7-33: There is insufficient detail in the CMS Report on potential sites (and consequent impacts) and construction methods and issues to allow a full evaluation relative to the other alternatives. The brief description of the process by which a site for an on-site upland disposal facility would be selected and evaluated does not provide details commensurate with the likely complexity of the process that would be required to implement this alternative. There is no information provided in the text indicating the minimum and maximum land area required to site a landfill. GE shall provide additional detail regarding the evaluation and analysis of the effectiveness, implementability, and reliability of the on-site upland disposal alternative (TD 3). In addition, GE shall provide* *additional details regarding the process of obtaining and evaluating a site for this alternative, including the components of short- and long-term effectiveness such as distance, number of truck trips, impacts on habitat, etc. GE shall also revisit the cost estimate for this alternative based upon the new information and revise it if necessary. Also see General Comment 1.*

GE Response: As noted in the Response to General Comment 1, GE is continuing to evaluate potential locations for an Upland Disposal Facility, and will complete that evaluation during the forthcoming period while discussions and evaluations are ongoing relating to a new remedial alternative for sediments and floodplain soil. The evaluation process for potential locations includes consideration of proximity to the River, potential availability for use, parcel size, location outside the 100- and 500-year floodplains, location outside any wetlands or other areas that would constitute resource areas under the Massachusetts Wetlands Protection Act and outside any areas designated by the NHESP as Priority Habitat of state-listed rare species, current land use (including that of the immediate surrounding area), and accessibility. The approximate minimum and maximum land areas potentially required to site a landfill are 50 and 280 acres, respectively.

Following completion of its ongoing evaluation, GE will, in the revised CMS Report, identify the potential locations for an Upland Disposal Facility and provide a full evaluation of the relative long-term reliability and effectiveness, short-term effectiveness, implementability, and cost of constructing and operating an Upland Disposal Facility at each of the identified locations. As noted above, GE will also provide an evaluation, in tables, of the ability of an Upland Disposal Facility at each of those locations to comply with ARARs.

<u>**Specific Comment 120 (Page 34):**</u> <u>*Page 7-34:*</u> *The assumed volume of leachate to be generated at the upland disposal facility for the various volumes is not discussed. EPA cannot determine based upon the information provided the validity of the assumption that the volume is small enough and the distance short enough that the leachate can be transported economically by truck and that GE's treatment facility has sufficient capacity to treat this additional waste stream. GE shall provide additional details regarding the volume of leachate to be generated, the capacity of the existing system to handle the anticipated volume, and the transport of the leachate to the facility.*

GE Response: For the purposes of the CMS, the conceptual design and operations of the Upland Disposal Facility were based largely on experience associated with the on-plant consolidation areas (OPCAs) constructed at the GE facility in Pittsfield. The volume of leachate generated was assumed to be similar to that generated at the OPCAs. The maximum observation of leachate generation at the OPCAs is approximately 50,000 gallons/acre/month while the facility is open and receiving materials. When the OPCAs are closed/covered, the leachate generation decreases to approximately 5,000 gallons/acre/month.

Although the OPCAs are generally smaller than the conceptual Upland Disposal Facility, the construction and operation of the Upland Disposal Facility are anticipated to be performed in a series of cells, such that individual smaller units or cells would be constructed, operated, and closed within the confines of the entire facility. As such, the size of any open cell and associated exposed material areas were assumed to be similar to those of an operating OPCA, and it was assumed that approximately 2 acres would be open and operating at a given time.

At this rate of leachate generation (100,000 gallons per month), construction of a temporary water treatment facility was not considered to be cost-effective, and it was assumed that a 5,000-gallon water truck could be used to transport collected leachate water for daily delivery to GE's Building 64G water treatment facility for treatment and discharge. Building 64G has a maximum treatment capacity of approximately 700 gpm, and there is sufficient excess capacity to accommodate the leachate volumes associated with the operation of the conceptual Upland Disposal Facility. Further, it was assumed that the Upland Disposal Facility would be within 20 miles of the GE facility, and as such travel distance for the water truck would not be a limiting factor.

Alternative TD5

Specific Comment 121 (Page 34): *Page 7-72: In the discussion of the thermal desorption alternative, the CMS states that the excavated sediments would be reduced to 18 to 20% moisture content by the hot exhaust gas stream. Given that a significant volume of sediment will be generated from hydraulic dredging and will have moisture content of approximately 50% following dewatering via a plate and frame filter press, it does not seem practical or economical to assume that moisture can be reduced to 18 to 20% using this method. GE shall re-evaluate this assumption and ensure that the process is described appropriately and that adequate costs are included to meet this moisture content requirement of the feed material.*

GE Response: The descriptions provided in Section 4 of the CMS Report for alternatives involving hydraulic removal of sediments indicated that the dewatering and handling of dredged sediments would include mechanical dewatering (using a plate and frame filter press) and potentially the addition of drying agents (such as lime kiln dust, sand, or dry treated materials). These steps, along with pre-heating of the materials by the thermal desorption process exhaust, would be used to achieve the 18 to 20% moisture content required for thermal desorption treatment (EPA, 1997). It was also assumed that mechanically removed sediments would require dewatering by being stockpiled at the staging areas to allow them to dewater by gravity, with drying agents added as necessary prior to treatment.

GE has re-evaluated the thermal desorption alternative, and has determined that it is reasonable to assume that an intermediate step of mixing a drying agent would be performed for hydraulically dredged sediments, as well as for mechanically removed sediments, to achieve an approximate 18 to 20% moisture content. For this re-evaluation, it has been assumed that, before going through the thermal desorption process, all hydraulically removed sediments would need to go through the following pre-treatment steps: (1) screening of the dredged materials and separation of those materials according to size; (2) mechanical dewatering of the finer fraction using a plate and frame filter press; (3) mixing of the dewatered materials with dry material (e.g., sand, excavated floodplain soils, or thermally treated materials); and (4) pre-heating of the amended materials by the thermal desorption process exhaust to further reduce the moisture content below 18 to 20%. A similar approach would be used for mechanically dredged sediments except that these sediments would undergo gravity dewatering instead of mechanical dewatering.

The actual amount and type of the dry materials to be added to the dewatered and screened sediments would be determined during the design phase. Nonetheless, for this revised evaluation, estimated costs for mixing dry materials with the dewatered and screened sediments, as well as costs associated with additional pre-treatment materials handling activities, have been added to the total estimated costs associated with TD 5. Revised TD 5 cost estimates for the minimum and maximum alternatives are included in Appendix D.

<u>Specific Comment 122 (Page 34):</u> *<u>Page 7-86:</u> No data for thermal desorption regarding the treatment cost per ton of material has been provided in the text. EPA anticipates significant variability in the cost to treat the material from various reaches due to the increasingly fine-grained nature of the material from Reach 5A to Reach 6 and impoundments in Reach 7 and 8. An assessment has not been provided of how the feasibility and cost-effectiveness of using this technology at all areas might vary. GE shall provide additional cost information, including details regarding the pre-treatment steps required to reduce moisture content and the related cost impacts.*

GE Response: As discussed in the prior response, GE has re-evaluated the thermal desorption alternative for all excavated/dredged sediments based on the inclusion of additional pre-treatment steps for those materials. These pre-treatment steps are described in the prior response. While these pre-treatment steps are largely intended to reduce moisture content, they would also result in the mixing of fine- and large-grained sediments such that the pre-treated materials would generally be considered homogeneous. Given the above pre-treatment assumptions, GE does not believe that it is necessary to further consider the sediment variability among reaches with regard to the feasibility or cost-effectiveness of this technology.

Section 8: Combined Cost Estimates

<u>Specific Comment 123 (Page 34):</u> *<u>Page 8-1:</u> GE has provided some details regarding how costs for the base alternatives were combined with the TD alternatives; however, the amount of information provided in Section 8 and Appendix E is insufficient for EPA to conduct a thorough review of the costs for the combined alternatives. GE shall provide detailed cost estimate build-up assumptions for the combined alternatives, providing a separate subheading for costs associated with restoration and the unit rate assumptions used to develop the costs (e.g. tree and shrub densities). GE shall also discuss the uncertainties associated with these cost estimates, (e.g. EPA's FS guidance assumes that the costs will be within -30% to + 50%).*

GE Response: The assumptions related to how the cost estimates were combined were provided in the bulletized lists in Section 8 of the CMS Report. There were no additional assumptions or changes related to combining costs. Tables SC123-1 and SC123-2 are provided to illustrate how these assumptions affected the individual SED and FP alternative costs when combined with the TD alternatives (using SED 6 and FP 4 as examples). The detailed cost estimate build-up assumptions (i.e., unit prices) requested by the EPA are, therefore, only applicable to the individual SED, FP, and TD alternative costs; and these assumptions were previously provided in GE's Cost and Pricing Information submitted in conjunction with the CMS Report as Confidential Business Information (CBI). Specific information related to restoration assumptions, including assumed tree and shrub densities, were, however, not included in the CBI package. Therefore, in response to EPA's request, this information has been included in GE's revised Cost and Pricing Information, which is being submitted separately as CBI.

With regard to cost uncertainties, as discussed in Section 2 of the CMS Report, in developing remedial cost estimates, GE generally relied on *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USACE/EPA, 2000) and *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final* (EPA, 1988). In accordance with these documents, for the "purpose of comparing remedial alternatives during the remedy selection process" (USACE/EPA, 2000), GE developed feasibility-level cost estimates for each of the alternatives, which included conceptual approaches to the achievement of various remedial objectives. Although based on site-specific conditions and parameters (e.g., removal volumes), these alternatives are indeed conceptual and are not considered to be fully designed. It follows that the associated estimated costs have considerable uncertainty. GE anticipates that the cost estimates presented in the CMS Report and revised in this Interim Response would be within the range of approximately -30% to +50% of the actual costs. This range corresponds to generally accepted rules of thumb for feasibility-level cost estimates and is in accordance with the above-referenced guidance (USACE/EPA, 2000).

Specific Comment 124 (Page 35): *Page 8-1: EPA notes that the combined cost estimates (with modifications otherwise specified in these comments and also the comments provided on the CBI cost package) are adequate for comparison of alternatives. However, EPA is making no representation that the cost estimation procedure used by GE is accurate or contains assumptions EPA would use. For example, the costs provided by GE in 2008 dollars do not include an escalation assumption over the duration of implementation of the alternative, and are based on a series of assumptions made regarding implementation of alternatives that may need to be revisited during design, if necessary.*

GE Response: Comment noted. GE has updated the combined cost estimates in accordance with EPA's comments and GE's responses on both the CMS Report and the CBI Cost and Pricing Information package. Tables SC 124-1 and 124-2 summarize the revised total and net present worth cost estimates for the combinations of sediment and treatment/disposition alternatives, and Tables SC 124-3 and 124-4 summarize the revised total and net present worth cost estimates for the combinations of floodplain soil and treatment/disposition alternatives.

Appendix C – Methodology for Mink IMPGs

Specific Comment 125 (Page 35): *Page C-2: GE comments in the CMS that the habitat contained in the two averaging areas is be "too small to support a local population of mink." EPA notes, however, that the appropriate approach in developing an averaging area is not whether the area can support an entire local subpopulation. Rather, it is the area of a size relevant to the foraging area for a sufficient number of individuals, such that loss of such a number of individuals would have consequences for the local subpopulation. In the CMS, here and elsewhere, it is assumed that population-level impacts can only occur if all individuals in a local population are affected, but that is not the case. For mink, the concentration-response curve is also quite steep, and moderate PCB exceedances of thresholds for successful reproduction can lead to complete reproductive failure. Therefore, the consequences of not meeting the IMPGs for the averaging areas are significant in ecological terms.*

GE Response: As discussed in Response to Specific Comment 35, GE believes that the PSA could support only a relatively few mink and that the local population of mink extends well beyond the PSA. In addition, as discussed in prior submissions to EPA on the ERA and in GE's original IMPG Proposal (GE, 2005), GE believes that the mink feeding study on which the ERA relied to predict effects on mink did not provide reliable evidence of an adverse effect on kit survival due to PCB exposure, even at the highest dose level in the study (3.7 mg/kg in diet). However, even accepting EPA's interpretation, the lower-bound IMPG is based on a statistical analysis that yielded an assumed 20% effect level, and the upper-bound IMPG is based on the mean of EPA's assumed no-effect and lowest-effect levels for kit survival. In this situation, even if the IMPG exceedances meant that the relatively few mink inhabiting the PSA – or the even fewer mink inhabiting each of the two averaging areas within the PSA – lost a portion of their kits due to PCB exposure, GE does not believe that this would prevent the maintenance of the local mink population or be significant in ecological terms.

Appendix F – CT 1-D Analysis

<u>Specific Comment 126 (Page 35):</u> *<u>Page F-2:</u> Concentrations of PCBs in smallmouth bass were extrapolated from the existing FCM predator model. Because the predator model was calibrated and validated for largemouth bass, this is a reasonable assumption, but only provided that the lipid contents of CT smallmouth bass are similar to largemouth bass upstream of Woods Pond Dam. GE shall provide an assessment of the applicable technical literature and data to support the assumption of similar lipid content.*

GE Response: GE used the downstream FCM predator model to assess PCB concentrations in fish from Connecticut because that approach was directed by EPA in Specific Condition 63 of EPA's April 13, 2007 conditional approval letter for the CMS Proposal. EPA's FCM predator model was parameterized using largemouth bass.

Figure SC126-1 provides a comparison between distributions of lipid content in smallmouth bass from Connecticut and largemouth bass collected upstream of Woods Pond Dam, using all available GE and EPA fillet data. This figure demonstrates that the central tendency in lipid content between the two species is relatively similar (approximately 1% for both species); the arithmetic mean lipid content is approximately 1.4% for largemouth bass and 1.2% for smallmouth bass. Further, while the lipid content in largemouth bass collected from the PSA is generally more variable, the range in lipids between the two species is relatively consistent.

<u>Specific Comment 127 (Page 35):</u> *<u>Page F-12:</u> There is discussion in the CMS of the factor of 2.3 to convert the fillet-only data to a whole body basis, claiming that EPA's use of this factor in the bioaccumulation modeling calibration and HHRA is inconsistent with directions provided to GE to use a factor of 5. EPA notes that there is no inconsistency. First, it is not correct that this factor was applied during model calibration or validation. The bioaccumulation model conducted fillet to whole body extrapolations based on an assumed equivalency on a lipid-normalized basis. For the area downstream of the PSA, an approximate 1:1 relationship between PCB concentrations in fillet lipids and whole body lipids was documented. Therefore, conversions were conducted on an individual fish basis using measurements or estimates of lipid contents.*

With regard to EPA's directions to GE to use the factor of 5 in comparing whole body data from the simulations with fillet-based human health IMPGs, that direction was based on a comparison of whole-body data from fish collected upstream of Woods Pond Dam with paired (i.e., from the same fish) ***skin-off*** *fillet samples. The factor of 2.3 comes from*

Bevelheimer et al. (1997) and was based on their comparison of whole body vs. ***skin-on*** *fillets. The factor of 5 is appropriate for comparison with human health IMPGs because the IMPGs were developed largely using the* ***skin-off*** *data; the factor of 2.3 is appropriate for comparisons of CT 1-D output to downstream fish data because the CT fish data are derived from* ***skin-on*** *samples. Because the skin includes a quantity of lipid, it is expected that the ratio between skin and whole body concentrations will be smaller for skin-on fillets than for skin-off fillets.*

GE Response: Comment noted.

Specific Comment 128 (Page 36): *Page F-14: EPA agrees that the calibration procedures undertaken by GE for this procedure seem reasonable. However some statistical comparisons would be helpful in addition to the graphical comparisons shown in Figures F-10 through F-15. Statistics to indicate overall model bias and precision would be useful in evaluating the model calibration. GE shall provide this additional information.*

GE Response: To address this comment, the same quantitative model performance metrics used by EPA in its *Final Model Documentation Report* to evaluate bias and precision of the FCM (described on pages 4-116 to 4-119 in EPA [2006c]) were applied in the evaluation of the CT 1-D Analysis estimates. As described in the FMD, EPA's FCM Phase 2 Calibration was evaluated using a model bias (MB*) statistic (Arnot and Gobas, 2004), which was derived on both a species-specific and reach-specific basis. This MB* statistic is the geometric mean of the ratio of simulated and measured PCB concentrations, and is a measure of the systematic overprediction (MB > 1) or underprediction (MB < 1) of the model (EPA, 2006c). In addition, EPA evaluated the overall model accuracy and precision using the mean absolute percent error (MAPE) metric. Both MB* and MAPE were computed based on the extended CT 1-D Analysis model/data comparison (utilizing data collected as early as 1977) presented in the Response to Specific Comment 130 below. Table SC128-1 presents these statistics on both a wet-weight and a lipid-normalized basis.

Table SC128-1. Summary of Quantitative Model Performance Metrics Used to Evaluate CT 1-D Analysis.

Basis	Comparison Type	Group	Number of Tissue PCB Measurements	Model Bias (MB*) Statistic[1]	Model Accuracy/Precision (MAPE[2]) Statistic
Wet-Weight	All Data		659	1.26	60%
	By Reach	Bulls Bridge	206	1.01	56%
		Lake Lillinonah	237	1.22	55%
		Lake Zoar	192	1.54	65%
		Lake Housatonic	24	2.27	85%
	By Species	Smallmouth bass	414	0.97	50%
		Bullhead[3]	100	1.36	61%
		Sunfish[4]	145	2.56	86%
Lipid-Normalized	All Data		525	0.67	65%
	By Reach	Bulls Bridge	164	0.65	59%
		Lake Lillinonah	202	0.63	69%
		Lake Zoar	159	0.75	65%
		Lake Housatonic	0	--	--
	By Species	Smallmouth bass	360	0.57	66%
		Bullhead[3]	60	0.95	51%
		Sunfish[4]	105	0.95	67%

Notes:

[1] MB > 1 indicates systematic overprediction, and MB < 1 indicates systematic underprediction.

[2] MAPE = Mean average percent error.

[3] Includes brown and yellow bullhead, where available.

[4] Includes pumpkinseed, bluegill, redbreast sunfish, and redear sunfish, where available.

The overall model bias statistic is 1.26 on a wet-weight basis (indicating a slight over-prediction) and 0.67 on a lipid-normalized basis (indicating somewhat of an under-prediction); this calibration thus provided a balance between wet-weight and lipid-normalized concentrations. For comparison, the model bias statistics for EPA's calibration of the FCM in the PSA and Reach 7/8 ranged from 0.8 to 1.3 by reach and from 0.8 to 2.3 by species. Thus, the CT 1-D FCM calibration was judged to be of similar quality to EPA's calibration in the upstream reaches. Similar to EPA's FCM, some variations in MB* are observed among species and reaches. The overall MAPE is 60% on a wet-weight basis, and 65% on a lipid-normalized basis. For comparison, overall MAPE for EPA's calibration of FCM for Reaches 5-8 was approximately 50% for all data and ranged from 30% to 71% by reach. Given the large uncertainty in the CT 1-D Analysis methodology, this level of combined accuracy/precision was considered acceptable for this extrapolation.

<u>Specific Comment 129 (Page 36):</u> *EPA notes that PCB concentrations in bass seem to be underpredicted at Bulls Bridge, with approximately 80% of the observations falling above the prediction line on both a wet-weight and lipid-normalized basis. This suggests that the Bulls Bridge attenuation factor may have been set too low (as a percentage of the Rising Pond Dam boundary condition). Other reaches seem to be reasonably well calibrated. GE shall provide a discussion of the apparent underprediction of concentrations in bass tissue at Bulls Bridge and a correction if necessary.*

GE Response: GE recognized that predicted bass concentrations are somewhat low at Bulls Bridge; this was discussed on page 13 of Appendix F to the CMS Report:

> "The calculated wet-weight PCB concentrations in smallmouth bass are somewhat lower than the measured concentrations (converted to whole-body concentrations) in 1990-1996 and 2004 at Bulls Bridge, but are within the range of the data for other years at that location and for all years at Lake Lillinonah and Lake Zoar (Figure F-10). Generally, the predicted lipid-normalized PCB concentrations in smallmouth bass are somewhat lower than observed concentrations (converted to whole-body concentrations) at Bulls Bridge and Lake Zoar, but are within the range of the data at those locations and at Lake Lillinonah (Figure F-13). These comparisons indicate that the FCM-calculated concentrations provide a fairly reasonable representation of measured smallmouth bass PCB concentrations (converted to whole-body concentrations) at these three locations."

As indicated in that discussion, although PCB concentrations in smallmouth bass predicted by the CT 1-D analysis are somewhat low at Bulls Bridge, those concentrations are still within the range of the data. Furthermore, there is no apparent bias in the model predictions for the other species simulated at Bulls Bridge, which could suggest a difference in food web structure or physiological parameters in this reach relative to the upstream reaches (Woods Pond and Rising Pond) for which FCM was calibrated (no adjustment of FCM parameters was made during development of the CT 1-D Analysis). Also, the predicted concentrations in fish at Bulls Bridge are based solely on the water column and sediment exposures predicted by the analysis. Increasing the sediment concentrations to account for the low bias in the Bulls Bridge bass by increasing the attenuation factor (as suggested by EPA) would compromise the sediment calibration and also would be inconsistent with the data used to establish the attenuation factor. Given these factors, as well as the numerous other uncertainties in this analysis, the overall calibration (as originally presented in Appendix F) represents an acceptable balance for all modeled media and impoundments, including both Bulls Bridge and the further downstream impoundments, for purposes of this extrapolation.

Specific Comment 130 (Page 36): *Additionally, EPA notes that the analysis would have been more robust if the 1D model results had been run through FCM for the period prior to the calibration period (i.e., add 1960-1989 to 1990-2004). This would be a relatively straightforward procedure because the 1D results for sediment are readily available and plotted on Figure F-8. In this manner, the FCM results could be used to validate (or calibrate) the 1D model for the years prior to the calibration period. GE shall provide this analysis.*

GE Response: As requested, the 1-D model results were run through the FCM for the entire simulation period, from 1963 to 2004. As in Appendix F, the model simulation results were compared to measured PCB data for smallmouth bass, bullhead, and sunfish at Bulls Bridge, Lake Lillinonah, Lake Zoar, and Lake Housatonic on both a wet-weight basis and a lipid-normalized basis. These comparisons are shown on Figures SC130-1 through SC130-3 (wet-weight basis) and Figures SC130-4 through SC130-6 (lipid-normalized basis). These figures continue to indicate relatively good agreement between predicted concentrations from the CT 1-D Analysis and observed data, including the additional data from the extended simulation period (i.e., data from 1977 to 1990). As in the prior analysis, predicted concentrations in smallmouth bass at Bulls Bridge are somewhat low during the period from 1990 to 2004 (as discussed in the Response to Specific Comment 129); however, predicted concentrations for the overall period are within the range of the data in most years. Predictions for other species and locations are generally good, with some cases where the model over-predicts the data (e.g., wet weight sunfish at Lake Zoar). Given the relatively good agreement between predicted concentrations and observed data at all locations and across all species, and considering the numerous uncertainties in the CT 1-D Analysis, no revision to the original calibration is considered necessary.

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