
**COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES
FOR THE
GENERAL ELECTRIC (GE)-PITTSFIELD/HOUSATONIC RIVER PROJECT
REST OF RIVER**

DCN: HR-052014-AAYR
SDMS: 557091



U.S. ENVIRONMENTAL PROTECTION AGENCY
New England Region
Boston, Massachusetts



U.S. ARMY CORPS OF ENGINEERS
New England District
Concord, Massachusetts

May 2014

Contract No. W912WJ-08-D-0008
Task Order No. 0002



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LIST OF ACRONYMS

ACEC	Area of Critical Environmental Concern
ARAR	applicable or relevant and appropriate requirement
BEHI	Bank Erosion Hazard Index
BMPs	best management practices
Board	EPA National Remedy Review Board
CDF	confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMR	Code of Massachusetts Regulations
CSTAG	EPA Contaminated Sediments Technical Advisory Group
cy	cubic yard
DFW	Massachusetts Division of Fisheries and Wildlife
EA	exposure area
EMNR	Enhanced Monitored Natural Recovery
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERE	environmental restrictions and easements
GE	General Electric Company
GHG	greenhouse gas
GWTP	groundwater treatment plant
HI	hazard index
IC	institutional control
IMPG	Interim Media Protection Goal
lb	pound
MESA	Massachusetts Endangered Species Act
MGL	Massachusetts General Laws
mg/kg	milligrams per kilogram
MNR	monitored natural recovery
NBS	Near Bank Stress
NCP	National Contingency Plan
NHESP	Natural Heritage and Endangered Species Program
NRWQC	National Recommended Water Quality Criteria
OMM	operation, maintenance, and monitoring
PCB	polychlorinated biphenyl
PSA	Primary Study Area
RCMS	Revised Corrective Measures Study
RCRA	Resource Conservation and Recovery Act
RME	reasonable maximum exposure
SA	sediment [exposure] area
TOC	total organic carbon
TMV	toxicity, mobility, or volume
tPCBs	total polychlorinated biphenyls
TSCA	Toxic Substances Control Act
WWTP	Wastewater Treatment Plant

1 **COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES**
2 **MAY 2014**

3 **1 INTRODUCTION**

4 In October 2010, the General Electric Company (GE) submitted to the U.S. Environmental
5 Protection Agency (EPA) a Revised Corrective Measures Study (RCMS) for the Rest of River
6 part of the GE-Pittsfield/Housatonic River Site. In July 2011, the EPA New England regional
7 office presented site information and potential cleanup strategies for the Rest of River to the EPA
8 National Remedy Review Board (the Board). Representatives of EPA’s Contaminated
9 Sediments Technical Advisory Group (CSTAG) also participated in the Board review for this
10 site.

11 After the review meeting, the Board issued a set of recommendations to EPA New England,
12 dated October 20, 2011. In response to the Board’s recommendations, and to further develop a
13 potential cleanup strategy for the Rest of River, EPA conducted additional technical evaluations
14 and worked closely with co-regulators from the Commonwealth of Massachusetts and the State
15 of Connecticut in a series of facilitated technical discussions that began in October 2011. Based
16 on agreements reached with the States of Massachusetts and Connecticut, EPA, in May 2012,
17 published a status report entitled “Potential Remediation Approaches to the GE-
18 Pittsfield/Housatonic River Site ‘Rest of River’ PCB Contamination.” This status report
19 provided an update to the public on the discussions among the agencies and outlined potential
20 remediation approaches for the Rest of River.

21 While considering the input from the Board and the States during these technical discussions,
22 EPA compiled additional technical information, conducted additional modeling work to refine
23 the potential remediation approaches, and evaluated these approaches in light of the criteria
24 outlined in the Resource Conservation and Recovery Act (RCRA) Permit. All of this work led
25 EPA to supplement the original analysis, and a revised Comparative Analysis of Alternatives
26 was presented to the Board in August 2012. At the same time, EPA entered into a series of
27 meetings with GE and co-regulators from the States of Massachusetts and Connecticut to discuss
28 and refine the potential approaches to remediation of the river. The meetings concluded in
29 December 2013 and resulted in minor revisions to the potential remediation approaches for Rest
30 of River. The revised information, as well as certain additional supporting documentation, is
31 presented in this document.

32 This comparative analysis is intended to provide a more detailed analysis of the different
33 alternatives under consideration for Rest of River.

34 **1.1 DESCRIPTION OF SED 9/FP 4 MOD ALTERNATIVE**

35 SED 9/FP 4 MOD, a new alternative developed following the meetings among EPA, GE, and the
36 States of Massachusetts and Connecticut described above, consists of SED 9/FP 4 with minor
37 revisions, and includes the following components:

1 River Sediment and Banks

2 ▪ Reach 5A

3 For Reach 5A, the approximately 5-mile stretch of the Housatonic River from the
4 confluence of the East and West Branches of the Housatonic (at Fred Garner Park in
5 Pittsfield) to the Pittsfield Wastewater Treatment Plant (WWTP), SED 9/FP 4 MOD
6 requires the removal of river bed sediment throughout the entire reach, removal of bank
7 soil in contaminated eroding riverbanks, and stabilization of contaminated erodible
8 riverbanks to meet cleanup levels in fish tissue and to reduce ecological risk and
9 downstream transport. Residual polychlorinated biphenyls (PCBs) in the bed sediment
10 would subsequently be capped, and the bed of the river generally returned to original
11 grade. Additional data will need to be collected to better quantify the concentrations of
12 PCBs in riverbanks and the locations of erodible riverbanks and to determine the actual
13 riverbed removal depth and cap thickness. For the purpose of this comparative analysis,
14 a sediment removal depth of 2.5 feet has been assumed for Reach 5A.

15 An important focus of the riverbank work will be to reduce bank erosion to acceptable
16 levels while maintaining the dynamic nature of the Housatonic River using the principles
17 of natural channel design, where appropriate. For banks that require excavation, the
18 hierarchy below of most-preferred to least-preferred reconstruction alternatives will be
19 followed:

- 20 1. Reconstruct the disturbed banks with bio-engineering "soft" restoration techniques.
- 21 2. Reconstruct the disturbed banks with a cap layer extending into the riverbank covered
22 with a bio-engineered "soft" layer.
- 23 3. Place a riprap cap or hard armoring on the surface of the banks (for example, if
24 necessary to protect adjacent infrastructure and property).

25 Some of the aspects of natural channel design are discussed in the context of channel
26 realignment in Attachment 1, Use of Channel Realignment along the Housatonic River
27 for Restoration and Remediation of PCB Contamination, and Attachment 2, Channel
28 Dynamics and Ecological Conditions in the Housatonic River Primary Study Area.
29 Additional information on Natural Channel Design can be found in Chapter 11, Rosgen
30 Geomorphic Channel Design, in *Part 654 National Engineering Handbook, Stream*
31 *Restoration Design* (U.S. Department of Agriculture, Natural Resources Conservation
32 Service, 2007).

33 ▪ Reach 5B

34 For Reach 5B, the approximately 2-mile stretch of the river from the Pittsfield WWTP to
35 Roaring Brook in Lenox, MA, SED 9/FP 4 MOD requires the excavation and restoration
36 of areas of river bed sediment and bank soil that exceed the reach-specific cleanup level
37 of 50 milligrams per kilogram (mg/kg) total PCBs (tPCBs), and use of Enhanced
38 Monitored Natural Recovery (EMNR) throughout the reach. Additional data will be
39 collected to determine PCB concentrations in the bed and banks that exceed reach-
40 specific cleanup standards. Any excavated Reach 5B riverbanks would be restored using

1 the hierarchy as discussed for Reach 5A. Backfill, including a suitable habitat layer, will
2 be used to restore the riverbed.

3 EMNR in this reach would involve the use of a sediment amendment, such as activated
4 carbon (see Attachment 3), to reduce the bioavailability of PCBs, thereby assisting in
5 achieving cleanup levels in fish tissue and reducing ecological risk and the downstream
6 transport of contaminants. The effectiveness of any amendment would first be evaluated
7 in a pilot study and would be implemented using an adaptive management framework
8 throughout Reach 5B.

9 ■ Reach 5C

10 For Reach 5C, the approximate 3-mile stretch of Housatonic River between Roaring
11 Brook and the headwaters of Woods Pond, SED 9/FP 4 MOD requires removal of river
12 bed sediment throughout the reach to meet fish tissue cleanup levels and to reduce
13 ecological risk and the downstream transport of contaminants. The residual PCBs in bed
14 sediment below the depth of excavation would subsequently be capped, as discussed
15 further below. There are few, if any, eroding riverbanks in this reach; therefore, banks in
16 this reach will be left intact, unless disturbed by other remediation activities.

17 ■ Backwaters

18 SED 9/FP 4 MOD requires, in areas outside Core Area 1 (see Attachment 4), surficial
19 sediment removal where either surface or subsurface average concentrations exceed
20 1 mg/kg PCBs. In addition, sediment excavation will be required in any area with
21 surficial PCB contamination that exceeds 50 mg/kg. An Engineered Cap will be placed
22 in these areas to sequester the PCB-contaminated sediment that remains at depth.
23 Sufficient sediment will be removed to allow an Engineered Cap to be placed such that
24 the riverbed is generally returned to original grade. Final removal depths, locations, and
25 Engineered Cap configurations will be determined during remedial design.

26 Backwaters in certain areas designated as having high-quality habitat for state-listed
27 species (known as “Core Area 1,” see Attachment 4) will generally not be remediated,
28 except in discrete areas with PCB concentrations greater than 50 mg/kg. In these discrete
29 areas, sediment will be removed such that an Engineered Cap can be installed and the
30 area returned to original grade. Core 1 areas with sediment PCB concentrations between
31 1 and 50 mg/kg will be evaluated for possible use of a sediment amendment such as
32 activated carbon, as discussed above for Reach 5B.

33 ■ Reach 6 (Woods Pond)

34 In Reach 6 (Woods Pond), SED 9/FP 4 MOD specifies the removal of contaminated
35 sediment in all areas of the pond and the placement of a cap, with the design generally
36 providing a minimum water depth of 6 feet in the pond with shallower water depths in the
37 near-shore areas. In deeper areas of the pond, sufficient sediment will be removed to
38 allow an Engineered Cap to be placed such that the riverbed is generally returned to or
39 below original grade. In addition to reducing human health risk from fish (and other
40 biota) consumption and ecological risk, this action in Woods Pond will reduce human

1 health risk due to direct contact with the sediment. This remedy also will remove a
2 significant mass of PCBs, reducing the potential for release in the case of dam failure,
3 and increasing the sediment/PCB-trapping efficiency of Woods Pond, thus assisting in
4 reducing downstream transport. Reach 6 will be monitored over the long term following
5 the cleanup and, if substantial PCBs accumulate in the pond, removal of the accumulated
6 sediment will be required.

- 7 ■ Columbia Mill Impoundment (Reach 7B), Eagle Mill Impoundment (Reach 7C), Willow
8 Mill Impoundment (Reach 7E), Glendale Impoundment (Reach 7G),

9 This component of SED 9/FP 4 MOD allows a number of potential approaches to better
10 integrate the cleanup with potential dam or impoundment use, maintenance, or removal.
11 First, if dam maintenance or removal is planned, SED 9/FP 4 MOD provides for GE to
12 coordinate with those planning work on these dams, to fund sampling and analysis, and to
13 take responsibility for the incremental costs associated with the presence of PCBs. Dam
14 removal itself is not a component of this cleanup plan and would be conducted by others
15 in coordination with GE and appropriate state and federal agencies.

16 If no dam removal is planned by the time GE would otherwise be required to move
17 forward with remediation of these impoundments, surficial sediment would be removed
18 in areas where either surface or subsurface average concentrations exceed 1 mg/kg PCBs.
19 An Engineered Cap will be placed in these areas to sequester the PCB-contaminated
20 sediment that remains at depth. In addition, sediment excavation will be required in any
21 area with surficial PCB contamination that exceeds 50 mg/kg. Sufficient sediment will
22 be removed in these areas to allow an Engineered Cap to be placed such that the riverbed
23 is generally returned to original grade. Final removal depths, locations, and Engineered
24 Cap configurations will be determined during remedial design. An additional option, in
25 lieu of capping, would allow GE to excavate the sediment in each impoundment to meet
26 an average 1 mg/kg PCBs cleanup standard in surface and subsurface sediment. These
27 actions will allow flexibility to address the dams and also result in achieving cleanup
28 levels in fish tissue, and reducing direct contact risk, ecological risk, and downstream
29 transport of contaminants.

- 30 ■ Reach 8 (Rising Pond)

31 SED 9/FP 4 MOD requires surficial sediment removal in areas where either surface or
32 subsurface average concentrations exceed 1 mg/kg PCBs. In addition, sediment
33 excavation will be required in any area with surficial PCB contamination that exceeds 50
34 mg/kg. An Engineered Cap will be placed in these areas to sequester the PCB
35 contaminated sediment that remains at depth. Sufficient sediment will be removed to
36 allow an Engineered Cap to be placed such that the riverbed is generally returned to
37 original grade. Final removal depths, locations, and Engineered Cap configurations will
38 be determined during remedial design. An additional option, in lieu of capping, would
39 allow GE to excavate the sediment in Rising Pond to meet an average 1 mg/kg PCBs
40 cleanup standard in surface and sediment. These actions will result in achieving cleanup
41 levels in fish tissue, and reducing ecological risk and downstream transport of
42 contaminants.

1 ▪ Flowing Subreaches in Reach 7 (Reaches 7A, 7D, 7F, 7H) and Reaches 9 through 16

2 Monitored natural recovery (MNR) would be implemented in the flowing subreaches in
3 Reach 7 (between Woods Pond and Rising Pond) as well as Reaches 9 through 16 (from
4 Rising Pond Dam through Connecticut). MNR would include monitoring to confirm
5 progress toward achieving cleanup levels in fish tissue and reducing ecological risk and
6 downstream transport, compliance with state and National Recommended Water Quality
7 Criteria (NRWQC) (to the extent not waived), and to support modifications to fish
8 consumption advisories.

9 Engineered Cap Design

10 Several components of SED 9/FP 4 MOD require construction of an Engineered Cap following
11 sediment removal. In each area to be capped, sediment would be removed to allow the
12 placement of an Engineered Cap to the final grades determined to be appropriate during design
13 of the remedy and to result in no net loss of flood storage capacity. Each cap will likely consist
14 of sacrificial mixing layer, a chemical isolation layer to minimize PCB migration up through the
15 cap, a protective layer (to prevent disruption and erosion of the isolation layer and exposure of
16 the underlying contaminated sediment), and a habitat layer. During remedial design, it will be
17 determined whether additional cap components are necessary (e.g., a filter layer or a mixing
18 layer) or other cap configurations are appropriate (see Attachment 5). As outlined above, if dam
19 removal activities take place in the Reach 7 impoundments, sediment contaminated with PCBs at
20 levels greater than 1 mg/kg could be removed as part of the dam removal project, thus making
21 the installation of a cap in those areas unnecessary.

22 Floodplain/Vernal Pools Adjacent to Reaches 5 through 8

23 This part of SED 9/FP 4 MOD would be performed in the floodplain while sediment cleanup
24 activities in adjacent sections of the river (described above) are taking place. Remediation of
25 floodplain soil under SED 9/FP 4 MOD includes:

26 ▪ Gathering additional information to support the final cleanup design and to achieve
27 cleanup levels.

28 ▪ Removing floodplain soil contaminated above cleanup levels (exposure area-specific
29 concentrations corresponding to a residual human health risk from direct contact of
30 1×10^{-5} or a Hazard Index (HI) of 1, whichever is lower) to a depth of 1 foot, except in
31 frequently used subareas, which will be excavated to 3 feet. “Frequently used
32 subareas” are portions of the floodplain that were determined during the human health
33 risk assessment to be used more intensively than other areas and thus are proposed to
34 undergo more cleanup than required for other direct contact exposure pathways.

35 ▪ Avoiding, minimizing, or mitigating impacts to state-listed species and habitats
36 identified by the Commonwealth of Massachusetts. These areas are referred to as
37 “Core Areas” as designated by the Massachusetts Natural Heritage and Endangered
38 Species Program (see Attachment 4). Core 1 Areas would be remediated only if
39 necessary to achieve exposure area-specific concentrations corresponding to a
40 residual human health risk of 1×10^{-4} or an HI of 1, whichever is lower. Impacts to

1 Core 2 and Core 3 Areas would be minimized and/or mitigated on a case-by-case
2 basis.

- 3 ■ Remediation of vernal pools to achieve the ecological risk-based amphibian cleanup
4 level of 3.3 mg/kg, while considering avoidance of Core Areas, as discussed above.
5 This work will be implemented using an adaptive management framework based on
6 the results of pilot studies, beginning with a subset of vernal pools. Concurrently,
7 other means to reduce the bioavailability of PCBs in vernal pools will be investigated
8 and tested. Based on the outcome of the remediation of the initial set of vernal pools,
9 other investigations and pilot testing, the location of the vernal pools and associated
10 habitat, determinations will be made about how and where additional vernal pool
11 remediation will occur.
- 12 ■ Restoring the excavated floodplain areas, access roads, and staging areas.

13 Additional SED 9/FP 4 MOD Remedy Components

14 The SED 9/FP 4 MOD alternative would also include long-term monitoring, maintenance,
15 inspection, periodic reviews, and institutional controls (ICs).

16 **1.2 DIFFERENCES BETWEEN SED 9/FP 4 AND SED 9/FP 4 MOD**

17 As noted above, the SED 9/FP 4 MOD alternative was derived from the SED 9 and FP 4
18 alternatives as described and evaluated in the RCMS. In EPA's discussions with GE and the
19 States of Massachusetts and Connecticut following release of the RCMS, each of the area-
20 specific components of SED 9/FP 4 was examined and, where appropriate, refined. Although
21 much of SED 9/FP 4 was retained without modification in some reaches, changes were
22 incorporated for other reaches. A reach-wide summary comparison of the original SED 9/FP 4
23 components and the refined SED 9/FP 4 MOD components is discussed briefly below. In
24 addition, Attachment 6 summarizes how the estimated volumes were derived for each
25 component of SED 9/FP 4 MOD.

26 In developing Alternative SED 9 MOD, Alternative SED 9 was modified as follows:

27 In Reach 5A, from the confluence of the East Branch and West Branch of the Housatonic River
28 at Fred Garner Park in Pittsfield to the Pittsfield WWTP, the depth of sediment removal was
29 increased from 2.0 to 2.5 ft. This increase in the removal depth results in an increase from an
30 estimated 134,000 cubic yards (cy) to an estimated 168,000 cy in the volume of contaminated
31 sediment to be excavated and disposed of. This sediment removal depth was derived from an
32 estimate of the thickness of the Engineered Cap to be placed in this reach. Actual cap thickness
33 will be determined during the design and implementation of the remedy. The area of riverbank
34 in Reach 5A targeted for remediation was defined quantitatively as banks containing greater than
35 5 mg/kg tPCBs and with a moderate-high or greater Bank Erosion Hazard Index (BEHI) and

1 Near Bank Stress (NBS) rating¹. Actual bank removal amounts will be determined during the
2 design and implementation of the remedy. Based on the current data, this would result in the
3 excavation of approximately 25,000 cy of bank soil. In addition, as discussed above, there are
4 provisions for restoring the banks through a hierarchy of options and incorporating the concepts
5 of natural channel design into remediation and restoration activities.

6 In Reach 5B, SED 9 called for removing all bed sediment to a depth of 2 ft. Instead, SED 9
7 MOD provides that only sediment in areas that are determined, based on additional sampling, to
8 have PCB contamination in excess of 50 mg/kg will be removed to a depth of 1 ft. This change
9 is expected to reduce the volume of sediment from Reach 5B requiring disposal from an
10 estimated 88,000 cy to an estimated 500 cy. In lieu of sediment removal, the remainder of the
11 reach will be subject to Enhanced Monitored Natural Recovery (EMNR), using activated carbon
12 or a similar amendment. A pilot study will be performed to determine the most appropriate
13 amendment to reduce the mobilization and bioavailability of PCBs. Based on the results of that
14 study, an amendment will be placed throughout Reach 5B. In SED 9 MOD, riverbanks in Reach
15 5B will be remediated only if the PCB concentration exceeds 50 mg/kg. Actual bank removal
16 amounts will be determined during the design and implantation of the remedy. Based on current
17 data, this refinement will reduce the estimated amount of contaminated bank soil requiring
18 disposal from 10,000 cy to an estimated 500 cy.

19 In Reach 5C, the depth of sediment removal was retained at 2 feet over the upstream 20 acres as
20 specified in SED 9. The depth of excavation was increased from 1.5 feet to 2 feet for the
21 downstream 37 acres of this reach. The increased removal depth in the lower section of Reach
22 5C will result in an estimated total volume of contaminated sediment of 186,000 cy to be
23 removed in SED 9 MOD vs. the estimated 156,000 cy for SED 9. This sediment removal depth
24 was derived from an estimate of the thickness of the Engineered Cap to be placed in this reach.
25 Actual cap thickness will be determined during the design and implementation of the remedy.

26 Changes in backwaters were implemented primarily to afford protection to Core Area 1 habitats
27 that are important for the protection of state-listed species. Rather than remove (or, in deeper
28 areas, only cap) sediment from all backwater areas with sediment PCB concentrations in excess
29 of 1 mg/kg, as was required in SED 9, SED 9 MOD will not involve excavating sediment in Core
30 Area 1 habitats unless the concentration exceeds 50 mg/kg. In core habitats from which sediment
31 is not removed due to this exclusion, the use of activated carbon or another amendment to reduce
32 bioavailability of PCBs will be investigated. In addition, instead of excavating and capping in all
33 backwater areas outside of Core Area 1 with a discrete concentration of 1 mg/kg PCBs,
34 excavation and capping will be required only in areas where the average concentration of PCBs
35 in surface or subsurface sediment exceeds 1 mg/kg, and in areas with greater than 50 mg/kg in
36 surficial sediment. However, all areas with surficial sediment concentrations above 1 mg/kg will
37 require excavation. Also, GE's RCMS proposed capping areas with existing water depths of
38 4 feet or greater without excavating any sediment. Capping without excavating in backwaters
39 was deleted from SED 9 MOD. These changes reduce the total estimated sediment removal

¹ The BEHI, which defines bank characteristics, and the NBS, which is based on flow characteristics, are used in the "Bank Assessment for Non-point Source Consequences of Sediment" (BANCS) model developed by Dr. David Rosgen to predict stream bank erosion rates.

1 volume from 109,000 cy to 95,000 cy and reduce the area of excavation to an estimated 59 acres
2 of backwaters.

3 In Woods Pond (Reach 6), SED 9 specified the removal of sediment over the entire pond to a
4 depth of 1 foot in the deep hole (23 acres) and to 3.5 feet in shallower areas of the pond. In
5 SED 9 MOD, contaminated sediment will be removed over the entire area of the pond, but the
6 requirement will be to increase the minimum depth of water in the pond to 6 feet (except in
7 nearshore areas) after capping is completed. This modification in the remedy increased the
8 estimated volume of sediment to be removed from 244,000 cy to 285,000 cy. In addition,
9 following remediation, SED 9 MOD requires that PCB concentrations in accumulating pond
10 sediments be monitored. If EPA determines that significant concentrations and a significant
11 depth of PCB-contaminated sediment have accumulated above the Engineered Cap in Woods
12 Pond, these sediments will be removed.

13 For the impounded subreaches in Reach 7 and also for Rising Pond (Reach 8), SED 9 specifies
14 one option—the removal of contaminated sediment to a depth of 1 foot in low shear-stress areas
15 and 1.5 feet in high shear-stress areas. SED 9 MOD provides for three options:

- 16 ▪ Coordinating with entities that are undertaking dam removal and providing funding
17 for sampling and analysis, and assuming responsibility for the incremental costs
18 associated with the presence of PCBs.
- 19 ▪ Surficial sediment removal followed by capping in areas where either surface or
20 subsurface average concentrations exceed 1 mg/kg PCBs. In addition, sediment
21 excavation followed by capping in any area with surficial PCB contamination that
22 exceeds 50 mg/kg. This variation from SED 9 allows averaging of PCB
23 concentrations in the subreach/reach rather than requiring excavation and capping
24 throughout the subreach.
- 25 ▪ Surface and subsurface sediment removal to achieve 1 mg/kg PCBs in sediment,
26 without the requirement for subsequent capping.

27 Both alternatives specify MNR for the free-flowing subreaches of Reach 7, as well as for
28 Reaches 9 through 16.

29 In developing Alternative FP 4 MOD, Alternative FP 4 was modified as follows:

30 In the floodplain, FP 4 required removal of 1 foot of contaminated soil (3 feet in heavily used
31 sub-areas) to meet the excess cancer risk level of 1×10^{-5} or an HI =1, whichever is lower, based
32 on direct contact with floodplain soils and consumption of agricultural products from floodplain
33 soil; and additional soil removal to meet the upper-bound IMPGs for ecological receptors.

34 FP 4 MOD generally adopts the same risk-based cleanup requirements for protection of human
35 health, but would avoid Core Area 1 habitats unless necessary to achieve a risk level of 1×10^{-4} or
36 an HI=1, whichever is lower, and would evaluate the need for remediation in Core Areas 2 and 3
37 habitats on a case-by-case basis. No additional remediation is required to meet ecological
38 IMPGs, except for amphibians in vernal pools. FP 4 MOD specifies a multi-phased adaptive
39 management approach to the remediation of vernal pools, requiring cleanup to the lower-bound

1 amphibian IMPG of 3.3 mg/kg tPCBs but generally avoiding Core Area 1 habitats. Remediation
2 of vernal pools using traditional means (excavation and reconstruction), placement of activated
3 carbon, and at least one other method will be evaluated in an initial set of pools. Based on this
4 evaluation, and taking into consideration Core Area habitat, EPA will determine the preferred
5 method/approach for each subsequent vernal pool remediation. These refinements would reduce
6 the volume of excavated contaminated floodplain soil from an estimated 121,000 cy to an
7 estimated 75,000 cy and would reduce the area subject to remediation from 72 acres to an
8 estimated 45 acres.

9 **2 EVALUATION OF SEDIMENT/FLOODPLAIN ALTERNATIVES**

10 The seven combined alternatives for river sediment and floodplain soil that were described in
11 Section 8 of the GE RCMS, with the addition of SED 9/FP 4 MOD and a “no action alternative”
12 (SED 1/FP 1), were selected to represent the full range of potential approaches to address
13 contamination in the Rest of River. These alternatives were evaluated relative to each other
14 using the evaluation criteria specified in the Reissued Resource Conservation and Recovery Act
15 (RCRA) Permit for the GE-Pittsfield/Housatonic River Rest of River Site.

16 **2.1 OVERVIEW OF ALTERNATIVES**

17 The nine combined sediment and floodplain alternatives are described in this section. Although
18 not explicitly referenced in the comparison for each criterion, this section essentially includes an
19 evaluation of the “no action” combination alternative (SED 1/FP 1). SED 1/FP 1 is identical to
20 SED 2/FP 1 except that SED 2 calls for MNR of sediment in all reaches, thus requiring
21 monitoring and institutional controls in all reaches. Therefore, other than cost and references to
22 monitoring, SED 1/FP 1 performs the same as SED 2/FP 1.

23 The nine selected combinations are as follows (see Table 1):

- 24 ▪ SED 1/FP 1
- 25 ▪ SED 2/FP 1
- 26 ▪ SED 3/FP 3
- 27 ▪ SED 5/FP 4
- 28 ▪ SED 6/FP 4
- 29 ▪ SED 8/FP 7
- 30 ▪ SED 9/FP 8
- 31 ▪ SED 10/FP 9
- 32 ▪ SED 9 MOD/FP 4 MOD

33 The alternatives were compared using a variety of quantitative, semi-quantitative, and qualitative
34 metrics (see Attachment 7) so that the principal advantages and disadvantages of each alternative
35 were identified.

Table 1 Combination Alternatives Matrix

Combination Alternative	Reach 5A	Reach 5B	Reach 5 Eroddible Banks	Reach 5C	Reach 5 Backwaters	Reach 6 Woods Pond	Reach 7 Impoundments	Reach 7 Channel	Reach 8 Rising Pond	Reaches 9-16	Floodplain
1 (SED 1/FP 1)	No Action	No Action	No Action	No Action	No Action	No Action	No Action	No Action	No Action	No Action	No Action
2 (SED 2/FP 1)	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	No Action
3 (SED 3/FP 3)	2 ft removal with capping	MNR	Removal/stabilization	Combination of TLC and MNR	MNR	TLC	MNR	MNR	MNR	MNR	Remove/replace top 12 inches to 10-4 ICR or HI = 1; In frequently used areas remove/replace top 3 feet to 10-5; Additional floodplain excavation to achieve the less strict ecological risk-based IMPGs; Remove/replace vernal pool soils > 5.6 mg/kg
4 (SED 5/FP 4)	2 ft removal with capping	2 ft removal with capping	Removal/stabilization	Combination of 2 ft removal with capping (in shallow areas) and capping (in deeper areas)	Combination of TLC and MNR	Combination of 1.5 ft removal with capping in shallow areas and capping in deep area	MNR	MNR	TLC	MNR	Remove/replace top 12 inches to 10-5 ICR or HI = 1; In frequently used areas remove/replace top 3 feet to 10-5; Additional floodplain excavation to achieve the less strict ecological risk-based IMPGs; Remove/replace vernal pool soils > 5.6 mg/kg
5 (SED 6/FP 4)	2 ft removal with capping	2 ft removal with capping	Removal/stabilization	2 ft removal with capping	Removal of sediments in >50 mg/kg in top 1 ft (with capping/backfill); TLC for remainder > 1 mg/kg	Combination of 1.5 ft removal with capping in shallow areas and capping in deep area	TLC	MNR	Combination of TLC in shallow areas and capping in deep areas	MNR	Remove/replace top 12 inches to 10-5 ICR or HI = 1; In frequently used areas remove/replace top 3 feet to 10-5; Additional floodplain excavation to achieve the less strict ecological risk-based IMPGs; Remove/replace vernal pool soils > 5.6 mg/kg
6 (SED 8/FP 7)	Removal to 1 mg/kg depth horizon with backfill	Removal to 1 mg/kg depth horizon with backfill	Removal/stabilization	Removal to 1 mg/kg depth horizon with backfill	Removal to 1 mg/kg depth horizon with backfill	Removal to 1 mg/kg depth horizon with backfill	Removal to 1 mg/kg depth horizon with backfill	MNR	Removal to 1 mg/kg depth horizon with backfill	MNR	Remove/replace top 12 inches to 10-6 ICR but not <2 ppm; In frequently used areas remove/replace top 3 feet to 10-6; Additional floodplain excavation to achieve the more strict ecological risk-based IMPGs; Remove/replace vernal pool soils > 3.3 mg/kg
7 (SED 9/FP 8)	2 ft removal with capping	2 ft removal with capping	Removal/stabilization	2 ft removal with capping in upper reach and 1.5 ft capping in lower reach	Combination of sediment removal with capping and capping without removal	3.5 ft removal and capping in shallow areas and 1 ft removal and capping in deep areas	Removal depths of 1 to 1.5 ft with capping	MNR	Removal depths from 1 to 1.5 ft with capping	MNR	Remove/replace top 12 inches to 10-5 ICR or HI = 1; In frequently used areas remove/replace top 3 feet to 10-5; Remove/replace vernal pool soils > 3.3 mg/kg; Remove/replace any additional soils in top 12 inches > 50 mg/kg
8 (SED 10/FP 9)	2 ft removal capping in selected areas	MNR	Removal/stabilization in selected areas	MNR	MNR	Removal of 2.5 ft in areas > 13 mg/kg in top 6 inches	MNR	MNR	MNR	MNR	Remove/replace top 12 inches to 10-4 ICR or HI = 1; In frequently used areas remove/replace top 3 feet to 10-4
9 (SED 9/FP 4 MOD)	2.5 ft removal and capping	Removal and backfill of areas > 50 mg/kg and EMNR in remainder of reach	Removal/stabilization of erodible river banks in Reach 5A and banks in reach 5B w/PCBs > 50mg/kg	2 ft removal with capping	Combination of 1 ft removal and capping in areas > 1 mg/kg, excluding certain high priority habitat	Combination of removal with capping ranging from 4 to 7 ft of removal based on water depth	Coordinate w/ dam removal; Removal depths of 1 to 1.5 ft with capping, or cleanup to 1 mg/kg	MNR	Removal depths of 1 to 1.5 ft with capping or cleanup to 1 mg/kg	MNR	Remove/replace top 12 inches to 10-5 ICR or HI = 1; Except in high priority habitat areas, then remove/replace top 12 inches to 10-4 ICR or HI = 1; In frequently used areas remove/replace top 3 feet to 10-5; Remove/replace vernal pool soils > 3.3 mg/kg

Note: Sediment removal depths specified in this table are approximate and are for volume/cost estimation and for comparison purposes only. Actual removal depths would be determined in accordance with the Modification of the Reissued RCRA Permit.

MNR – Monitored Natural Recovery
EMNR – Enhanced Monitored Natural Recovery

ICR – Incremental Cancer Risk
IMPGs – Interim Media Protection Goals

TLC – Thin-Layer Capping

1 The SED 9/FP 4 MOD alternative was modeled in 2012, and the model-derived metrics
2 summarizing the performance of this alternative are presented in Attachment 7. Subsequent
3 refinements to the SED 9/FP 4 MOD alternative resulting from meetings with GE and the co-
4 regulators, as discussed in Section 1, are relatively minor for modeling purposes, and it was not
5 necessary to generate new metrics. Accordingly, the metrics for the refined SED 9/FP 4 MOD
6 alternative are unchanged from the original SED 9/FP 4 MOD. A refined cost estimate was
7 generated for SED 9/FP 4 MOD (Attachment 8).

8 The criteria for evaluation of remedial alternatives for the Rest of River are specified in Part II,
9 Section G, of the Reissued RCRA Permit for the GE-Pittsfield/Housatonic River Site (Appendix
10 G to the Consent Decree) and are similar, but not identical to, evaluation criteria delineated in the
11 National Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Section
12 300.430(e)(9)(iii). The nine evaluation criteria include three general standards, and six selection
13 decision factors:

- 14 ▪ General standards:
 - 15 – Overall protection of human health and the environment.
 - 16 – Control of sources of releases.
 - 17 – Compliance with federal and state applicable or relevant and appropriate
18 requirements (ARARs).
- 19 ▪ Selection decision factors:
 - 20 – Long-term reliability and effectiveness.
 - 21 – Attainment of Interim Media Protection Goals (IMPGs).
 - 22 – Reduction of toxicity, mobility, or volume (TMV) of wastes.
 - 23 – Short-term effectiveness.
 - 24 – Implementability.
 - 25 – Cost.

26 Each of these nine criteria is evaluated with respect to the degree to which it is achieved by the
27 eight selected combinations of SED and FP alternatives in Sections 2.2 through 2.10. Although
28 an individual analysis of SED 9/FP 4 MOD against the nine criteria is not provided in this
29 document, the analysis below sufficiently analyzes how this alternative meets the criteria while
30 also comparing it to the eight other combination alternatives.

31 An overview and a comparative analysis of treatment/disposition alternatives are presented in
32 Section 3. The nine criteria for the treatment/disposal alternative analysis are the same as
33 described above for the SED and FP alternatives.

34 **2.2 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT**

35 The evaluation of whether a particular remedial alternative would provide overall human health
36 and environmental protection relies heavily on the evaluations under several other permit
37 criteria, including but not limited to the following: (1) attainment of IMPGs, (2) compliance with
38 ARARs, (3) long-term reliability and effectiveness, and (4) short-term effectiveness. A

1 summary of the comparative evaluation of the alternatives considering these factors is presented
2 below.

3 SED 2/FP 1 (MNR in all reaches of the river and no action in the floodplain) is the least
4 protective alternative, relying on natural recovery processes to achieve reductions in PCB
5 concentrations in sediment, surface water, and fish tissue, and a reduction in PCB loading to the
6 river and PCB transport to the floodplain. Given the persistence and unsafe concentrations of
7 PCBs in floodplain soil, riverbanks, sediment, and biota in many reaches of the river, and the
8 continuing input and downstream transport of PCBs from eroding banks and channel incision
9 into the floodplain, this alternative is not protective.

10 The other alternatives would result in reductions in PCB concentrations and potential exposures
11 by permanently removing PCB-contaminated sediment, removing and stabilizing riverbank soil,
12 capping certain areas of the river, and removing PCB-contaminated floodplain soil. These
13 alternatives offer varying degrees of protection and short-term disturbance and include MNR and
14 ICs for the flowing subreaches in Reach 7 and in Reaches 9 through 16.

15 SED 10/FP 9 includes selective removal of some sediment in Reach 5A and some bank
16 stabilization, and limited floodplain soil removal. These actions would result in some reduction
17 in the mass of PCBs transported through the system and a marginal improvement in fish tissue
18 PCB concentrations. In the floodplain, the soil removal would result in reasonable maximum
19 exposure (RME) human health risks below an HI of 1 and a 1×10^{-4} cancer risk. Some ecological
20 IMPGs would be achieved in some areas of the floodplain and river. This alternative has limited
21 short-term impacts but is questionable in its long-term effectiveness.

22 SED 3/FP 3 includes remediation of all of Reach 5A, but relies on MNR and ICs in Reach 5B, a
23 portion of Reaches 5C, 5D, and Reach 7 impoundments, and on thin-layer capping in a portion
24 of Reach 5C and in Reach 6. This alternative offers a marginal reduction in the PCB mass
25 transported through the system and in fish tissue concentrations when compared to SED 10/FP 9,
26 and achieves the RME 1×10^{-6} risk for one sediment exposure area (EA). The upper-bound
27 ecological IMPGs are achieved. Human health risks for direct contact in the floodplain are
28 below an HI of 1 and achieve 1×10^{-4} for the RME individual. In addition, the RME 1×10^{-5} risk
29 level is achieved in the frequently used subareas. This alternative also has limited short-term
30 impacts but uncertain long-term effectiveness.

31 The remaining alternatives, SED 5/FP 4, SED 6/FP 4, SED 8/FP 7, SED 9/FP 8, and SED 9/FP 4
32 MOD, include various remediation techniques and amounts of removal and capping.
33 SED 5/FP 4 and SED 6/FP 4 include some components of thin-layer capping and capping
34 without removal. Capping without removal will impact the bathymetry and hydrodynamics of
35 the river. Thin-layer capping is not a suitable technology considering the mass and high
36 concentrations of PCBs in the sediment and is not expected to result in significant long-lasting
37 benefits in the reaches for which it is considered. Model predictions for the annual mass of
38 PCBs transported through the system are similar for all of these alternatives, as are the predicted
39 fish tissue concentrations. Although SED 8/FP 7 removes the majority of the PCBs from the
40 river and a significant amount of PCBs from the floodplain, it is projected to take approximately
41 50 years to implement, thus the improvements are not realized as rapidly as with the other
42 alternatives.

1 For the floodplain, these alternatives would involve removal of progressively more PCB-
2 contaminated soil, in increasing order of removal: SED 9/FP 4 MOD, SED 5/FP 4, SED 6/FP 4,
3 SED 9/FP 8, and finally, SED 8/FP 7. Consequently, there would be progressively greater
4 reduction in exposure and risk to human health and ecological receptors, yet with associated
5 increasing impacts to floodplain habitat and potential adverse impacts to habitat supporting state-
6 listed species. The floodplain component of SED 9/FP 4 MOD was developed specifically with
7 these adverse impacts in mind and represents a balance between reducing risks to humans and
8 ecological receptors and impacts to Core Area habitats. This alternative will achieve a human
9 health direct contact level of 1×10^{-5} or an HI of 1 in many areas, yet avoids conducting
10 remediation in Core Area 1 habitats unless necessary to achieve an HI of 1 non-cancer or 1×10^{-4}
11 cancer risk level.

12 To evaluate the PCB concentrations in fish tissue and resulting human health risks due to
13 consumption of fish, computer modeling was used to predict fish tissue concentrations during
14 and following the implementation of each alternative. The boundary conditions used for this
15 model framework reflect the cleanup that has been completed in the upstream reaches (see
16 Attachment 9). The output from the model is included in Attachment 10. As noted above, the
17 model results shown for SED 9/FP 4 MOD reflect the August 2012 specifications for this
18 alternative; the refinements made subsequently were minor and would not result in any
19 meaningful differences in the resulting fish tissue concentrations for this alternative.

20 These modeling results indicate that fish tissue PCB concentrations predicted to result from all
21 remedial alternatives at the end of the model simulation period (52 to ~80 years) would not
22 achieve the RME IMPGs in all reaches (Table 2). As a result, under all alternatives, ICs
23 (including but not limited to fish consumption advisories) would likely be needed for a period of
24 time following remediation to provide human health protection from fish consumption.
25 However, a number of alternatives do achieve other less stringent IMPGs, and there are
26 differences among the alternatives in the time necessary to achieve various risk levels. For
27 example, as indicated in the far right column of Table 2, Page 2, for the CTE (central tendency or
28 average) individual, the probabilistic risk model shows some alternatives achieving an HI of 1
29 within the 52-year modeling period in all reaches. Fate and transport modeling indicates that
30 SED 9/FP 4 MOD achieves this IMPG in all reaches except 5B, in most cases more rapidly than
31 all other alternatives except SED 9/FP 8. The modeling does not simulate the effect of the
32 placement of activated carbon in Reach 5B.

33 The performance of the alternatives for all risk levels is shown in Attachment 10. For many of
34 the alternatives shown in the figures in Attachment 10, upon completion of the remediation, the
35 trajectories shown in the plots converge at a particular concentration (which varies by reach) and
36 then indicate a very slight additional decrease over time. This behavior is primarily driven by
37 the non-zero PCB boundary conditions specified in the model (see Attachment 9) and, therefore,
38 is uncertain. If the boundary PCB loads are less than were assumed, the fish tissue
39 concentrations would decline more than the model predictions before leveling off; however, if
40 the boundary PCB loads are greater than assumed, the point of convergence would be at a higher
41 tissue concentration.

1 Estimates from the Connecticut one-dimensional (1-D) analysis indicate that the RME 1×10^{-5} /
2 HI = 1 deterministic IMPGs for fish consumption are not achieved in any of the four
3 impoundments modeled in Connecticut under SED 2/FP 1 (MNR) or SED 10/FP 9 (SED 10/FP 9
4 achieves the adult non-cancer IMPG only in two of the impoundments). All other alternatives
5 achieve these IMPGs in all or most of the Connecticut impoundments by the end of the modeling
6 period (see Table 2). Notwithstanding, the State of Connecticut has calculated more stringent
7 criteria for unlimited fish consumption that may not be met in any of these impoundments at the
8 end of the modeling period.

9 In addition, alternatives SED 2/FP 1 and SED 10/FP 9 would not meet federal and state water
10 quality criteria for freshwater aquatic life and therefore would not be protective of the
11 environment; however, the other alternatives do meet these criteria in all reaches by the end of
12 the modeling period. None of the alternatives analyzed would achieve the federal and state water
13 quality criteria for human consumption of organisms in any of the Massachusetts reaches.
14 SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9 would not achieve these criteria in any Connecticut
15 impoundments, although the results for Connecticut have a high degree of uncertainty due to the
16 empirical semi-quantitative nature of the model used to predict the water column PCB
17 concentrations following remediation. Acknowledging that uncertainty, however, the analysis
18 does show that SED 5/FP 4, SED 6/FP 4, SED 8/FP 7, SED 9/FP 8, and SED 9/FP 4 MOD
19 would restore water quality consistent with the criteria in significant segments of the river in
20 Connecticut.

21 All alternatives rely to varying degrees on ICs throughout the river in both Massachusetts and
22 Connecticut to be protective of human health in the long term. Those alternatives that rely more
23 extensively on these controls (SED 2/FP 1 and SED 10/FP 9) over longer timeframes and larger
24 areas have more uncertainty that they will protect human health in the long term, and such
25 controls provide no protection for ecological risks. Those alternatives that rely on these controls
26 over shorter timeframes or smaller areas (SED 8/FP 7, SED 9/FP 8, and SED 9/FP 4 MOD) have
27 higher overall protection of human health.

28 In summary, the standard of overall protection of human health and the environment requires a
29 balancing of the short-term and long-term adverse impacts of the alternatives with the benefits
30 achieved by each alternative. Restoration of the riverbed, riverbanks, and floodplain can be
31 achieved and maintained (see Attachments 11 and 12); therefore, the short-term impacts to the
32 environment can be successfully mitigated. Among the alternatives evaluated in this
33 comparative analysis, SED 9/FP 4 MOD was judged to provide the best overall protection of
34 human health and the environment because it achieves this important balance between both
35 short- and long-term risks and long-term benefits.

36 **2.3 CONTROL OF SOURCES OF RELEASES**

37 The extent to which each of the alternatives reduces or minimizes further PCB releases was
38 evaluated. This evaluation is driven by a comparison of the sediment and riverbank components
39 of the sediment-floodplain alternatives because the floodplain soil is not a significant source of
40 PCB releases to the river, except in the situation of the river channel relocating into contaminated
41 floodplain.

1 **2.3.1 Mass of PCBs Transported Downstream**

2 The model simulation predicts that, in 52 years, the reductions from upstream source control and
 3 other upstream and facility remediation, along with natural recovery processes within the Rest of
 4 River (as reflected in SED 2), would result in reductions of 37% and 41% in the annual mass of
 5 PCBs passing Woods Pond and Rising Pond Dams, respectively, and a reduction of 50% in the
 6 annual mass of PCBs transported from the river to the floodplain in Reaches 5 and 6.²

7 The reductions relative to current conditions in the annual PCB mass transported within the river
 8 (as represented by the predicted PCB mass passing Woods Pond and Rising Pond Dams) and to
 9 the floodplain within Reaches 5 and 6 at the end of the model projection period for the various
 10 alternatives are summarized in Table 3.

11 **Table 3 Percent Reduction in Annual PCB Mass Passing Woods Pond and**
 12 **Rising Pond Dams and Transported to the Reach 5/6 Floodplain for Alternatives**
 13 **(relative to current conditions) and Solids Trapping Efficiency for Woods Pond**

Location	SED 2/ FP 1	SED 3/ FP 3	SED 5/ FP 4	SED 6/ FP 4	SED 8/ FP 7	SED 9/ FP 8	SED 10/ FP 9	SED 9/ FP 4 MOD
Woods Pond Dam	37%	94%	97%	97%	98%	97%	62%	89%
Rising Pond Dam	41%	87%	93%	95%	96%	96%	62%	89%
Reach 5/6 Floodplain	50%	97%	98%	98%	99%	98%	68%	92%
Solids Trapping Efficiency in Woods Pond	15%	13%	15%	15%	15%	26%	24%	30%

14 The model results show that, relative to current conditions, the decrease in the mass of PCBs
 15 passing Woods Pond and Rising Pond Dams, respectively, ranges from 37% and 41% for SED 2
 16 to 98% and 96% for SED 8. All alternatives that include some active remediation would achieve
 17 a decrease of at least 87% for all three compliance points, except for SED 10, which provides for
 18 PCB mass reductions in the 60 to 70% range.

20 Reduction in PCB mass transport in the river and transport to the floodplain is directly related to
 21 the amount of PCB-contaminated sediment that is removed and/or capped and the extent to
 22 which erosion from contaminated banks is decreased for each alternative. Accordingly,
 23 SED 2/FP 1 and SED 10/FP 9 do the least to control continuing releases. Although SED 8/FP 7
 24 and SED 9/FP 8 do the most to control releases, SED 3/FP 3, SED 5/FP 4, SED 6/FP 4, and
 25 SED 9/FP 4 MOD also provide significant control of releases.

26 PCBs are attached to solids that move through the river system. Therefore, trapping of solids in
 27 Woods Pond is a mechanism to reduce downstream migration of PCBs. SED 9/FP 8,
 28 SED 9/FP 4 MOD, and SED 10/FP 9 nearly double the solids trapping efficiency of Woods Pond
 29 when compared to the other alternatives. These three alternatives also control sources of releases
 30 by removing a significant mass of PCBs from behind Woods Pond Dam. In the event of a

² The initial (i.e., current) annual PCB mass values used in the model are 20 kilograms per year (kg/yr) passing Woods Pond Dam, 19 kg/yr passing Rising Pond Dam, and 12 kg/yr transported from the river to the floodplain in Reaches 5 and 6.

1 serious breach or failure of the dam, the release of PCBs downstream would be less for these
2 alternatives than for the other alternatives that rely primarily on capping or MNR.

3 **2.3.2 Releases Due to Extreme Flood Event**

4 The different alternatives are expected to have different responses in an extreme flood event.
5 SED 2/FP 1, which includes no active remediation, will result in the same amount of PCB-
6 contaminated sediment and soil from eroding banks being released and mobilized downstream as
7 would be the case under current conditions. SED 10/FP 9 is expected to result in similar, but
8 slightly less, downstream transport because it specifies the remediation of only a small area in
9 Reach 5A and the residual PCB-contaminated sediment in Woods Pond is not capped.

10 SED 3/FP 3 will result in slightly less transport than the previous alternatives; however, the use
11 of a thin-layer cap in Reach 5C and Woods Pond, and MNR in Reach 5B, the backwaters, and
12 Reach 7 impoundments is not expected to adequately control sources of releases in an extreme
13 event. Alternatives SED 5/FP 4 and SED 6/FP 4 are expected to provide adequate protection in
14 an extreme event in Reaches 5 and 6, but the use of thin-layer capping and backfill in the
15 downstream reaches provides a high level of uncertainty in performance. Alternatives
16 SED 8/FP 7 and SED 9/FP 8 are expected to provide the highest level of protection of all the
17 alternatives because they include the greatest amount of remediation and engineering controls.
18 SED 9/FP 4 MOD is expected to provide adequate protection in an extreme flood event in all
19 reaches, with the exception of Reach 5B, from which PCB-contaminated bed sediment and bank
20 soil may erode and be transported downstream. However, the areas of the highest concentrations
21 in Reach 5B will be removed, and the remaining concentrations are low enough that the impacts
22 are not expected to be unacceptable.

23 To assess the extent to which the sediment components of these alternatives would mitigate the
24 potential effects of an extreme high-flow event that could cause buried sediment (deeper than the
25 15-centimeter (cm) zone of biogenic reworking) to be exposed, model predictions of erosion and
26 reach-average PCB concentrations in surface sediment following an extreme high-flow event
27 were compared. Although the model simulation predicts varying responses to high-flow events,
28 including the extreme event (50- to 100-year flood) simulated in Year 26 of the projection, the
29 results generally show that buried sediment containing PCBs would not be exposed to any
30 significant extent during high-flow events under any remediation alternative. However, this
31 conclusion has some uncertainty because survey transects, Acoustic Doppler Current Profiler
32 measurements, and deep sediment cores collected in the river indicate that high-flow events have
33 the potential to remobilize the sediment column to considerable depths that are not reflected in
34 the two-dimensional averaged model grid cells. Therefore, the alternatives that include thin-
35 layer capping or backfill are not likely to perform as well as the model predicts. Although thin-
36 layer capping has been used successfully at other sites, site-specific conditions (e.g., higher PCB
37 contamination levels and high river flows), have raised concerns about its suitability in Rest of
38 River.

39 **2.3.3 Releases Due to River Channel Meandering**

40 The projected releases for SED2/FP 1 and SED 10/FP 9 have greater uncertainty because the
41 model does not simulate changes in the planform of the river channel, which could result in large

1 contributions of soil (and associated PCBs) from erosion into the floodplain over time. The
2 results for the remaining alternatives are less uncertain than those associated with SED 2/FP 1
3 and SED 10/FP 9 because they include bank stabilization and operation, maintenance, and
4 monitoring (OMM), both of which reduce the potential for large contributions of soil (and
5 associated PCBs) from the banks and floodplain. SED 9/FP 4 MOD addresses all eroding
6 contaminated banks in Reach 5A and targets only banks in Reach 5B that have PCB
7 concentrations exceeding 50 mg/kg and specifies bioengineering techniques wherever possible.

8 **2.3.4 Releases During Implementation**

9 There are differences among the alternatives in terms of the potential for releases during
10 implementation, including both resuspension-related releases during sediment removal as well as
11 potential releases from open excavations in the floodplain during an extreme weather event.
12 Although engineering controls and/or best management practices (BMPs) would be applied to
13 minimize such releases, they could not entirely prevent such releases. The potential for such
14 short-term releases would be a function of the duration of the remedy and the overall extent of
15 open excavation/dredging areas. For alternatives involving active remediation, durations range
16 from 5 to 52 years and areas of excavation and dredging range from 76 acres to over 700 acres.
17 The effects of such releases are reflected in the model output.

18 **2.4 COMPLIANCE WITH FEDERAL AND STATE ARARs**

19 A summary of some of the more significant chemical-, location-, and action-specific ARARs
20 applicable to the range of alternatives considered in this comparative analysis is presented in this
21 section. A chart summarizing the determination of ARARs for SED 9/FP 4 MOD is provided in
22 Attachment 13. Charts summarizing ARARs for other alternatives can be found in the RCMS.

23 **2.4.1 Chemical-Specific ARARs**

24 Chemical-specific ARARs include federal and state water quality criteria for PCBs (such as
25 NRWQCs). These criteria consist of freshwater aquatic life and human health criteria (based on
26 consumption of water and/or organisms).

27 Alternatives SED 2/FP 1 and SED 10/FP 9 would not achieve the federal and state water quality
28 criteria for freshwater aquatic life in Massachusetts (but would in Connecticut). All other
29 alternatives would achieve these criteria in all reaches of the river.

30 None of the alternatives would achieve the federal and state water quality criteria for
31 consumption of organisms in any of the Massachusetts reaches, and the model indicates that the
32 alternatives may not meet the criteria in all Connecticut reaches. However, alternatives
33 SED 5/FP 4, SED 6/FP 4, SED 8/FP 7, SED 9/FP 8, and SED 9/FP 4 MOD would likely restore
34 water quality in significant segments of the river (greater than 50% of the impoundments) in
35 Connecticut.

36 **2.4.2 Location-Specific ARARs**

37 All alternatives that include active remediation would involve temporary disturbance of wetlands
38 and a discharge of dredged or fill material into waters of the state and/or the United States.

1 SED 9/ FP 4 MOD is the least damaging practicable alternative; it uses a less intrusive method of
2 sediment remediation and balances the extent of remediation with avoidance, minimization, and
3 mitigation in locations designated by the Commonwealth of Massachusetts as sensitive areas, as
4 discussed below. See also EPA’s Clean Water Act Section 404 Wetlands and Floodplain
5 Analysis (Attachment 14).

6 The Massachusetts Endangered Species Act (MESA) is applicable to all alternatives except
7 SED 2/FP 1. MESA and its regulations were promulgated to protect state-listed species and their
8 habitats. Unacceptable levels of PCBs are present in such habitat areas in the Rest of River.
9 During the implementation of the preferred alternative, the removal of PCBs from the Rest of
10 River is anticipated to provide a benefit to state-listed species inhabiting the area due to the
11 reduction in adverse effects to ecological receptors. In overseeing the response actions, EPA, in
12 coordination with the Massachusetts Department of Fish and Game/Division of Fisheries and
13 Wildlife (DFW), consistent with the requirements of MESA (Massachusetts General Laws
14 (MGL) c. 131A) and its implementing regulations (321 Code of Massachusetts Regulations
15 (CMR) 10.00; MESA), will guide efforts to avoid, minimize, and mitigate impacts to state-listed
16 species.

17 Although a final MESA evaluation will not be completed until the remedy design phase, by
18 focusing on the Core Areas (Attachment 4), EPA and the Commonwealth believe that a
19 framework has been established to achieve MESA standards of assessing alternatives to both
20 temporary and permanent impacts to state-listed species, and of limiting the impact to an
21 insignificant portion of the local populations of affected species (see 321 CMR 10.23). For
22 example, the parties focused on avoidance of some of the most important and sensitive rare
23 species habitats in Core Area 1. Similarly, in Core Areas 2 and 3, minimization and mitigation
24 efforts will be employed, including careful consideration of PCB remediation methods, the
25 sequence and timing of remediation activities, and after-the-fact habitat mitigation. These
26 approaches will assist in achieving the substantive requirements of MESA.

27 Although the Core Areas play an important role in guiding avoidance and minimization of
28 impacts to state-listed species, in some cases the “take” of state-listed species may be
29 unavoidable. In those cases, consistent with MESA’s status as a location-specific ARAR, EPA
30 will work with the Commonwealth to minimize impacts and to ensure that an adequate long-term
31 net-benefit mitigation plan for the affected state-listed species is designed and implemented, as
32 required by 321 CMR 10.23(2)(c).

33 **2.4.3 Action-Specific ARARs**

34 All alternatives meet action-specific ARARs; therefore, this criterion does not provide a basis for
35 distinguishing among the alternatives.

36 **2.5 LONG-TERM RELIABILITY AND EFFECTIVENESS**

37 The assessment of long-term reliability and effectiveness for the alternatives included an
38 evaluation of the magnitude of residual risk, the adequacy and reliability of the alternatives, and
39 the potential long-term impacts on human health or the environment.

1 **2.5.1 Magnitude of Residual Risk**

2 The magnitude of residual risk for each of the alternatives is evaluated in this section considering
3 the individual sediment and floodplain components separately, primarily because residual risks
4 differ between the in-river and floodplain environments.

5 **2.5.1.1 Potential Residual Risks Associated with River Sediment, Water, and Fish**

6 SED 2/FP 1 would rely on natural processes to reduce PCB concentrations and would include
7 monitoring the effectiveness of these processes. Implementation of the sediment component of
8 the other alternatives would further reduce the potential for exposure to PCBs for humans and
9 ecological receptors through various combinations of removal, capping, thin-layer capping,
10 and/or natural recovery processes. The Housatonic River models were used to predict the extent
11 to which each sediment alternative would reduce PCBs in surficial sediment, surface water, and
12 fish tissue. For purposes of comparison, fish tissue PCB concentrations are presented here
13 because fish tissue concentrations integrate the effects of changes in surface sediment and water
14 column concentrations and, therefore, are representative of the relative effectiveness of each
15 alternative in reducing the potential for PCB exposure. Figures 2 and 3 in Attachment 7 show
16 the residual surface sediment concentrations and surface water concentrations.

17 Table 4 presents the subreach-average largemouth bass fillet³ PCB concentrations at the start of
18 the model projection period and at the end of the projection period⁴, and shows the percent
19 reduction in tissue PCB concentrations for each of the alternatives. These results are also
20 presented graphically for Reaches 5 through 8 and for the Connecticut impoundments in
21 Attachment 10.

22 Based on these comparisons, SED 2/FP 1 and SED 10/FP 9 provide the least long-term
23 reductions in fish PCB concentrations. All of the remaining alternatives produce a reduction of
24 approximately 99% in Reach 5A. For the other reaches, SED 3/FP 3 results in markedly less
25 reduction in comparison to the more active alternatives (SED 5/FP 4 through SED 9/FP 4 MOD),
26 which are effective in achieving large reductions in fish tissue PCB concentrations over all
27 reaches of the river. The sole exception is Reach 5B for the SED 9/FP 4 MOD alternative. This
28 alternative would reduce the bioavailability of PCBs in the sediment with an amendment such as
29 activated carbon. The Housatonic River model, upon which these results are based, is not able to
30 simulate this process and therefore, fish tissue concentrations are likely overestimated in Reach
31 5B. The resulting reduction in concentrations from the amendment is expected to be greater than
32 model predictions, although the extent of these reductions cannot be quantified.

33 Although some level of fish consumption advisory would need to be maintained at the
34 conclusion of remediation for many of the alternatives, an additional measure of long-term
35 reliability and effectiveness that can be used to distinguish among the alternatives is the time
36 required to achieve a certain IMPG.

³ The fillet concentrations are derived by dividing the whole-body tissue concentrations output from the food-chain model by a factor of 5.

⁴ The simulation period is 52 years for all alternatives except SED 8/FP 7, which is 81 years due to the longer construction time for SED 8/FP 7 and the requirement for 30-year projections post-remediation.

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Table 4 Modeled Subreach Average Fish (Fillet) PCB Concentrations at End of Project Modeling Period and Percent Reductions for Alternatives

Reach	Initial Conc.	SED 2/ FP 1	SED 3/ FP 3	SED 5/ FP 4	SED 6/ FP 4	SED 8/ FP 7	SED 9/ FP 8	SED 10/ FP 9	SED 9/ FP 4 MOD
Fish PCB Concentration (mg/kg wet weight)									
Reach 5A	18	7.3	0.3	0.3	0.3	0.2	0.3	4.2	0.3
Reach 5B	17	9.3	3.0	0.2	0.2	0.2	0.3	6.6	3.5
Reach 5C	14	7.4	1.8	0.2	0.2	0.1	0.2	5.8	0.8
Reach 5D (Backwaters)	22	9.5	6.3	0.4	0.4	0.3	0.4	11	1.1
Reach 6	15	8.6	0.7	0.2	0.2	0.1	0.2	3.7	0.7
Reach 7	6.4 - 13	2.8 - 6.4	0.7 - 2.1	0.4 - 1.6	0.2 - 0.7	0.1 - 0.6	0.2 - 0.7	1.9 - 4.4	0.4 - 1.4
Reach 8	6.3	3.6	1.6	0.3	0.2	0.2	0.2	2.7	0.4
Connecticut (Bulls Bridge Dam Impoundment)	0.4	0.2	0.04	0.01	0.009	0.007	0.009	0.1	0.02
Percent Reduction in Fish PCB Concentration Relative to Initial Conditions									
Reach 5A		60%	99%	99%	99%	99%	98%	77%	99%
Reach 5B		47%	83%	99%	99%	99%	98%	62%	80%
Reach 5C		48%	87%	99%	99%	99%	99%	59%	94%
Reach 5D (Backwaters)		57%	72%	98%	98%	99%	98%	51%	95%
Reach 6		44%	95%	99%	99%	99%	99%	76%	95%
Reach 7		45 - 63%	80 - 91%	84 - 97%	94 - 98%	94 - 99%	93 - 98%	59 - 75%	86 - 95%
Reach 8		43%	75%	95%	97%	97%	96%	57%	94%
Connecticut (Bulls Bridge Dam Impoundment)		60%	91%	97%	98%	98%	98%	73%	95%
Percent Reduction in Fish PCB Concentration Relative to SED 2 (MNR)									
Reach 5A			96%	96%	96%	97%	96%	42%	96%
Reach 5B			68%	98%	98%	98%	97%	29%	61%
Reach 5C			76%	97%	97%	99%	97%	22%	89%
Reach 5D (Backwaters)			34%	96%	96%	97%	96%	-16%	89%
Reach 6			92%	98%	98%	99%	98%	57%	91%
Reach 7			67 - 75%	75 - 86%	89 - 93%	91 - 96%	89 - 93%	31 - 32%	75 - 88%
Reach 8			56%	92%	94%	94%	94%	25%	87%
Connecticut (Bulls Bridge Dam Impoundment)			80%	95%	96%	97%	96%	50%	81%

Notes:

1. PCB concentrations shown (except for the initial concentrations) represent subreach-average values predicted by EPA's model at the end of the model projection period (52 years for SEDs 2, 3, 5, 6, 9, and 10, and 81 years for SED 8).
2. For SED 9/FP 4 MOD, the Reach 5B PCB concentrations do not factor in the use of an amendment, such as activated carbon. The use of this amendment is expected to reduce fillet PCB concentrations to less than the 3.5 mg/kg predicted by the modeling; the modeling does not factor in the effects of the amendment.
3. Values shown as ranges in Reach 7 represent the range of modeled PCB concentrations at the end of the projection within each of the Reach 7 subreaches.
4. The results from the Connecticut model are very uncertain due to the empirical, semi-quantitative nature of the analysis.
5. Percent reduction represents the change in annual average PCB concentrations predicted by EPA's model between the beginning and the end of the projection period.
6. Reach 7 reductions were calculated separately by subreach. Individual subreach initial and SED 2 concentrations were not provided by GE in the CMS, so reductions shown for SED 9/FP 4 MOD were calculated from EPA model results.

1 Plots of fish tissue concentrations by reach in Attachment 10 (average fillet PCB concentrations)
2 show that although SED 10/FP 9 would have the shortest implementation schedule and would
3 achieve some reductions quickly relative to other removal alternatives, SED 9/FP 8 has improved
4 performance relative to all other alternatives, balancing the magnitude of the reductions with the
5 time required to achieve them.

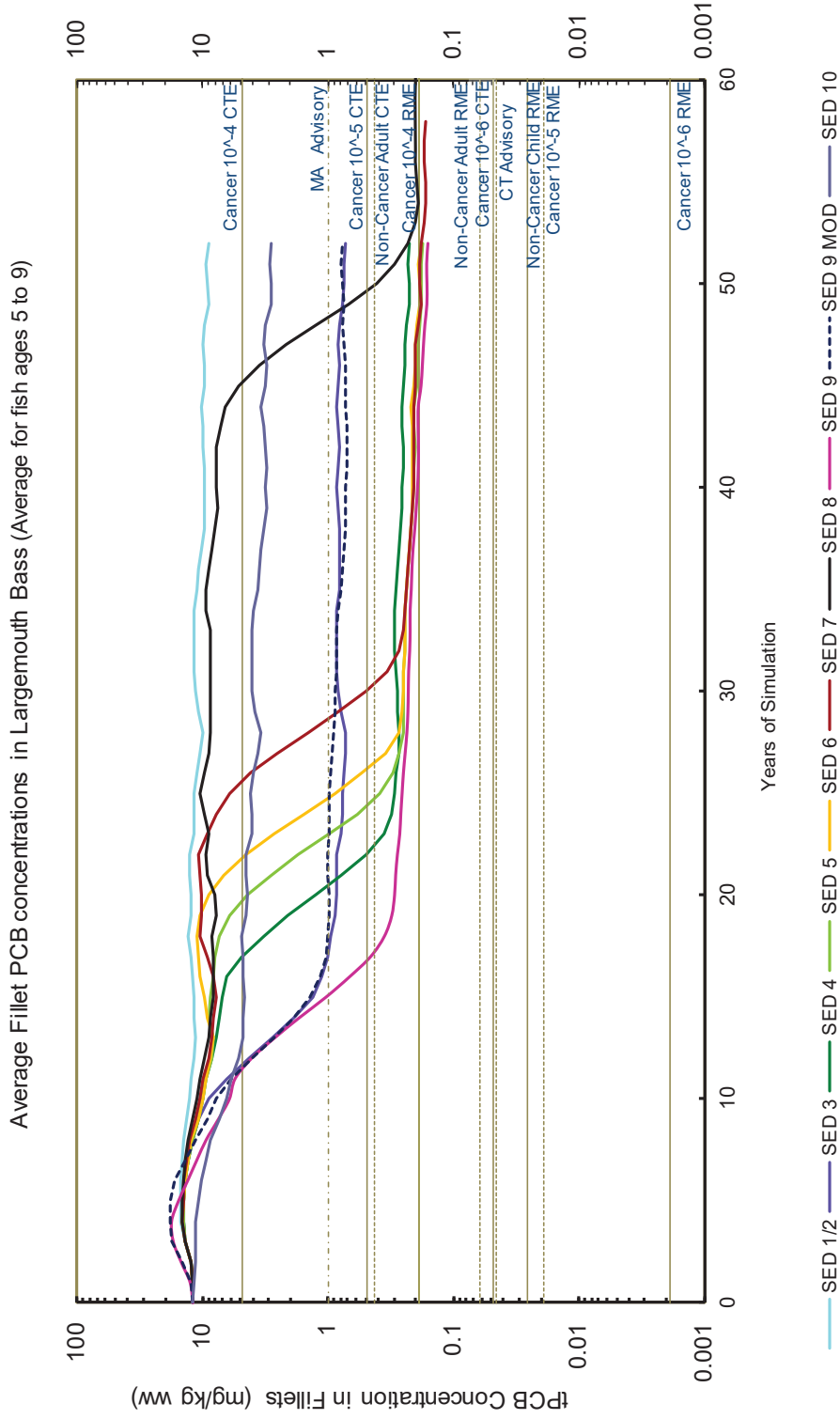
6 For example, in Reach 6 (Woods Pond) (see Figure 1), reduction in fillet tissue PCB
7 concentrations corresponding to the CTE 1×10^{-5} cancer risk would not be achieved by
8 SED 2/FP 1 and SED 10/FP 9 during the 52-year simulation period and, based on the
9 trajectories, for many years thereafter. SED 3/FP 3 and SED 9/FP 4 MOD similarly do not
10 achieve the CTE 1×10^{-5} cancer risk concentration during the simulation period but have
11 significantly better performance than SED 2/FP 1 and SED 10/FP 9, achieving the Massachusetts
12 consumption advisory concentration and a trajectory that will reach the CTE 1×10^{-5} cancer risk
13 concentration many decades earlier than SED 2/FP 1 and SED 10/FP 9.

14 SED 9/FP 8 achieves significant reductions in a shorter period of time than comparable
15 alternatives. SED 5/FP 4 and SED 6/FP 4 achieve significant reductions in a time period greater
16 than SED 9/FP 8, but sooner than SED 8/FP 7. SED 8/FP 7, while achieving the largest overall
17 reductions, has a long implementation period, such that the time to achieve risk reduction is
18 extended beyond that of other alternatives.

19 Because SED 10/FP 9 specifies only partial remediation in Reach 5A, allowing unremediated
20 sediment to remain exposed in that reach, and does not include remediation in the other reaches
21 upstream of Woods Pond, potential recontamination of the remediated areas due to transport of
22 PCBs from unremediated areas is a concern for this alternative.

23 **2.5.1.2 Potential Residual Risks Associated with Floodplain Soil**

24 Under SED 2/FP 1, floodplain soil PCB concentrations, as well as any potential risks, will
25 remain generally similar to current conditions. Implementation of the floodplain component of
26 the other alternatives (FP 3, FP 4, FP 4 MOD, FP 7, FP 8, and FP 9) would reduce the potential
27 risks to humans and ecological receptors from exposure to PCBs in the floodplain by removing
28 PCB-contaminated soil and backfilling those excavations with clean material. The reduction in
29 potential exposure and associated risks would occur upon completion of remediation in a given
30 area. As the removal volume and area affected among the alternatives increase, the reduction in
31 exposure also increases. Among the alternatives evaluated, SED 8/FP 7 would provide the
32 greatest reduction in potential exposures, removing the largest volume of PCB-contaminated soil
33 over the greatest area of the floodplain (377 acres), and over the longest period (52 years) (see
34 Table 5).



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Notes: Average calculated for days from Aug. 28th through Oct. 26th of each year; average calculated for fish ages 5 to 9. Fillet-based concentrations were calculated as whole body concentrations divided by 5.0. Horizontal lines represent fish consumption (deterministic) IMPGs. (Figures for other reaches are presented at the end of Attachment 10.)

Figure 1 Average Fillet PCB Concentrations in Largemouth Bass from Reach 6

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Table 5 Summary of Percent of Floodplain and Sediment Exposure Areas Achieving IMPGs for Direct Human Contact

Exposure Assumptions	Risk Level	Percent of 128 Floodplain and Sediment Exposure Areas Achieving IMPGs							
		SED 2/ FP 1	SED 3/ FP 3	SED 5/ FP 4	SED 6/ FP 4	SED 8/ FP 7	SED 9/ FP 8	SED 10/ FP 9	SED 9/ FP 4 MOD
RME	Cancer 1x10 ⁻⁴	100	100	100	100	100	100	100	100
	Cancer 1x10 ⁻⁵	56	71	100	100	100	100	61	71-100
	Cancer 1x10 ⁻⁶	7	9	13	14	100	15	7	9-13
	Non-Cancer	81	100	100	100	100	100	100	100
CTE	Cancer 1x10 ⁻⁴	100	100	100	100	100	100	100	100
	Cancer 1x10 ⁻⁵	100	100	100	100	100	100	100	100
	Cancer 1x10 ⁻⁶	88	98	99	99	100	99	97	98-99
	Non-Cancer	99	100	100	100	100	100	100	100
		Percent of 12 Floodplain Frequently Used Subareas Achieving IMPGs							
RME	Cancer 1x10 ⁻⁴	92	100	100	100	100	100	100	100
	Cancer 1x10 ⁻⁵	42	100	100	100	100	100	67	100
	Cancer 1x10 ⁻⁶	17	42	42	42	100	42	17	42
	Non-Cancer	58	100	100	100	100	100	100	100
CTE	Cancer 1x10 ⁻⁴	100	100	100	100	100	100	100	100
	Cancer 1x10 ⁻⁵	92	100	100	100	100	100	100	100
	Cancer 1x10 ⁻⁶	67	100	100	100	100	100	92	100
	Non-Cancer	67	100	100	100	100	100	100	100

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4 Because different areas of the floodplain are used by human and ecological receptors in different
5 ways and with varying degrees of frequency and intensity, the extent to which each of the
6 alternatives evaluated in this section would reduce potential residual risks from PCB exposure in
7 the floodplain has been evaluated in terms of the extent to which they would achieve the IMPGs.
8 The comparative evaluation of the alternatives based on achievement of IMPGs is presented in
9 Section 2.6. An evaluation of the achievement of the IMPGs and the time relative to no action is
10 provided in Section 2.6.3.

11 For all alternatives specifying removal of floodplain soil, PCBs will remain in soil below the
12 depths designated for removal (1 foot except in the frequently used subareas where the removal
13 is to 3 feet). Exposure to this deeper soil is not anticipated under current uses. In the event that
14 future exposure to such deeper soil may be reasonably anticipated in particular areas, it would be
15 addressed, under all alternatives except SED 2/FP 1, by ICs. Additionally, under those
16 alternatives, ICs would be implemented where necessary to address potential risks from
17 reasonably anticipated future uses.

18 **2.5.2 Adequacy and Reliability**

19 **2.5.2.1 Use of Technologies Under Similar Conditions**

20 SED 1/FP 1 is the no action alternative, and SED 2/FP 1 involves MNR with ICs in the river and
21 no action in the floodplain. MNR has been selected at other contaminated sediment sites as part

1 of the overall remedy, and no action has been adopted as a remedy component at other sites. The
2 other seven alternatives involve different combinations of remedial technologies and processes.

3 For the sediment alternatives, the selected approaches include removal in the dry and/or wet
4 (followed by capping or backfilling in most cases), capping without prior removal, thin-layer
5 capping, riverbank stabilization (using a combination of bioengineering and hard stabilization
6 techniques), and MNR. All of the remedial technologies included in the sediment alternatives
7 under evaluation have been used at other sites.

8 The floodplain components of the alternatives involving remediation would rely primarily on
9 removing floodplain soil from areas of various types of habitats and backfilling the excavations,
10 and implementation of ICs. These technologies and combinations of technologies have been
11 implemented at other sites. (Restoration is discussed in the following subsection.)

12 **2.5.2.2 General Reliability and Effectiveness**

13 The alternatives under evaluation generally use technologies that have been shown to be reliable
14 and effective at other sites. However, as noted in Section 13 of the June 2011 Site Information
15 Package, thin-layer capping is not expected to be a reliable or effective component for this site,
16 and backfill may not be suitable for reaches with higher bed shear stresses.

17 For all of the active alternatives except SED 9/FP 4 MOD and SED 10/FP 9, eroding riverbanks
18 in Reach 5A would be stabilized using a combination of bioengineering and, if necessary, hard
19 engineering technologies. SED 9/FP 4 MOD would be designed to target specifically sections of
20 riverbank that are highly erodible and also contain elevated concentrations of PCBs in Reach 5A
21 and riverbank soils with PCB concentrations greater than 50 mg/kg in Reach 5B. The
22 stabilization techniques would be similar for all of the alternatives, and are expected to be
23 reliable and effective in stabilizing the banks and controlling erosion. Any potential for long-
24 term impacts would be mitigated through proper construction, and OMM practices. Natural
25 channel design concepts would be used, where practical, to ensure that bank stabilization does
26 not accelerate erosion in other areas, and would not result in ecological impacts.

27 Any areas remediated would require subsequent restoration to reestablish habitat functions and
28 values. Remediation and restoration would progress incrementally from upstream to
29 downstream, affecting small stretches of the river and floodplain at any given time. OMM
30 programs, including invasive species control, would ensure proper reestablishment of vegetation
31 for a period of time following remediation. There is a significant body of knowledge with
32 respect to ecosystem restoration that documents the ability to reestablish the pre-remediation
33 conditions and functions of the affected habitats (see Appendix D of the 2011 Site Information
34 Package). Accordingly, restoration is expected to be fully effective and reliable in returning
35 these habitats, including vernal pool habitat, to their pre-remediation state. As a result, the
36 likelihood of effective restoration is equal under any of the alternatives.

37 **2.5.2.3 Reliability of Operation, Maintenance and Monitoring Requirements and** 38 **Technical Component Replacement Requirements**

39 All alternatives would incorporate reliable long-term maintenance and/or monitoring following
40 remediation. For example, all sediment alternatives would include inspection and repair or

1 replacement of any caps or bank stabilization measures. In general, the extent of such
2 maintenance and monitoring programs would increase as the extent of capping and bank
3 stabilization increases for the various alternatives (i.e., progressively more from SED 10/FP 9 to
4 SED 9/FP 8).

5 Similarly, the backfilled/restored areas of the floodplain would be monitored through periodic
6 inspections to verify that planted vegetation is surviving and growing, and to identify areas
7 where the backfill may be eroding or in need of repair. This is a reliable means of assessing the
8 need for maintenance and would be similar for all alternatives except that the alternatives
9 involving more extensive remediation in the floodplain will necessarily require more extensive
10 maintenance and monitoring, which could be difficult to implement in certain areas of the
11 floodplain due to remoteness, the extent of standing water, and the extent of vegetation.
12 Depending on the timing, location, and scale of any repairs, temporary access roads and staging
13 areas may need to be constructed in the floodplain. These difficulties can be overcome to a great
14 extent through proper planning, selection of experienced contractors, and effective oversight of
15 activities.

16 **2.5.3 Potential Long-Term Impacts on Human Health and the Environment**

17 The evaluation of potential long-term impacts on human health or the environment includes
18 evaluation of potentially affected populations, long-term impacts on the various habitats that
19 would be affected by the remedial alternatives, and the biota that inhabit those habitats
20 (including impacts on state-listed species), impacts on the aesthetics and recreational use of the
21 river and floodplain, impacts on banks and bed load movement (i.e., fluvial geomorphic
22 processes), and potentially available measures that may be employed to mitigate these impacts.
23 The long-term impacts of exposure to PCBs left in place are not evaluated in this section.

24 **2.5.3.1 Potentially Affected Populations**

25 Implementation of all of the alternatives except SED 2/FP 1 (which would not involve remedial
26 construction activities) would result in some short- and long-term impacts on floodplain habitats,
27 with the impacts occurring over longer periods of time as the alternatives become more
28 comprehensive and the duration for implementation increases. For all alternatives, however,
29 implementation of remediation would generally proceed from upstream to downstream, affecting
30 short stretches of the river and associated floodplain at any given time. In the case of
31 SED 9/FP 4 MOD, impacts to habitats supporting state-listed species would be limited due to the
32 design of the alternative, which includes specific protocols for addressing Core Areas. The long-
33 term impacts of the alternatives on the affected habitats and the plants and animals that inhabit or
34 use those habitats, as well as the long-term impacts on the aesthetics and recreational use of the
35 affected habitats by people, are discussed and compared below.

36 **2.5.3.2 Long-Term Impacts on Habitats and Biota**

37 The extent and severity of long-term impacts from remedial construction activities are dependent
38 on the types of habitat affected, the size of the affected areas, the success of the restoration

1 approach(es), and the length of time needed for restoration. Table 6, from GE's RCMS,
2 identifies the habitat types and summarizes the areas of each habitat affected by the alternatives.⁵
3 As discussed above, long-term impacts would be mitigated through proper restoration measures.
4 Because restoration of affected habitats is dependent on several factors and processes, the length
5 of time necessary to restore a habitat is variable.

6 Aquatic Riverine Habitat: The potential post-restoration impacts of sediment removal/capping,
7 as well as capping or thin-layer capping without removal, on aquatic riverine habitat include the
8 following:

- 9 ▪ The caps would change the surficial substrate type from its current condition (sand,
10 sand and gravel, or silt) to armor stone, lasting until deposition of natural sediment
11 from upstream changes the surficial sediment back to a condition similar to its prior
12 condition. To the extent that a habitat layer is specified as the part of any cap in the
13 final design, this impact would be reduced or eliminated.
- 14 ▪ There may be a temporary loss of woody debris and shade in Reaches 5A and 5B
15 depending on the removal areas, bank stabilization techniques, and restoration
16 techniques. These changes could alter the riverine habitat because woody debris
17 provides structure that is important to many aquatic and semi-aquatic species, and
18 shade limits the temperature increases in the river water. The reintroduction of
19 woody debris and replanting of trees would be a component of the restoration plan.
- 20 ▪ Sediment removal and/or capping would remove or bury the existing aquatic
21 vegetation and benthic invertebrates, and temporarily displace the fish.
22 Recolonization would occur, and the vegetation and invertebrates that would
23 recolonize these areas are not expected to differ substantially from the pre-existing
24 species if a habitat layer is included in the cap design. In addition, after the removal
25 of the negative effect of PCBs on the benthic community, it is expected that overall
26 improvements to the community would be realized.
- 27 ▪ There is the potential that the disturbed areas could be colonized by invasive species.
28 This impact may be mitigated via active control of invasive species.
- 29 ▪ For alternatives that specify capping without excavation or require thin-layer capping,
30 the increase in substrate elevation due to the cap could change the hydrodynamics and
31 vegetative characteristics of the areas and the biota dependent on them.

⁵ EPA does not believe that the infrastructure included in these estimates provided by GE has been optimized and expects that, for the selected remedy, the staging areas and roads will be designed to minimize the footprint and adverse impacts to the floodplain, neighborhoods, and local roads while allowing the remediation to proceed in a timely and effective manner.

1 **Table 6 Habitat Areas in Primary Study Area Affected by Alternatives^a**

Habitat	SED 2/ FP 1	SED 3/ FP 3	SED 5/ FP 4	SED 6/ FP 4	SED 8/ FP 7	SED 9/ FP 8	SED 10/ FP 9	SED 9/ FP 4 MOD
Aquatic Riverine Habitat (acres)	-	79	127	127	127	127	20	99
Riverbank (linear miles)	--	14	14	14	14	14	1.6	3.5
Impoundment Habitat (acres)	--	60	101	139	139	139	42	139
Backwater (acres)	--	0	61	70	86	66	0	59
Floodplain Wetland Forest (acres)	-	38	60	60	178	56	14	TBD ^d
Shrub and Shallow Emergent Wetlands (acres)	-	19	22	22	70	31	3.7	TBD ^d
Deep Marshes (acres)	-	1.9	0.3	0.3	4.7	3.1	0	TBD ^d
Vernal Pools (acres) ^b	-	15 (58)	15 (58)	15 (58)	17 (61)	18 (61)	0	TBD ^d
Disturbed Upland Habitats (acres)	-	14	15	15	25	11	7.5	TBD ^d
Upland Forested Habitats (acres)	-	4.2	4.9	4.6	6.4	2.8	0.7	TBD ^d
Total (acres) ^c	--	231	406	453	653	454	88	343

2 ^a Includes habitat areas within the boundaries of the Woodlot (2002) natural community mapping; includes remediation areas as well as areas
3 impacted by access roads and staging areas.

4 ^b Number of vernal pools affected is shown in parentheses.

5 ^c Total habitat area affected does not include riverbanks, and can differ from total surface area affected since the total shown includes all
6 habitats within the boundaries of the Woodlot (2002) mapping (see note a).

7 ^d EPA estimates that the total area of floodplain to be affected equals 45 acres. Specific locations and habitat types are to be determined based
8 on habitats and occurrences of state-listed species as defined by the Core Areas. These estimates do not include supporting infrastructure.

9 In summary, in the aquatic riverine habitat, impacts due to remediation will be temporary. It is
10 expected that over time the physical substrate type in the river would approximate its prior
11 condition, and a biotic community consistent with that substrate type would become
12 reestablished. The inclusion of a habitat layer in any cap design and implementation of an
13 appropriate restoration plan is expected to accelerate the recovery of the aquatic biota. For all
14 alternatives, areas either upstream or downstream of the immediate remediation at any given
15 time would act as sources of and refuge for aquatic species both during and after remediation of
16 an area is completed.

17 Riverbank Habitat: The potential impacts of bank stabilization on riverbank habitat include the
18 following:

- 19 ■ The implementation of stabilization measures that eliminate vertical and/or undercut
20 banks would result in a loss of habitat for birds and other animals that depend on such
21 banks (e.g., kingfisher, bank swallow, and the state-listed wood turtle). However,
22 proven techniques are available to provide adequate bank stabilization with minimal
23 loss of this type of habitat.
- 24 ■ The removal of any mature trees overhanging the river as part of bank
25 stabilization/remediation would result in a temporary change in the vegetative
26 character of the banks. Although this impact may be mitigated to some extent by

1 planting of trees following remediation, it is not practical to replant large trees that
2 are currently found along the banks. However, in the long term, normal growth will
3 result in mature trees that overhang the river and essentially restore the vegetative
4 character to its prerediation conditions.

- 5 ▪ The use of bank stabilization measures could potentially result in a temporary
6 reduction in slides and burrows of muskrat and beaver, and could potentially also
7 reduce access routes and movement of reptiles, amphibians, and smaller and less
8 mobile mammals between the river and wetland habitats. These potential impacts can
9 be taken into account and mitigated in the design of bank stabilization.
- 10 ▪ Any colonization by invasive plant species would require active control measures.

11 As a result of these potential impacts, stabilized riverbanks would not immediately return to their
12 current condition or level of function; however, over time they are expected to do so. Because
13 all of the alternatives except SED 2/FP 1 would involve stabilization of the eroding banks in
14 Reaches 5A and/or 5B, temporary impacts along those banks would result from any alternative
15 specifying active remediation. SED 10/FP 9 would involve remediation and stabilization of only
16 a small portion of the banks in Reaches 5A and 5B, totaling approximately 1.6 linear miles.
17 SED 9/FP 4 MOD would limit removal/stabilization of banks in Reach 5A to only those areas
18 with both moderate-high or greater erosion potential and PCB concentrations greater than
19 5 mg/kg based on sampling to be performed during remedial design. SED 9/FP 4 MOD also
20 would specify a decision-tree approach to bank stabilization with soft restoration techniques
21 favored over hard armoring. For SED 9/FP 4 MOD, in Reach 5B, only a very small percentage
22 of riverbanks will be affected because only those areas with soil PCB concentrations greater than
23 50 mg/kg would be remediated. Actual bank removal amounts will be determined during the
24 design and implementation of the remedy. Based on existing data, SED 9/FP 4 MOD would
25 entail disturbance of approximately 3.5 linear miles of Reach 5A riverbank and less than 0.2
26 linear miles of Reach 5B riverbank.

27 Impoundment Habitat: The potential impacts from removal and/or capping or thin-layer capping
28 on the habitat of impoundments are similar to the impacts on aquatic riverine habitat discussed
29 above. In general, they would include a temporary or longer-term change in the surface
30 substrate, and an alteration in the biological community in the affected impoundment. It is
31 anticipated that as sand and organic sediment from upstream are deposited over time, a
32 biological community typical of such impoundments would reestablish itself. The alternatives
33 that involve capping or thin-layer capping without removal in the impoundments would change
34 the bottom elevation, potentially changing the vegetative characteristics, and the biota dependent
35 on them, in the shallow portions of the impoundments. By contrast, the placement of a cap or a
36 thin-layer cap in deeper areas of the impoundments, including the “deep hole” portion of Woods
37 Pond, is not expected to have any significant long-term ecological impacts. The inclusion of a
38 habitat layer in a cap would accelerate the recovery. The amount of acreage affected in each
39 alternative is summarized in Table 6.

1 Backwater Habitat: The potential impacts of thin-layer capping or sediment removal/capping in
2 backwaters include the following:

- 3 ▪ Change in surficial substrate from organic silty material to sand, which would
4 continue until enough silt and organic material have been deposited to approximate
5 prior conditions.
- 6 ▪ Change in vegetative characteristics corresponding to the change in substrate type and
7 elevation (including, in shallower areas where the thin-layer cap exceeds the depth of
8 water, a potential change from emergent wetlands vegetation to species more tolerant
9 of less frequently inundated or drier conditions).
- 10 ▪ Change in the wildlife communities using the backwaters until such time as the soil,
11 hydrological, and vegetative conditions of the backwaters return to conditions
12 comparable to prerediation conditions.

13 The area disturbed in each alternative is summarized in Table 6. All of the alternatives (except
14 SED 2/FP 1) would have the potential impacts described above, which would be mitigated
15 through the inclusion of a habitat layer and using proper restoration techniques.

16 Floodplain Wetland Forest Habitat: The potential post-restoration impacts of floodplain soil
17 removal, as well as the construction of access roads and staging areas, on floodplain wetland
18 forest habitat include the following:

- 19 ▪ The removal of mature trees from the forested floodplain areas subject to soil removal
20 or the construction of access roads and staging areas would result in a loss of mature
21 forested habitat in those areas. Following replanting, the plant community succession
22 in these areas would progress as a maturing forest for a period of years.
- 23 ▪ Tree removal would cause a temporary loss of the coarse woody debris that is used as
24 structural wildlife habitat and, for a short period of time, the annual leaf litter that
25 provides habitat for numerous woodland species.
- 26 ▪ There would be a temporary relocation or loss of the forest wildlife species that
27 currently use the mature forested habitats that would be removed, and the return of
28 those species, including sensitive species, would be encouraged through proper
29 restoration that reestablishes the functions of the ecosystem.

30 The area impacted by each alternative is summarized in Table 6.

31 Shrub and Shallow Emergent Wetlands and Deep Marshes: The potential post-restoration
32 impacts of floodplain soil removal include:

- 33 ▪ Changes in soil composition and chemistry due to the replacement of existing wetland
34 soil.
- 35 ▪ Changes in the hydrology of these wetlands due to impacts on the swales, drainage
36 features, and microtopography that influence the hydrology.
- 37 ▪ Changes in vegetative characteristics due to the changes in soil and hydrological
38 conditions.

1 These potential impacts would be mitigated through proper restoration to ensure that soil and
2 hydrological conditions similar to prerediation conditions are reestablished. Table 5 shows
3 the area impacted by each alternative.

4 Vernal Pools and Surrounding Habitat: The potential impacts of floodplain soil removal and
5 associated facilities on vernal pools and the surrounding non-breeding habitat for vernal pool
6 amphibians, include the following:

7 ▪ The excavation and replacement of the surface soil and vegetation within and around
8 vernal pools could potentially change the sediment types and stratigraphy,
9 microtopography, and foliage cover of these pools, as well as the surface flow
10 patterns into and out of the pools. These changes could alter the hydrology of the
11 pools. However, these impacts would be mitigated by proper restoration techniques.

12 ▪ There is also the potential for temporary changes in the vegetative characteristics of
13 vernal pools because the vegetative composition (living and dead) of these pools
14 would take some time to become reestablished following remediation. In addition,
15 mature trees around the periphery of the pools, if removed, would take time to
16 become reestablished.

17 ▪ Changes in soil composition in the vernal pools are possible; however, replacement
18 soil would be selected to match as closely as possible the characteristics of the
19 existing vernal pool soil.

20 ▪ Habitats immediately adjacent to vernal pools are important for maintaining water
21 quality and providing shade and vegetative litter for the pool. The proximate non-
22 breeding terrestrial habitats, with features such as coarse woody debris and the
23 burrows of small mammals, provide a variety of protective cover, temperature and
24 moisture regulation, and overwintering habitat functions for vernal pool amphibians.
25 Any impacts to these adjacent areas will be restored using supplemental plantings to
26 reestablish the native plant community and habitat.

27 ▪ Implementation of effective restoration techniques would reestablish vernal pool
28 functions that would allow sensitive vernal pool species (including wood frogs,
29 spotted salamanders, and the state-listed Jefferson salamander) to return to the vernal
30 pools following completion of remediation.

31 The area affected by each alternative is listed in Table 6. Due to the iterative decision-tree
32 approach to vernal pools included in SED 9/FP 4 MOD, it is not possible to calculate comparable
33 acreage for that alternative. The floodplain component of SED 9/FP 4 MOD would specifically
34 recognize Core Area habitats and/or known occurrences of state-listed species and thus would
35 have more limited impacts on these resources than the other alternatives specifying remediation
36 in the floodplain.

37 Upland Habitats: Most of the affected upland areas consist of disturbed upland habitats, which
38 include agricultural fields and cultural grasslands. Because these areas support altered or early
39 successional plant communities that have limited ecological value, no long-term impacts would
40 be expected from the remediation in these areas under any of the remedial alternatives.

1 Where the remediation or supporting activities would affect upland forested habitats, they would
 2 have similar potential impacts as discussed for floodplain forests. As shown in Table 6, except
 3 for SED 2/FP 1, all of the sediment and floodplain alternatives would have some, although
 4 relatively limited, impacts on these habitats.

5 **2.5.3.3 Long-Term Impacts on State-Listed Species**

6 All of the alternatives, except SED 2/FP 1, would affect the priority habitats of some state-listed
 7 species of concern regulated under MESA. GE conducted an evaluation for each potentially
 8 affected state-listed species to assess whether each of the remedial alternatives would result in a
 9 “take” of that species under MESA and, where there would be a take, to assess whether the
 10 alternative would impact a significant portion of the local population(s) of the species.

11 The SED 9/FP 4 MOD alternative differs from the other alternatives in providing more
 12 specificity about the options for avoiding, minimizing, or mitigating impacts to state-listed
 13 species. As part of their Priority Habitat mapping process, taxonomic experts from DFW’s
 14 Natural Heritage and Endangered Species Program (NHESP) routinely delineate habitat for each
 15 state-listed species based on field-documented records or “occurrences.” NHESP has outlined
 16 four types of Housatonic Core Areas for this project (see Attachment 4). Core Areas 1, 2, and 3
 17 represent subsets of the delineated state-listed species habitat found in the Primary Study Area
 18 (PSA). Core Area 4 represents a subset of the documented and potential vernal pool habitat in
 19 the PSA. Although an estimate for the number of species affected cannot be summarized in a
 20 manner similar to that of other alternatives, the SED 9/FP 4 MOD approach will target cleanup
 21 depending on the location of these Core Areas.

22 The effect of the additional flexibility incorporated into SED 9/FP 4 MOD can best be
 23 demonstrated by a comparison with the SED 5/FP 4 alternative, which has the same
 24 specifications for floodplain remediation without the consideration of Core Areas. For
 25 SED 5/FP 4, there are an estimated 57.8 acres of floodplain soil (excluding vernal pools) that
 26 would require remediation to address the direct contact pathway. The overlap of these 57.8 acres
 27 with Core Areas 1 through 3 is shown in Table 7.

28 **Table 7 Overlap of the 57.8 Acres of Floodplain Soil Requiring Remediation**
 29 **under FP 4 with Core Areas 1 through 3**

Total Acreage	Overlap Only with Core Area 1	Overlap with Core Area 3 (Excluding Core Area 1)	Overlap with Core Area 2 (Excluding Core Areas 1 and 3)	No Overlap with Core Areas 1, 2, and 3
57.8 acres	11.6 acres	13 acres	17 acres	16.2 acres

30
 31 SED 5/FP 4 specifies the extent of remediation needed to achieve a PCB concentration
 32 corresponding to a risk level of 1×10^{-5} or an HI of 1, whichever is lower, regardless of the
 33 presence of Core Areas. In SED 9/FP 4 MOD, however, remediation may be reduced or
 34 minimized in certain Core Areas, provided that the residual concentration will meet a risk level
 35 of 1×10^{-4} or an HI of 1, whichever is more stringent. A procedure to address Core Areas was
 36 included in the Draft Modification to the RCRA Permit to be released in June 2014. Based on

1 that procedure, the area to be remediated in SED 9/FP 4 MOD was estimated to be reduced by
2 approximately 11 acres if Core Area 1 habitats were not remediated. A reduction of remediation
3 in 20% of the overlap of Core Areas 2 and 3, along with mitigation/restoration for remediation in
4 these areas, could reduce the area to be remediated by an additional 6 acres, thus reducing the
5 total estimated acreage of floodplain remediation to approximately 40 acres under SED 9/FP 4
6 MOD.

7 Based on the iterative approach for vernal pools called for in SED 9/FP 4 MOD, 5 acres of
8 vernal pool are estimated to require active remediation as part of the initial set of pools. Thus,
9 the total acreage of floodplain excavation for SED 9/FP 4 MOD, including vernal pools, is
10 estimated to be approximately 45 acres. Remediation of additional vernal pools may occur,
11 based on the adaptive management approach described above. Therefore, this approach is
12 expected to have less of a long-term impact on state-listed species than other alternatives such as
13 SED 5/FP 4.

14 **2.5.3.4 Long-Term Impacts on Aesthetics and Recreational Use**

15 All alternatives, except SED 2/FP 1, would have some short-term impacts on the aesthetic
16 features of the Rest of River. Floodplain soil excavation, as well as the construction of access
17 roads and staging areas necessary to support sediment and soil removal, would require removal
18 of trees and vegetation, which would detract from the natural appearance of those areas until
19 restoration plantings have matured. The various alternatives would have impacts on aesthetics
20 corresponding to the amount of area remediated (see Table 6) and the duration of the
21 implementation of the remedy. Similarly, all of the alternatives, except SED 2/FP 1, would
22 disrupt, to some extent, recreational use of the river and floodplain during the remediation
23 period. These affected uses include canoeing, fishing, waterfowl and other game hunting,
24 hiking, dirt biking, and general recreation. However, because remediation would proceed
25 incrementally from upstream to downstream, these impacts would affect small areas at a given
26 time. It is expected that any alternative will include a component to manage and maintain public
27 recreational opportunities safely during remediation.

28 None of the alternatives is expected to have long-term impacts on aesthetics or recreational use.
29 In addition, the preference for the use of bioengineering or “soft” restoration techniques on
30 riverbanks in SED 9/FP 4 MOD is expected to produce a more aesthetically pleasing method of
31 bank stabilization over other alternatives that could rely more heavily on the use of riprap or
32 other armoring methods.

33 **2.5.3.5 Long-Term Impacts on Fluvial Geomorphic Processes**

34 Bank stabilization activities, which are intended to prevent bank erosion and channel migration
35 from exposing new areas of PCB-contaminated soil, would minimize the current processes of
36 bank erosion and lateral channel migration. As discussed in Attachment 1, the river was altered
37 substantially by human activities over the past centuries. These alterations have resulted in an
38 unstable river channel, which is acting to regain a state of dynamic equilibrium that includes
39 changes in the planform of the river channel. All of the alternatives involving active
40 remediation, except SED 10/FP 9 and SED 9/FP 4 MOD, would rely on stabilization of eroding
41 riverbanks in Reach 5A and in Reach 5B. In SED 10/FP 9 and SED 9/FP 4 MOD, only select
42 areas of the banks are proposed for stabilization. During remedial design, natural channel design

1 techniques could be implemented to reduce the instability of the river channel and banks.
2 Natural channel design, coupled with bank stabilization and restoration techniques, would
3 provide for a mix of riverbank types, including vertical and undercut banks, and less near-bank
4 sheer stress.

5 The stabilization of the banks, as well as the capping of the riverbed, would reduce the supply of
6 sediment to the river from these sources. This reduction could affect in-river processes such as
7 sediment transport (as bed load or suspended load), point bar development, and changes in
8 channel dimension (i.e., width and/or depth), as determined by sediment deposition/erosion
9 patterns. Based on geomorphological considerations and modeling results, the reduction in
10 sediment load associated with riverbank stabilization and riverbed armoring under any of the
11 alternatives would not be expected to result in a large-scale, long-term impact on these river
12 morphologic processes or on in-river hydrologic characteristics such as water depth and current
13 velocity.

14 **2.5.3.6 Potential Measures to Mitigate Long-Term Impacts**

15 For all of the alternatives that involve active remediation, a variety of restoration measures are
16 available to mitigate long-term impacts resulting from their implementation. As summarized
17 above, these methods, when implemented properly, will reestablish functions and values and
18 minimize the potential for long-term negative impacts from the remediation.

19 **2.6 ATTAINMENT OF IMPGs**

20 In the assessment of IMPG attainment for the alternatives, the post-remediation average PCB
21 concentrations in an exposure area, as defined in the Human Health Risk Assessment
22 (WESTON, 2005), were compared to the relevant IMPGs for both the sediment and floodplain
23 components. In addition, the whole-body fish tissue PCB concentrations predicted by the model
24 (or estimated by the Connecticut 1-D analysis) at the end of the model projection period were
25 converted to fillet concentrations and compared to the fish consumption IMPGs (Attachment 10).

26 For ecological receptors, the modeled sediment or prey tissue concentrations at the end of the
27 projection period, and/or the estimated floodplain soil concentrations for the appropriate
28 averaging areas, were compared to the relevant IMPGs. For insectivorous birds and piscivorous
29 mammals, these comparisons used procedures that consider both the sediment and the floodplain
30 components of the alternatives.

31 This comparative analysis focused on a comparison of the total number of averaging areas with
32 predicted PCB concentrations that achieve the applicable IMPG(s). In addition, for the sediment
33 component of each alternative, as required by the Permit, the time that it would take to achieve
34 the IMPGs was estimated. For the floodplain component of each alternative, the timeframe to
35 achieve IMPGs is assumed to be the same as that required to complete the remediation in a
36 particular area (i.e., the reduction in soil concentrations would occur upon completion of backfill
37 placement). IMPG attainment for each of these human exposure pathways and ecological
38 receptor groups is described in the following subsections.

1 **2.6.1 Comparison to Human Health IMPGs**

2 **2.6.1.1 Human Direct Contact with Floodplain Soil and Sediment**

3 For all of the alternatives under evaluation, a detailed comparison of human direct contact IMPG
4 attainment (RME and CTE IMPGs, respectively⁶) for the floodplain soil and sediment exposure
5 areas (EAs) was conducted and is summarized in Table 5, taken from GE's RCMS. These
6 comparisons indicate the following regarding IMPG attainment in the floodplain and sediment
7 EAs:

8 Floodplain Direct Contact EAs: The floodplain components of the alternatives, with the
9 exception of SED 2/FP 1, were by design established to achieve designated risk levels for the
10 RME cancer risk or HI of 1. For direct contact with floodplain soil, the floodplain soil PCB
11 concentrations under SED 2/FP 1 (which were assumed to be the same as current levels) are
12 within or below the range of the RME and CTE IMPGs associated with the cancer risk of 1×10^{-4}
13 in all 120 floodplain EAs. However, the PCB concentrations exceed the non-cancer-based RME
14 IMPG (HI = 1) in 24 of the EAs. Furthermore, 5 of the 12 frequently used subareas do not
15 achieve the non-cancer RME IMPG (and one does not achieve the RME IMPG associated with a
16 cancer risk of 1×10^{-4}). The risk levels achieved by the SED 9/FP 4 MOD alternative, which was
17 not evaluated in GE's RCMS, are also shown in Table 5. This alternative achieves the human
18 health risk target of 1×10^{-5} or 1×10^{-4} for RME receptors (depending on the impact to core habitat
19 areas and following the process outlined above), or an HI of 1, while avoiding Core Area 1
20 habitat areas unless necessary to achieve a minimum risk level of 1×10^{-4} or an HI of 1).

21 Sediment Direct Contact EAs: For direct contact with sediment, for sediment [exposure] area
22 (SA) 3 (Woods Pond, and a small portion of Reach 5C and the backwaters immediately upstream
23 of Woods Pond) and SA 7 (Glendale impoundment)⁷, which are the sediment EAs that do not
24 currently achieve acceptable risk levels due to RME non-cancer risk exceeding an HI of 1, model
25 projections indicate that during the modeling period, the RME non-cancer risk level (HI = 1)
26 would be achieved with no action. The remaining alternatives all involve active remediation in
27 Woods Pond, and all achieve an HI of 1 in less time, ranging from 21 years for SED 8/FP 7, to
28 approximately 15 years for SED 5/FP 4 and SED 6/FP 4, and less than 10 years for SED 3/FP 3,
29 SED 9/FP 8, SED 10/FP 9, and SED 9/FP 4 MOD.

30 **2.6.1.2 Human Consumption of Floodplain Agricultural Products**

31 Because there are no current EAs in the floodplain being used for agricultural production, this
32 pathway does not pose current risks. However, there is the potential for future risk if land uses
33 change and, in that case, ICs would need to be established for all remedial alternatives.

⁶ The RME IMPGs are those based on RME assumptions (representing more highly exposed individuals), and the CTE IMPGs are those based on CTE assumptions (representing individuals with average exposure).

⁷ It appears that due to rounding issues GE in the RCMS does not recognize that SA 7 exceeds the RME HI of 1.

1 **2.6.1.3 Human Consumption of Fish**

2 Table 2, reproduced in large part from GE’s RCMS, presents a detailed evaluation, for all of the
 3 alternatives, of whether the fish tissue PCB concentrations predicted by the model for each river
 4 reach or subreach at the end of the modeled period (when converted to fillet concentrations)
 5 would achieve the various RME and CTE IMPGs for human consumption of fish. The risk
 6 levels for fish consumption for the SED 9/FP 4 MOD alternative, which was not evaluated in
 7 GE’s RCMS, have been included in this table. Attachment 10 provides a graphical
 8 representation of how the alternatives perform when compared to the various risk levels.

9 **2.6.2 Comparison to Ecological IMPGs**

10 This section compares the extent to which each alternative under evaluation would achieve the
 11 IMPGs for the various ecological receptors. The tables included in this section are taken in large
 12 part from GE’s RCMS.

13 **2.6.2.1 Benthic Invertebrates**

14 The IMPGs for benthic invertebrates apply to bed sediment in 32 averaging areas in Reaches 5
 15 through 8; achievement of IMPGs for the alternatives evaluated is summarized in Table 8 and
 16 shown graphically in Attachment 7, Figure 4. The table shows, for each alternative, the
 17 percentage of the averaging areas in which the model-predicted sediment concentrations would
 18 achieve the upper-bound and lower-bound IMPGs. The figure presents the same data in terms of
 19 the total area over which the benthic invertebrate IMPGs are achieved.

20 All alternatives evaluated, with the exception of SED 2/FP 1 and SED 10/FP 9, achieve the
 21 upper-bound IMPG for benthic invertebrates of 10 mg/kg tPCBs in sediment in all areas. SED 6,
 22 SED 7, and SED 8 also achieve the lower-bound IMPG of 3 mg/kg tPCBs in all averaging areas.
 23 SED 2, SED 3, SED 4, and SED 10 achieve the lower bound IMPG in 22% to 91% of the
 24 averaging areas. SED 9/FP 4 MOD achieves the lower-bound IMPG in 93% of the averaging
 25 areas, but is anticipated to have better performance due to the amendment of Reach 5B sediment
 26 with activated carbon, which will protect benthic invertebrates by reducing the bioavailability of
 27 PCBs, a process that cannot be simulated by the model.

28 **Table 8 Summary of Percent Averaging Areas Achieving IMPGs for Benthic**
 29 **Invertebrates**

IMPGs	Percent of Averaging Areas Achieving IMPGs in Surface Sediments							
	SED 2/FP 1	SED 3/FP 3	SED 5/FP 4	SED 6/FP 4	SED 8/FP 7	SED 9/FP 8	SED 10/FP 9	SED 9/FP 4 MOD
Upper Bound (10 mg/kg in sediment)	72	100	100	100	100	100	84	100
Lower Bound (3 mg/kg in sediment)	22	63	91	100	100	100	34	931

30 Note: Addition of activated carbon to Reach 5B sediment may achieve protection equivalent to 3 mg/kg at current total organic
 31 carbon (TOC).

1 **2.6.2.2 Amphibians**

2 The IMPGs for amphibians apply to the 66 vernal pools identified by EPA in the Reach 5
 3 floodplain (Woodlot, 2002) and to 29 defined backwater areas. Table 9 provides a summary of
 4 the percent of the averaging areas achieving the lower-bound and upper-bound amphibian
 5 IMPGs in the 66 vernal pools (based on the floodplain component of each alternative) and in the
 6 29 backwater areas (based on the sediment component). Attachment 7, Figure 5, presents the
 7 same data graphically in terms of the actual area achieving the IMPGs. Note that Table 9 and
 8 Attachment 7, Figure 5 do not include data for SED 9/FP 4 MOD because the extent of vernal
 9 pool and backwater remediation is dependent upon further analysis in Core Areas.

10 SED 8/FP 7 and SED 9/FP 8 would achieve both the upper-bound (5.6 mg/kg tPCBs) and lower-
 11 bound (3.27 mg/kg tPCBs) amphibian IMPGs in all areas, whereas SED 10/FP 9, the lowest
 12 performing alternative, would provide only marginal improvement over MNR (SED 2/FP 1).
 13 Although SED 3/FP 3 achieves the upper-bound IMPG in 85% of the averaging areas, as shown
 14 in Attachment 7, Figure 5, these represent only 51% of the total acreage. SED 9/FP 4 MOD will
 15 achieve protection of amphibians through an iterative decision-tree process that will be followed
 16 after extensive data collection to select a subset of vernal pools for remediation and restoration
 17 using traditional techniques, and pilot testing of remediation technology options, followed by
 18 implementation of concepts proven in this process. This approach will ensure that remediation
 19 of vernal pools will not result in more harmful impacts than the current exposure to PCBs.
 20 SED 9/FP 4 MOD will achieve the upper- and lower-bound IMPGs in all backwaters, except
 21 potentially in backwaters, or portions thereof, that coincide with Core Area 1 habitats. In these
 22 areas, an amendment such as activated carbon may be used to further reduce bioavailability of
 23 any residual contamination.

24 **Table 9 Summary of Percent of Averaging Areas Achieving IMPGs for**
 25 **Amphibians**

IMPGs	Percent of Averaging Areas Achieving IMPGs in Surface Soil/Sediment						
	SED 2 / FP 1	SED 3 / FP 3	SED 5 / FP 4	SED 6 / FP 4	SED 8 / FP 7	SED 9 / FP 8	SED 10 / FP 9
Upper Bound (5.6 mg/kg in soil/sediment)	18	85	98	100	100	100	21
Lower Bound (3.27 mg/kg in soil/sediment)	13	27	40	48	100	100	14

26

27 **2.6.2.3 Warmwater and Coldwater Fish**

28 The IMPGs for fish protection apply to whole-body fish tissue PCB concentrations; the IMPG
 29 for warmwater fish is 55 mg/kg and the IMPG for coldwater fish is 14 mg/kg. Table 10 is a
 30 summary presentation of IMPG attainment for warmwater fish within the 14 subreaches of
 31 Reaches 5 through 8 and for coldwater fish within the 8 subreaches of Reach 7. Attachment 7,

1 Figure 6, presents the projected warmwater fish tissue PCB concentrations by reach for the
 2 alternatives evaluated. Attachment 7, Figure 7 presents the projected fish tissue PCB
 3 concentrations for coldwater fish for the Reach 7 subreaches.

4 All alternatives would achieve the warmwater fish IMPG in 100% of the areas. SED 5/FP 4,
 5 SED 6/FP 4, SED 8/FP 7, SED 9/FP 8, and SED 9/FP 4 MOD would also achieve the coldwater
 6 fish IMPG in all areas. SED 3/FP 3 would achieve the coldwater fish IMPG in all except one of
 7 the Reach 7 subreaches, whereas SED 10/FP 9 would not achieve the coldwater fish IMPG in
 8 any reach and, in effect, would provide no improvement over MNR (SED 2/FP 1).

9 **Table 10 Summary of Percent of Averaging Areas Achieving Warmwater and**
 10 **Coldwater Fish Protection IMPGs**

IMPGs	Percent of Averaging Areas Achieving IMPGs in Fish Tissue							
	SED 2/FP 1	SED 3/FP 3	SED 5/FP 4	SED 6/FP 4	SED 8/FP 7	SED 9/FP 8	SED 10/FP 9	SED 9/FP 4 MOD
Warmwater Fish Protection (55 mg/kg in fish)	100	100	100	100	100	100	100	100
Coldwater Fish Protection (14 mg/kg in fish)	0	88	100	100	100	100	0	100

11

12 **2.6.2.4 Insectivorous Birds**

13 The IMPG for insectivorous birds (represented by wood duck) applies to PCB tissue
 14 concentrations in their prey, which consists of both aquatic and terrestrial insects, and thus, it
 15 depends on both sediment and floodplain concentrations in the 12 designated averaging areas.
 16 Because each remedial alternative involves a sediment component and a floodplain component,
 17 an assessment of the achievement of the insectivorous bird IMPG was made by using the model-
 18 predicted sediment endpoint concentration in each averaging area to determine the corresponding
 19 target floodplain soil level in that area that would result in achievement of the IMPG, and then
 20 comparing the estimated floodplain soil exposure point concentration (EPC) in that area to the
 21 target level.

22 Table 11 summarizes, for each alternative, the percentage of the 12 averaging areas that would
 23 achieve the IMPG for insectivorous birds, based on a comparison of the calculated target
 24 floodplain soil concentration in each averaging area to the post-remediation floodplain EPC in
 25 each area. Attachment 7, Figure 8, presents the same data in terms of the acreage achieving the
 26 IMPG. Note that Table 11 and Attachment 7, Figure 8 do not include data for SED 9/FP 4 MOD
 27 because the extent of vernal pool and backwater remediation is dependent upon further analysis
 28 in Core Areas.

1 **Table 11 Summary of Percent of Averaging Areas Achieving IMPGs for**
 2 **Insectivorous Birds**

IMPG	Percent of Averaging Areas Achieving IMPG						
	SED 2/FP 1	SED 3/FP 3	SED 5/FP 4	SED 6/FP 4	SED 8/FP 7	SED 9/FP 8	SED 10/FP 9
Insectivorous Birds (4.4 mg/kg in prey)	33	83	100	100	100	100	58

3
 4 All alternatives evaluated, with the exception of SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9,
 5 SED 9/FP 4 MOD (except as discussed below) would achieve the wood duck IMPG at the end of
 6 the model simulation period in 100% of the areas. Under MNR (SED 2/FP 1), the IMPG is
 7 achieved in 33% of the averaging areas, representing 265 acres of the total 720 acres. SED
 8 10/FP 9, would achieve the IMPG in 58% of the areas (381 acres), whereas SED 3/FP 3 would
 9 achieve the IMPG in 83% of the averaging areas (573 acres). SED 9/FP 4 MOD will protect
 10 insectivorous birds by substantially reducing sediment PCB concentrations that drive
 11 contaminant concentrations in the aquatic portion of the diet while simultaneously reducing
 12 floodplain soil PCB concentrations that lead to elevated PCBs in the terrestrial portion of the
 13 diet.

14 **2.6.2.5 Piscivorous Birds**

15 The IMPG for piscivorous birds (represented by osprey) applies to whole-body fish tissue
 16 concentrations in the 14 subreaches in Reaches 5 through 8.

17 Table 12 summarizes, for each alternative, the percentage of the 14 subreaches (considered the
 18 averaging areas) in which the model-predicted fish concentrations would achieve the piscivorous
 19 bird IMPG. SED 6/FP 4, SED 8/FP 7, and SED 9/FP 8 would achieve the osprey IMPG in 100%
 20 of the 14 averaging areas; SED 5/FP 4 would achieve the IMPG in 93% (13) of the averaging
 21 areas; and SED 9/FP 4 MOD would achieve the IMPG in 71% (10) of the areas. SED 3/FP 3
 22 would achieve the IMPG in only 43% (6) of the 14 averaging areas, and SED 10/FP 9 would
 23 achieve the IMPG in none of the areas, which represents no improvement over MNR.
 24 Attachment 7, Figure 9, shows the same data in terms of the acreage achieving the IMPG.

1 **Table 12 Summary of Percent of Averaging Areas Achieving Piscivorous Bird**
 2 **IMPGs**

IMPG	Percent of Averaging Areas Achieving IMPG in Fish Tissue							
	SED 2/FP 1	SED 3/FP 3	SED 5/FP 4	SED 6/FP 4	SED 8/FP 7	SED 9/FP 8	SED 10/FP 9	SED 9/FP 4 MOD
Piscivorous Birds (3.2 mg/kg in fish)	0	43	93	100	100	100	0	71

3
 4 **2.6.2.6 Piscivorous Mammals**

5 As is the case for insectivorous birds, the IMPGs for piscivorous mammals (represented by
 6 mink) apply to PCB concentrations in their prey, which consists of both aquatic and terrestrial
 7 animals. There are two designated averaging areas for mink, Reaches 5A/5B and Reaches
 8 5C/5D/6. Because each remedial alternative involves a sediment component and a floodplain
 9 component, an assessment of the achievement of the piscivorous mammal IMPGs was made by
 10 using the model-predicted sediment endpoint concentration in each averaging area to determine
 11 the corresponding target floodplain soil concentration in that area that would result in
 12 achievement of the upper- and lower-bound IMPGs, and then comparing the estimated post-
 13 remediation floodplain soil EPC in that area to those target levels.

14 Table 13 summarizes the comparison of the post-remediation floodplain EPC in each averaging
 15 area to the calculated target floodplain soil concentration in that area, presenting the percentage
 16 of the two averaging areas that would achieve the upper-bound and lower-bound IMPGs,
 17 respectively, for piscivorous mammals. Attachment 7, Figure 10, presents the same data in terms
 18 of the acreage achieving the two IMPGs under each alternative. Note that Table 13 and
 19 Attachment 7, Figure 10 do not include data for SED 9/FP 4 MOD because the extent of vernal
 20 pool and backwater remediation is dependent upon further analysis in Core Areas.

21 Only SED 8/FP 7 would achieve both the upper-bound and lower-bound IMPGs in both
 22 averaging areas. SED 5/FP 4, SED 6/FP 4, and SED 9/FP 8 would all achieve the upper-bound
 23 IMPG only in both averaging areas. SED 10/FP 9 and SED 3/FP 3 would not achieve either
 24 IMPG in either of the areas, and therefore, would provide no improvement over MNR
 25 (SED 2/FP 1). As discussed earlier with reference to insectivorous birds, SED 9/FP 4 MOD will
 26 achieve protection of piscivorous mammals by simultaneously reducing PCB concentrations in
 27 both the aquatic and terrestrial dietary components.

Table 13 Summary of Percent of Averaging Areas Achieving IMPGs for Piscivorous Mammals

IMPGs	Percent of Averaging Areas Achieving IMPGs						
	SED 2/FP 1	SED 3/FP 3	SED 5/FP 4	SED 6/FP 4	SED 8/FP 7	SED 9/FP 8	SED 10/FP 9
Upper Bound (2.43 mg/kg in prey)	0	0	100	100	100	100	0
Lower Bound (0.984 mg/kg in prey)	0	0	0	0	100	0	0

2.6.2.7 Omnivorous/Carnivorous Mammals

The IMPGs for omnivorous/carnivorous mammals (represented by the short-tailed shrew) apply to floodplain soil in seven averaging areas in the PSA. Table 14 summarizes the evaluation of IMPG attainment for omnivorous/carnivorous mammals in the seven averaging areas, presenting the percentage of the areas in which the average floodplain soil concentration would achieve the upper-bound and lower-bound IMPGs for omnivorous/carnivorous mammals. Attachment 7, Figure 11 presents the same data in terms of the total acreage over which the IMPGs are achieved by the various alternatives. Note that Table 14 and Attachment 7, Figure 11 do not include data for SED 9/FP 4 MOD because the extent of vernal pool and backwater remediation is dependent upon further analysis in Core Areas.

This summary shows that each alternative, with the exception of SED 2/FP 1 (MNR), SED 3/FP 3, SED 10/FP 9, and SED 9/FP 4 MOD (except as discussed) would achieve both the upper-bound and lower-bound omnivorous/carnivorous mammal IMPGs in 100% of the areas. Both SED 3/FP 3 and SED 10/FP 9 would achieve only the upper-bound IMPG in 100% of the areas, which is only a slight improvement over SED 2/FP 1 (MNR), which achieves the upper-bound IMPG in 86% of the averaging areas. SED 3/FP 3 would achieve the lower bound in 71% of the areas, whereas both SED 10/FP 9 and SED 2/FP 1 would achieve the lower bound in 57% of the areas. The targeted remediation of floodplain soil included in alternative SED 9/FP 4 MOD will provide some protection of omnivorous mammals; however, because remediation areas have not yet been determined, it is not known in which averaging areas IMPGs will be achieved.

Table 14 Summary of Percent of Averaging Areas Achieving IMPGs for Omnivorous/Carnivorous Mammals

IMPGs	Percent of Averaging Areas Achieving IMPGs in Floodplain Soil						
	SED 2/FP 1	SED 3/FP 3	SED 5/FP 4	SED 6/FP 4	SED 8/FP 7	SED 9/FP 8	SED 10/FP 9
Upper Bound (34.3 mg/kg in floodplain soil)	86	100	100	100	100	100	100
Lower Bound (21.1 mg/kg in floodplain soil)	57	71	100	100	100	100	57

2.6.2.8 Threatened and Endangered Species

The IMPG for threatened and endangered species (represented by the bald eagle) applies to whole-body fish PCB concentrations in the 14 subreaches in Reaches 5 through 8. All alternatives would achieve the threatened and endangered species IMPG in all areas.

2.6.3 Summary

For human health direct contact with floodplain soil and agricultural use, all alternatives, with the exception of SED 2/FP 1, were designed to achieve a specified reduction in risk level upon completion of remediation. It would not be expected under SED 2/FP 1 that any reduction in risk would occur over a reasonable timeframe.

For human health direct contact with sediment, for SA 3 (Woods Pond) and SA 7 (Glendale impoundment), which are the sediment EAs that do not currently achieve acceptable risk levels due to RME non-cancer risk exceeding an HI of 1, model projections indicate that within 22 years the RME non-cancer risk level (HI = 1) would be achieved with no active remediation (SED 2/FP 1). The remaining alternatives all involve active remediation in Woods Pond and all achieve an HI of 1 in shorter periods of time, ranging from 21 years for SED 8/FP 7, to approximately 15 years for SED 5/FP 4 and SED 6/FP 4, and less than 10 years for SED 3/FP 3, SED 9/FP 8, SED 10/FP 9, and SED 9/FP 4 MOD.

For human fish consumption, no active remediation (SED 2/FP 1) would result in the HI of 1 and the RME 1×10^{-4} level being exceeded for the RME and CTE adult and child for more than 250 years. The same is the case with SED 10/FP 9 for the HI of 1 and the RME 1×10^{-4} level; however, the CTE 1×10^{-4} risk level is achieved in some reaches. All other alternatives achieve varying risk levels far sooner than those two alternatives (see Table 2).

For benthic invertebrates, numerous EAs meet the upper-bound IMPG with SED 2/FP 1 and SED 10/FP 9; however, very few EAs attain the lower-bound IMPG within 200 years with these two alternatives. SED 6/FP 4, SED 8/FP 7, SED 9/FP 8, and SED 9/FP 4 MOD all achieve the lower-bound IMPG, or its equivalent in the case of SED 9/FP 4 MOD in Reach 5B, in all EAs

1 within 20 years (with the exception of some EAs for SED 8, which requires a longer duration for
2 implementation).

3 Neither SED 2/FP 1 nor SED 10/FP 9 achieves either the upper-bound or lower-bound
4 amphibian IMPG in the majority of backwater areas or vernal pools in less than 100 years. The
5 other alternatives achieve either the upper-bound or lower-bound IMPG in many or all areas or
6 pools in much less time, and for alternatives SED 6/FP 4 and SED 9/FP 8, typically in less than
7 20 years. SED 9/FP 4 MOD would provide protection to amphibians by reducing exposure
8 concentrations through an iterative decision-tree approach to remediating vernal pools.

9 Warmwater fish IMPGs are attained for all alternatives, including MNR (SED 2/FP 1).
10 However, the coldwater fish IMPGs are not attained in less than 100 years in the subreaches of
11 Reach 7 either with SED 2/FP 1 or with SED 10/FP 9. The other alternatives that include active
12 remediation attain this IMPG in all but one subreach (Subreach 7B, for SED 3/FP 3) within a
13 range of timeframes dependent on the implementation schedule for the alternative.

14 The IMPG for insectivorous birds is not attained in 8 of 12 EAs with MNR (SED 2/FP 1), and is
15 not attained in 5 of 12 areas with SED 10/FP 9. For other alternatives, most achieve the IMPG in
16 all areas.

17 The piscivorous bird IMPG is not achieved by SED 2/FP 1 or SED 10/FP 9 for any reach in less
18 than 100 years, and in some cases, over 200 years. SED 6/FP 4, SED 8/FP 7, and SED 9/FP 8 all
19 achieve the IMPG in all reaches in a much reduced timeframe, typically less than 20 years, with
20 the exception of SED 8/FP 7, for which timeframes are controlled by the longer duration of
21 implementation.

22 The lower-bound IMPG for piscivorous mammals is achieved only by SED 8/FP 7. However,
23 SED 5/FP 4, SED 6/FP 4, SED 8/FP 7, and SED 9/FP 8 achieve the upper-bound IMPG. The
24 other alternatives do not achieve either IMPG. MNR (SED 2/FP 1) would result in the upper-
25 bound IMPG not being achieved for over 250 years.

26 With MNR (SED 2/FP 1), the omnivorous/carnivorous mammal upper-bound IMPG is not
27 achieved in three of the seven EAs, with two achieving the lower-bound IMPG. All other
28 alternatives achieve either the upper-bound or lower-bound IMPG, with SED 5/FP 4,
29 SED 6/FP 4, SED 8/FP 7, and SED 9/FP 8 all achieving the lower-bound IMPG.

30 The threatened and endangered species IMPG (based on the bald eagle) is achieved with no
31 action and therefore, for all alternatives.

32 **2.7 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME OF WASTES**

33 The degree to which the alternatives under evaluation would reduce the TMV of PCBs is
34 discussed below.

35 **2.7.1 Treatment Process Used and Materials Treated**

36 None of the sediment-floodplain alternatives, except for SED 9/FP 4 MOD, includes any
37 proposed treatment processes that would reduce the toxicity of PCBs in the sediment or soil.

1 SED 9/FP 4 MOD specifies sediment amendment with activated carbon, or similar material, in
2 some areas. Although such amendment does not directly reduce the absolute toxicity of PCBs, it
3 reduces the effective toxicity by limiting the bioavailability of the contaminants. Because none
4 of the other alternatives provides for this treatment, SED 9/FP 4 MOD surpasses all other
5 alternatives in the amount of materials treated and the degree of reduction in toxicity due to
6 treatment.

7 **2.7.2 Amount of Hazardous Materials Destroyed or Treated**

8 SED 9/FP 4 MOD includes amendment of some sediments/soils with material(s) that will reduce
9 the bioavailability of contaminants. None of the other remedial alternatives specifies any
10 treatment processes; therefore, no hazardous materials would be destroyed or treated by any of
11 the other alternatives. Accordingly, SED 9/FP 4 MOD surpasses all other alternatives in the
12 amount of materials treated and the degree of reduction in toxicity due to treatment.

13 **2.7.3 Degree of Expected Reductions in Toxicity, Mobility, or Volume**

14 Reduction of Toxicity: Of the remedial alternatives under evaluation, only SED 9/FP 4 MOD
15 includes the evaluation and use of sediment/soil amendments such as activated carbon in
16 Reaches 5B and the backwaters and in selected vernal pools to more effectively bind PCBs to the
17 inorganic sediment/soil matrix. This type of treatment has been documented to reduce the
18 bioavailability of organic contaminants and is, therefore, expected to reduce the toxicity in these
19 areas. Because none of the other alternatives includes this treatment, SED 9/FP 4 MOD
20 surpasses all other alternatives in the amount of materials treated and the degree of reduction in
21 toxicity due to treatment.

22 Reduction of Mobility: Under SED 2/FP 1, no reduction of mobility of PCBs in the river would
23 be achieved through remedial action, and only past and ongoing upstream source
24 control/remediation and naturally occurring processes would provide for a reduction of PCB
25 mobility. Under all other alternatives, reductions would be achieved through sediment removal,
26 capping, backfilling, thin-layer capping, and/or bank stabilization activities. In the case of
27 SED 9/FP 4 MOD, additional reduction in the mobility of PCBs will be achieved through the use
28 of the sediment amendment(s) discussed above, which prevent PCB release to overlying waters
29 and subsequent transport downstream.

30 Reduction in sediment PCB mobility can be viewed in terms of reduction in the annual mass of
31 PCBs passing Woods Pond and Rising Pond Dams, and the solids/PCB trapping efficiency of
32 Woods Pond shown in Attachment 7, Figures 1 and 12. The percent reduction in PCB mass
33 passing over Woods Pond and Rising Pond Dams at the conclusion of the 52-year (81-year in the
34 case of SED 8/FP 7) model simulation period for each of the alternatives evaluated is shown in
35 Table 3 and discussed with reference to the General Standard “Control of Sources of Releases”
36 in Section 2.3.

37 Attachment 7, Figure 12, shows the solids trapping efficiency of Woods Pond at the conclusion
38 of each of the alternatives evaluated. As indicated in this figure, alternatives that include
39 deepening of Woods Pond (SED 9/FP 8, SED 9/FP 4 MOD, and SED 10/FP 9) achieve modest,
40 and nearly equivalent, increases in solids trapping in the pond, increasing the trapping of solids

1 from approximately 15% for MNR and for alternatives that do not include the deepening of
 2 Woods Pond, to approximately 25% in the case of SED 9/FP 8 and SED 10/FP 9, and to
 3 approximately 30% in the case of SED 9/FP 4 MOD. It is important to note, however, that
 4 because of continuing release of PCBs from the trapped sediment, the PCB trapping efficiency
 5 will be less than that for solids, although this effect will be similar for all alternatives and,
 6 therefore, does not distinguish among them.

7 Reduction of Volume: Implementation of each of the sediment-floodplain alternatives, except
 8 SED 2/FP 1, would reduce the volume of PCB-contaminated sediment, bank soil, and floodplain
 9 soil in the Rest of River through permanent removal of the material. Table 15, from GE's
 10 RCMS, and Attachment 7, Figure 13, summarize the approximate removal volume and
 11 corresponding PCB mass that would be removed under each such alternative. The volume and
 12 mass removed under the SED 9/FP 4 MOD alternative, which was not evaluated in GE's RCMS,
 13 are also shown in this table.

14 **Table 15 Removal Volume and Corresponding PCB Mass for Alternatives**

Alternative	Removal Volume – Sediment/Soil (cy)	Estimated PCB Mass (lb)
SED 2/FP 1	---	---
SED 3/FP 3	243,000	21,700
SED 5/FP 4	533,000	33,300
SED 6/FP 4	677,000	37,300
SED 8/FP 7	2,902,000	94,100
SED 9/FP 8	1,098,000	53,100
SED 10/FP 9	267,700	13,900
SED 9/FP 4 MOD	990,000	46,970

15
 16 **2.7.4 Degree to Which Treatment Is Irreversible**

17 None of the sediment-floodplain alternatives, except SED 9/FP 4 MOD, includes any proposed
 18 treatment processes that would reduce the toxicity of PCBs in the sediment or soil. The use of
 19 an amendment, as specified in SED 9/MOD 4, is expected to be irreversible.

20 **2.7.5 Type and Quantity of Residuals Remaining after Treatment**

21 None of the sediment-floodplain alternatives, except SED 9/FP 4 MOD, includes any proposed
 22 treatment processes that would reduce the toxicity of PCBs in the sediment or soil. The use of
 23 an amendment, as specified in SED 9/MOD 4, is not expected to significantly affect the type and
 24 quantity of residuals remaining after treatment.

1 **2.8 SHORT-TERM EFFECTIVENESS**

2 Evaluation of the short-term effectiveness of the remedial alternatives includes consideration of
 3 the short-term impacts of implementing these alternatives on the environment (considering both
 4 ecological effects and increases in greenhouse gas (GHG) emissions), on local communities
 5 (including communities along transport routes), and on the workers involved in the remedial
 6 activities. Short-term impacts are those that would occur during and immediately after the
 7 performance of the remedial activities in a given area. Because SED 2/FP 1 would involve no
 8 remedial construction activities, its implementation would not produce any short-term impacts;
 9 all of the other alternatives would have some short-term impacts. Because any remediation
 10 would be conducted using a phased approach, these impacts would be dispersed over the
 11 remedial action period and area, and thus, would not last for the entire duration of the project in
 12 all affected areas. The tables shown in this section were taken from GE’s RCMS and modified
 13 where possible to include the SED 9/FP 4 MOD alternative. The estimated durations of the
 14 alternatives evaluated, ranging from 5 years for SED 10/FP 9 to over 50 years for SED 8/FP 7,
 15 are summarized in Table 16.

16 **Table 16 Construction Duration for Alternatives**

	SED 2/ FP 1	SED 3/ FP 3	SED 5/ FP 4	SED 6/ FP 4	SED 8/ FP 7	SED 9/ FP 8	SED 10/ FP 9	SED 9/ FP 4 MOD
Construction Duration (years)	—	10	18	21	52	14	5	13

17
 18 **2.8.1 Impacts on the Environment – Effects Within the Rest of River Area**

19 Short-term impacts on the Rest of River environment from remedial construction activities
 20 would include PCB releases to the water column and air during sediment removal and other in-
 21 river activities, as well as alteration of natural habitats where remediation would be conducted or
 22 support facilities would be built, with the attendant impacts on the plants and animals that use
 23 those habitats. These impacts are described and compared among the alternatives in the
 24 following subsections.

25 PCB Releases: Sediment removal activities would result in some resuspension of PCB-
 26 contaminated sediment into the water column. This could potentially result in transient increases
 27 in PCB levels in surface water and aquatic biota downstream of the removal operations. Under
 28 all of the active remediation alternatives, except SED 9/FP 8 and SED 9/FP 4 MOD, sediment
 29 removal in Reach 5A and, where applicable, Reach 5B, would be conducted in the dry using
 30 sheetpile containment, which would allow the greatest control of resuspension. However, the
 31 potential still exists for suspended or residual sediment containing PCBs to be released from the
 32 work area both during sheetpile installation and removal, and during a high-flow event when
 33 overtopping of the sheeting could occur. Under SED 9/FP 8 and SED 9/FP 4 MOD, sediment
 34 removal in those subreaches would be conducted in the wet, which would have the potential for
 35 causing resuspension of PCB-contaminated sediment. In addition, under remedial alternatives
 36 that would involve sediment remediation in other reaches, removal activities would be conducted

1 in the wet from barges. These activities, as well as boat and barge traffic, would result in some
2 resuspension of sediment containing PCBs, which would be minimized through the use of
3 engineering controls, such as silt curtains.

4 Other than SED 2/FP 1, which does not involve sediment removal, SED 3/FP 3 has the lowest
5 potential for PCB resuspension because it would involve the smallest area of sediment removal
6 (42 acres in Reach 5A), and that removal would be conducted in the dry. SED 10/FP 9 would
7 involve a smaller area of dry removal (20 acres in Reach 5A), but would also involve the
8 removal of sediment in the wet from 42 acres in Woods Pond. The other alternatives would
9 involve substantially more sediment removal, with some or much of it conducted in the wet,
10 which would result in more resuspension over a longer period of time than either SED 3/FP 3 or
11 SED 10/FP 9.

12 Similarly, sediment and soil removal and related processing activities have the potential to
13 produce airborne PCB emissions that could impact downwind communities. This potential also
14 increases with the scope and duration of the removal activities, which increase from SED 3/FP 3
15 and SED 10/FP 9 through SED 8/FP 7. Monitoring and implementation of best management
16 practices (BMPs) are expected to result in minimal releases.

17 Impacts on Aquatic Riverine Habitat: The potential short-term impacts of sediment remediation
18 activities, including removal with capping or backfilling and capping or thin-layer capping
19 without removal, on aquatic riverine habitat include the following: removal of the habitat used
20 by aquatic plants, benthic invertebrates, and fish; change in surface substrate from its current
21 condition (sand, sand and gravel, or silt) to armor stone or backfill material; removal or burial of
22 most, if not all, vegetation, benthic invertebrates, and other organisms present in the sediment;
23 disruption and displacement of fish; alteration of habitat for birds and mammals living adjacent
24 to the river that feed in areas subject to remediation; and possible colonization by invasive
25 species. In addition, capping or thin-layer capping without removal would raise the elevation of
26 the river bottom, which, in shallower areas, could change the vegetative characteristics of those
27 areas and the biota dependent on them.

28 Under SED 3/FP 3, these types of potential short-term impacts would occur over 42 acres of
29 aquatic riverine habitat, all in Reach 5A. Under SED 9/FP 4 MOD, remediation would be
30 42 acres in Reach 5A and 57 acres in Reach 5C, for a total of 99 acres of riverine habitat. Under
31 SED 5/FP 4, SED 6/FP 4, SED 8/FP 7, and SED 9/FP 8, these impacts would occur over
32 approximately 127 acres of aquatic riverine habitat. Under SED 10/FP 9, which involves the
33 smallest amount of removal of contaminated sediment, these impacts would occur in only
34 20 acres of such habitat (in Reach 5A).

35 Incorporation of a habitat layer in the cap design would mitigate some of these impacts. In
36 addition, implementation of the remediation in a phased approach affecting a small area at any
37 given time would also minimize some of these impacts.

38 Impacts on Riverbank Habitat: The potential short-term impacts of bank stabilization activities in
39 Reaches 5A and 5B on the riverbanks include removal of trees, other vegetation, and woody
40 debris from the riverbanks, with the resulting temporary loss of shade for the river and the loss of
41 the wildlife that use those features; short-term elimination of vertical and undercut banks used by

1 various species for nesting; short-term loss of slide and burrow habitat for muskrats and beavers;
2 potential short-term reduction in wildlife access routes and movement of various species between
3 their aquatic and terrestrial habitats; and the possible colonization by invasive species.

4 All of the alternatives, except SED 2/FP 1 (MNR) and SED 10/FP 9, would result in such
5 impacts on the eroding riverbanks subject to stabilization. SED 2/FP 1 would not have any such
6 impacts, and SED 10/FP 9 would limit these impacts to a small portion of the riverbank in
7 Reaches 5A and 5B. The approach to bank remediation in SED 9/FP 4 MOD is based on the
8 consideration of both the erosion potential of areas of bank as well as the PCB concentrations in
9 bank soil, reducing the amount of bank remediation by focusing only on those portions of the
10 banks in Reach 5A that have both high erosion potential and elevated PCB concentration, and in
11 Reach 5B on a limited amount of bank soil with the highest PCB concentrations (greater than
12 50 mg/kg).

13 Impacts on Impoundment Habitat: The potential short-term impacts of sediment remediation
14 activities, including removal with capping (or backfilling), capping or thin-layer capping without
15 removal, and removal without capping, on impoundment habitat are similar to the short-term
16 impacts on aquatic riverine habitat, as described above, except that placement of a cap or thin-
17 layer cap in the deep hole portion of Woods Pond would not be expected to have any significant
18 short-term ecological impacts.

19 Apart from SED 2/FP 1, all of the alternatives under evaluation would have some impacts on
20 impoundment habitat. Table 6 shows the amount of area affected by each alternative.

21 Impacts on Backwater Habitat: The potential short-term impacts of sediment remediation
22 activities, including thin-layer capping and sediment removal with capping (or backfilling), on
23 backwater habitat include the following: burial or removal of most, if not all, vegetation, benthic
24 invertebrates, and other organisms in the sediment.

25 Because SED 2/FP 1, SED 3/FP 3, and SED 10/FP 9 would not involve any remediation in the
26 backwaters, they would have no short-term impacts to backwater habitat. The other alternatives
27 would all have short-term impacts to backwater habitat because they would affect 61 to 86 acres
28 of such habitat (see Table 6).

29 Impacts on Floodplain Habitats: The potential short-term impacts on the various floodplain
30 habitats resulting from floodplain soil removal and the construction and use of access roads and
31 staging areas include the following:

- 32 ▪ For floodplain wetland forest habitats, the short-term impacts could potentially
33 include the following: (1) removal of living trees, shrubs, other vegetation, and
34 woody debris, which would result in a temporary loss of cover, nesting, and feeding
35 habitat for wildlife species that rely on forested floodplains; (2) possible colonization
36 by invasive plant species; and (3) increase in construction and equipment traffic,
37 which could disrupt some forest animals or result in mortality to certain slow-moving
38 smaller animals. Many of these short-term impacts can be mitigated by appropriate
39 restoration activities, including replacement of existing soil and leaf litter with
40 backfill soil designed to function similarly to existing native soil, to provide the best

- 1 opportunity for plant growth and hydraulic conductivity, and implementing an
2 invasive species management program.
- 3 ■ For shrub and emergent wetlands (both shallow and deep), the short-term impacts
4 could potentially include: (1) clearing of vegetation, with consequent impacts on
5 nesting, burrowing, and/or escape habitat and food for birds, amphibians, reptiles,
6 mammals, and invertebrates that use these wetland areas; (2) alteration of the
7 hydrology of the wetlands; (3) possible colonization by invasive species; and
8 (4) increase in construction and equipment traffic, with the resulting potential for
9 disruption or mortality to slow-moving animals. Many of these short-term impacts
10 can be mitigated by appropriate restoration activities, including replacement of
11 existing soil with soil designed to function similarly to existing native soil, to provide
12 the best opportunity for plant growth and hydraulic conductivity and implementing an
13 invasive species management program.
 - 14 ■ For vernal pools and the biota that use them, the short-term impacts could potentially
15 include: (1) removal of amphibian and invertebrate eggs, larvae, or adults in the
16 affected portions of the pools; (2) removal of physical components of the pools
17 (organic surface soil, vegetation, and other organic materials) and their replacement;
18 (3) alteration of the hydrology of the pools; (4) tree clearing within and adjacent to
19 the pools, temporarily reducing the shade and infusion of biomass provided to the
20 pools; (5) temporary loss of obligate vernal pool breeding species from all or parts of
21 these pools; (6) possible colonization by invasive species; (7) impacts on the non-
22 breeding terrestrial habitats surrounding the vernal pools; and (8) loss or
23 fragmentation of landscape connectivity among networks of vernal pools and between
24 vernal pools and non-breeding habitats. Many of these short-term impacts can be
25 mitigated by appropriate restoration activities, including replacement of preexisting
26 physical components such as woody debris, implementing an invasive species
27 management program, and conducting remediation in a phased approach.
 - 28 ■ For upland habitats, the short-term impacts would potentially include temporary loss
29 of trees and associated vegetation and impacts to the wildlife that use such areas.
 - 30 ■ In all of these habitats, and in the absence of any mitigation, the short-term impacts
31 would potentially include the direct removal or disruption of any state-listed species
32 present in the affected areas, as well as alteration of their habitat.
 - 33 ■ The short-term impacts could potentially also include impairment of a number of
34 other functions provided by the floodplain, which would be mitigated through proper
35 restoration. For example, by removing woody debris and vegetation and altering
36 microtopography in disturbed areas, the floodplain remedial construction activities
37 would reduce the floodplain roughness that produces flow resistance and contributes
38 to the important flood flow alteration function of the floodplain. In addition, the
39 construction activities could alter the floodplain's groundwater recharge/discharge
40 function and its functions of water quality maintenance, nutrient process, and
41 production export.

1 All of the alternatives involving removal would have these potential short-term impacts on the
2 habitats outside the river. Table 6 shows the amount of each habitat type potentially impacted by
3 each alternative.

4 With specific reference to vernal pools, SED 2/FP 1 (MNR) and SED 10/FP 9 (which does not
5 include remediation of contaminated soil in vernal pools) would have no direct impact on any of
6 the vernal pools. All of the other alternatives, with the exception of SED 9/FP 4 MOD, would
7 impact those vernal pools to a generally similar extent. Because of the iterative pilot-study-
8 based approach to remediation/restoration of vernal pools included in the SED 9/FP 4 MOD
9 alternative, the vernal pool component of SED 9/FP 4 MOD was designed specifically to provide
10 superior performance with regard to vernal pools, comprehensively considering both the positive
11 and negative impacts of active remediation. For additional information on wetland and
12 floodplain impacts, see Attachment 12.

13 **2.8.2 Carbon Footprint – Greenhouse Gas Emissions**

14 Estimates have been developed of the GHG emissions (i.e., carbon footprint) anticipated to occur
15 through sediment removal/capping, floodplain soil and tree removal, and related ancillary
16 activities during the implementation of the alternatives under evaluation. Table 17 summarizes
17 the total carbon footprint associated with each alternative, including a breakdown of direct,
18 indirect, and off-site emission sources. To provide context regarding the emissions reported
19 below, the number of passenger vehicles that would emit an equivalent quantity of CO_{2-eq} in
20 1 year is also presented in the table. A graphical comparison of the total GHG emissions for the
21 alternatives evaluated is shown in Attachment 7, Figure 14.

22 SED 10/FP 9 would have the lowest amount of total GHG emissions (40,000 tonnes);
23 SED 3/FP 3 would have the next lowest amount (47,000 tonnes); SED 5/FP 4, SED 6/FP 4,
24 SED 9/FP 8, and SED 9/FP MOD would have between 100,000 and 190,000 tonnes of such
25 emissions; and SED 8/FP 7 would have by far the greatest amount of GHG emissions (520,000
26 tonnes).⁸

⁸ Comparison among the three emission categories indicates that, on average, off-site emissions account for more than half of the GHG emissions for each combination (the most significant off-site sources being steel sheeting manufacture [with the exception of SED 9] and production of cement to be used in sediment stabilization). Direct emissions sources (including those associated with construction and transportation activities) generally account for 40 to 50% of the total GHG emissions.

Table 17 Calculated GHG Emissions Anticipated to Result from Alternatives

Alternative	Total GHG Emissions (tonnes)	Direct Emissions (tonnes)	Indirect Emissions (tonnes)	Off-Site Emissions (tonnes)	No. of Vehicles with Equivalent Annual Emissions
SED 2/FP 1	---	---	---	---	---
SED 3/FP 3	47,000	26,000	1,200	20,000	9,000
SED 5/FP 4	100,000	46,000	2,300	53,000	19,100
SED 6/FP 4	140,000	65,000	3,500	72,000	28,800
SED 8/FP 7	520,000	220,000	10,300	290,000	99,400
SED 9/FP 8	190,000	79,000	3,800	110,000	36,300
SED 10/FP 9	40,000	12,000	900	27,000	7,600
SED 9/FP 4 MOD	171,000	70,000	3,400	98,000	32,200

2.8.3 Impacts on Local Communities and Communities Along Truck Transport Routes

Implementation of all alternatives (except SED 2/FP 1) would result in some short-term impacts to the local communities along the Housatonic River. These short-term effects would include changes to the visual appearance of the river, riverbanks, and affected areas of the floodplain, as well as disruption of recreational activities in those areas due to the remediation as well as the construction of access roads and staging areas. They would also include increased construction traffic, noise, and nuisance dust in those areas.

Construction activities would affect some recreational activities along the river and in the floodplain. Depending on the particular alternative, these potentially would include fishing, canoeing (including canoe launches), hiking, dirt biking, general recreation, and both waterfowl and other game hunting. During the period of active construction, restrictions on recreational uses of the river and the floodplain would be imposed in the areas where remediation-related activities are taking place. Due to safety considerations, boaters, anglers, hikers, hunters, and other recreational users would not be able to use the river, floodplain, or riverbank in the construction and support areas. However, due to the phased nature of any remediation, only a small portion of the total recreational acreage would be affected at any one time, and active measures to decrease impacts to recreation (e.g., providing for transport of canoes around the area being impacted) will be considered.

The extent of these impacts on Housatonic River and floodplain use would vary depending on the overall area affected by remediation and support facility construction, as well as the length of time required to complete the remediation. These impacts would be least for SED 10/FP 9 (91 acres, 5 years). They would be more extensive for SED 3/FP 3 (237 acres, 10 years), SED 9/FP 4 MOD (300 to 400 acres, 13.4 years), SED 5/FP 4 (410 acres, 18 years), SED 6/FP 4

1 (447 acres, 21 years), and SED 9/FP 8 (469 acres, 14 years). The alternative with the greatest
 2 potential impact on these uses of the river and floodplain is SED 8/FP 7 (774 acres, 52 years).⁹

3 In addition, due to the need to deliver equipment to the work areas, remove excavated materials,
 4 and deliver capping, backfill, and bank stabilization materials to the site, both on-site and local
 5 (off-site) truck traffic would increase over current conditions. This additional traffic could
 6 increase the likelihood of accidents, noise levels, emissions of vehicle/equipment exhaust, and
 7 nuisance dust to the air, and would persist over the duration of remedial activities. Table 18
 8 summarizes the number of truck trips associated with transporting excavated materials from the
 9 staging areas to the disposal or treatment facilities and delivering capping/backfill and bank
 10 stabilization materials to the remediation areas. The total annual truck trips and total years of
 11 truck traffic for each alternative are show graphically in Attachment 7, Figure 15.

12 As shown in Table 18, apart from SED 2/FP 1, SED 10/FP 9 would involve the fewest number of
 13 total truck trips (31,600) and SED 3/FP 3 would involve the next fewest (49,700). SED 5/FP 4,
 14 SED 6/FP 4, SED 9/FP 4 MOD, and SED 9/FP 8 would involve between 115,500 and 188,400
 15 truck trips; and SED 8/FP 7 would require by far the most total truck trips (approximately
 16 515,000). However, on an annual basis, SED 9/FP 8 would involve the greatest number of truck
 17 trips per year (13,500) based on its accelerated schedule with work occurring in more than one
 18 reach at a time.

19 **Table 18 Estimated Truck Trips for Removal of Excavated Material and**
 20 **Delivery of Capping/Backfill Material for Alternatives**

Alternative	Truck Trips for Excavated Material ^a	Truck Trips for Capping/Backfill Material ^b	Total Truck Trips ^c
SED 2/FP 1	---	---	---
SED 3/FP 3	20,100 (2,000)	29,600 (3,000)	49,700 (5,000)
SED 5/FP 4	44,300 (2,500)	71,200 (4,000)	115,500 (6,500)
SED 6/FP 4	56,100 (2,700)	80,500 (3,800)	136,600 (6,500)
SED 8/FP 7	242,000 (4,700)	273,300 (5,300)	515,300 (10,000)
SED 9/FP 8	90,800 (6,500)	97,600 (7,000)	188,400 (13,500)
SED 10/FP 9	22,200 (4,400)	9,400 (1,900)	31,600 (6,300)
SED 9/FP 4 MOD	81,700 (6,100)	68,800 (5,100)	150,500 (11,200)

21 ^a Truck trips estimated assuming 20-ton capacity trucks for hauling excavated material and 16-ton trucks for local hauling of
 22 capping/backfill material. Note that many of these truck trips will not take place on public roads, and will be on a network of
 23 on-site roads constructed specifically for the purposes of remediation.

24 ^b Capping material includes cap, thin-layer cap, backfill, and bank stabilization materials.

25 ^c The number in parentheses represents average annual truck trips.

⁹ EPA does not believe that the infrastructure included in these estimates by GE has been optimized and expects that, for the selected remedy, the staging areas and roads will be designed to minimize the footprint and adverse impacts to the floodplain, neighborhoods, and local roads while allowing the remediation to proceed in a timely and effective manner.

1 The additional truck traffic would also increase the risk of traffic accidents along transport
 2 routes. The number of injuries or fatalities from the increased off-site truck traffic that would be
 3 associated with the alternatives under evaluation¹⁰ is summarized in Table 19, with the annual
 4 incidence of injuries and fatalities.

5 The incidence of potential injuries from accidents associated with increased truck traffic would
 6 be lowest for SED 10/FP 9 (1.09 injuries), with estimated injuries for the other alternatives
 7 ranging from 1.98 (SED 3/FP 3) to 11.0 (SED 8/FP 7). Similarly, estimated fatalities due to
 8 increased truck traffic are lowest for SED 10/FP 9 (0.05), with estimated fatalities for the other
 9 alternatives ranging from 0.09 (SED 3/FP 3) to 0.51 (SED 8/FP 7).

10 **Table 19 Incidence of Accident-Related Injuries/Fatalities Due to Increased Truck**
 11 **Traffic**

Impacts	SED 2/ FP 1	SED 3/ FP 3	SED 5/ FP 4	SED 6/ FP 4	SED 8/ FP 7	SED 9/ FP 8	SED 10/ FP 9	SED 9/ FP 4 MOD
Non-Fatal Injuries								
Number	---	1.98	3.29	4.03	11.0	5.43	1.09	5.36
Average Annual Number	---	0.21	0.18	0.19	0.21	0.40	0.21	0.40
Probability*	---	0.86	0.96	0.98	1.00	1.00	0.66	1.00
Fatalities								
Number	---	0.09	0.15	0.19	0.51	0.25	0.05	0.25
Average Annual Number	---	0.010	0.008	0.009	0.010	0.019	0.010	0.019
Probability*	---	0.09	0.14	0.17	0.40	0.22	0.05	0.22

12 * Probability indicates the probability of at least one injury/fatality.

13 **2.8.4 Potential Measures to Avoid, Minimize, or Mitigate Short-Term Community**
 14 **Impacts**

15 A number of measures would be employed in an effort to avoid, minimize, and mitigate potential
 16 detrimental effects of construction activities on the affected communities (e.g., minimize truck
 17 travel on local roads). As would be expected, the level of impact, and therefore, the extent of the
 18 necessary mitigation, is related to the scale/scope of the alternative and the time period of
 19 construction. Therefore, SED 8/FP 7 would have the most significant effect on local

¹⁰ This analysis quantified transport-related risks only for trucks used to import capping, backfill, and bank stabilization materials to the site over public roads, as well as to dispose of materials used for the staging areas and access roads following completion of remediation. The risks from transporting excavated materials to the staging areas are evaluated as part of risks to workers, discussed below; and the risks from transporting such materials from the staging areas to local or off-site disposal or treatment facilities are evaluated as either worker risks or traffic accident risks under the relevant treatment/disposition alternatives.

1 communities and would require the greatest degree of mitigation. SED 10/FP 9 would have the
 2 least such effect.

3 **2.8.5 Risks to Remediation Workers**

4 There would be health and safety risks to site workers implementing each of these alternatives.
 5 An estimate of the injuries or fatalities to workers from implementation of the alternatives is
 6 summarized in Table 20.

7 Risks to site workers would be lowest with SED 10/FP 9 (2.6 injuries), with the estimated
 8 injuries for all other alternatives at least twice that of SED 10/FP 9, ranging from 5.5
 9 (SED 3/ FP 3) to 30.2 (SED 8/FP 7). Similarly, estimated fatalities for site workers are lowest
 10 for SED 10/FP 9 (0.03), with estimated fatalities for the other alternatives ranging from
 11 0.05 (SED 3/FP 3) to 0.34 (SED 8/FP 7).

12 **Table 20 Incidence of Accident-Related Injuries/Fatalities Due to Implementation**
 13 **of Alternatives**

Impacts	SED 2/ FP 1 ^a	SED 3/ FP 3	SED 5/ FP 4	SED 6/ FP 4	SED 8/ FP 7	SED 9/ FP 8	SED 10/ FP 9	SED 9/ FP 4 MOD
Labor-hours (hours)	–	597,504	1,071,053	1,154,960	3,281,738	1,179,703	285,106	1,000,000
Duration (yrs)	–	10	18	21	52	14	5	13
Non-Fatal Injuries								
Number	–	5.5	9.9	10.7	30.2	10.9	2.6	9.2
Average Annual Number	–	0.55	0.55	0.51	0.58	0.78	0.53	0.69
Probability ^b	–	1.00	1.00	1.00	1.00	1.00	0.93	1.00
Fatalities								
Number	–	0.05	0.11	0.11	0.34	0.13	0.03	0.10
Average Annual Number	–	0.005	0.006	0.005	0.007	0.009	0.005	0.007
Probability ^b	–	0.05	0.10	0.11	0.29	0.12	0.03	0.10

14 ^a Although the monitoring activities under SED 2 would involve the potential for accidents to site workers involved in those
 15 activities, these risks would be minimal, and would be mitigated through implementation of health and safety measures similar
 16 to those successfully applied during such activities on the river in the past.

17 ^b Probability indicates the probability of at least one injury/fatality.

1 **2.9 IMPLEMENTABILITY**

2 **2.9.1 Ability to Construct and Operate the Technology**

3 The equipment, materials, procedures, and personnel necessary to construct and operate the
4 technologies comprising each of the alternatives are all readily available.

5 All of the alternatives would be implemented using well-established and available in-river
6 remediation and floodplain soil removal methods and equipment, available construction
7 technologies to build land-based support facilities, and readily available methods to implement
8 monitoring and ICs. The remedial components selected (i.e., sediment removal in the dry or wet
9 via mechanical or hydraulic methods, sediment capping and thin-layer capping, floodplain soil
10 removal and backfilling, and MNR) have been used in similar applications as part of previous
11 work at the GE-Pittsfield/Housatonic River Site and at many other sites.

12 Potential uncertainties include difficulties associated with contracting over long time periods and
13 uncertainties in obtaining the large quantities of capping and backfill materials (which would
14 range from approximately 308,000 cubic yards (cy) to approximately 2.9 million cy, as shown in
15 Table 21 from GE’s RCMS). These challenges have been overcome at other sites, and, in
16 addition, the concept of adaptive management would be used to address these uncertainties by
17 reassessing the implementation methods at regular intervals.

18 In addition, habitat restoration techniques are available and have been used successfully at other
19 sites. Restoration can reliably reestablish pre-remediation conditions for these habitats over the
20 timeframes of the various alternatives, which range from 5 to 52 years, using a phased approach.
21 Post-remediation monitoring and maintenance will ensure that the selected restoration techniques
22 reestablish the prior conditions and functions of the affected habitats.

23 **Table 21 Required Capping/Backfill/Stabilization Material Volumes for**
24 **Alternatives**

Combination	Sand (cy)	Capping Material (cy)	Soil Backfill (cy)	Total Material (cy)
SED 2/FP 1	---	---		---
SED 3/FP 3	150,800	76,100	81,000	307,900
SED 5/FP 4	372,800	246,100	133,000	751,900
SED 6/FP 4	438,800	279,100	133,000	850,900
SED 8/FP 7	1,976,800	255,100	677,000	2,908,900
SED 9/FP 8	446,800	221,400	195,000	863,200
SED 10/FP 9	33,500	34,900	29,000	97,400
SED 9/FP 4 MOD	571,000	155,500	75,000	801,500

25 Note: Capping material quantities include materials for caps, thin-layer caps, and backfill in the river, as well as bank
26 stabilization. Soil backfill includes the backfill to be placed in floodplain excavations.

1 **2.9.2 Reliability of the Technology**

2 The individual technical components of all alternatives, both individually and in combination,
3 are considered reliable, as shown by previous work conducted at the site, including the ½-Mile
4 and 1½-Mile Reach removal actions, which included many of the components of the alternatives,
5 and similar work performed at riverine/floodplain hazardous waste sites for a number of years.
6 Although information regarding remedies at other sediment sites indicates that there have been a
7 limited number of dredging/removal projects of the magnitude of the largest of the alternatives
8 being considered here (i.e., SED 8/FP 7), the techniques being used are considered readily
9 scalable and adaptable to the size and setting of the Rest of River. As discussed above, although
10 thin-layer capping has been used at other sites, it is not expected to be a reliable or effective
11 component for this site.

12 **2.9.3 Regulatory and Zoning Restrictions**

13 No regulatory and/or zoning restrictions are known that would affect the implementability of any
14 of the alternatives under evaluation. Implementation of all alternatives, except SED 2/FP 1,
15 would require GE to obtain permission for access to the properties where the work would be
16 conducted or where the support facilities would be located. Although many of these properties
17 are owned by the Commonwealth or the City of Pittsfield (which have agreed to allow access in
18 the Consent Decree), it is anticipated that access agreements would be required from numerous
19 other property owners – up to approximately 35 such landowners for SED 10/FP 9, 35 to 45 for
20 SED 3/FP 3, 35 to 50 for SED 9/FP 4 MOD, 40 to 50 for SED 5/FP 4, 50 to 60 for SED 6/FP 4
21 and SED 9/FP 8, and 80 to 95 for SED 8/FP 7. Obtaining access to all these properties for the
22 type of work and length of time that may be needed would require negotiations with landowners;
23 however, this is feasible given the timeframe over which the work would be accomplished (5 to
24 52 years). In contrast to other more extensive alternatives, SED 9/FP 8 and SED 9/FP 4 MOD
25 may have an advantage in this respect due to the remediation method (no sheetpile, no large
26 cranes, less clearing, and smaller access roads), requiring less extensive agreements with
27 landowners in Reaches 5A and 5B.

28 **2.9.4 Ease of Undertaking Additional Corrective Measures**

29 None of the alternatives being evaluated would preclude the implementation of additional
30 corrective measures if deemed necessary to meet performance standards and/or to achieve
31 protection of human health and the environment. If additional corrective measures are necessary
32 for those alternatives that include the installation of engineered bank stabilization and/or
33 sediment caps, it may be necessary to remove and reinstall such structures, thereby increasing the
34 overall cost of the remedy in comparison with alternatives that do not include such protective
35 structures. However, this consideration does not provide a reasonable basis for distinguishing
36 between the alternatives. Additional corrective actions, such as repairs, if necessary, should
37 provide the same implementation challenges for all active alternatives.

38 **2.9.5 Ability to Monitor Effectiveness of Remedy**

39 The ability to implement a monitoring program for determining the effectiveness of the remedy
40 is similar for all alternatives evaluated in this Comparative Analysis. Such a monitoring program

1 would typically include some combination of water, sediment, and biota sampling to determine
2 PCB flux, residual sediment PCB concentrations, and concentrations of PCBs in edible fish
3 species. Sampling and analysis of these environmental media is not different for any of the
4 alternatives. However, alternatives that have little or no active remediation are less reliable;
5 therefore, they would require more extensive monitoring.

6 **2.9.6 Coordination with Other Agencies**

7 All of the alternatives would include coordination with EPA and state agencies in
8 implementation of biota consumption advisories and other ICs (e.g., environmental restrictions
9 and easements (EREs) and conditional solutions), discussions on potential MESA issues,
10 obtaining access to state-owned lands, and public/community outreach programs. The
11 alternatives with a greater extent of remediation and a longer implementation time would likely
12 require more extensive and prolonged coordination activities. However, the alternatives in
13 which less remediation is performed would require more extensive ICs.

14 **2.9.7 Availability of Suitable Treatment, Storage, and Disposal Facilities**

15 This component of the selection decision factor is discussed in Section 3, Comparative Analysis
16 of Treatment/Disposition Alternatives.

17 **2.9.8 Availability of Prospective Technologies**

18 This component of the selection decision factor is discussed in Section 3, Comparative Analysis
19 of Treatment/Disposition Alternatives.

20 **2.10 COST**

21 The estimated costs for each of the alternatives evaluated, including total capital costs, estimated
22 annual OMM costs, and total estimated present worth costs, are summarized in Table 22. The
23 total costs for these alternatives (without considering treatment/disposition costs) range from
24 \$5 million (for MNR, SED 2/FP 1) to \$917 million (most extensive remediation option,
25 SED 8/FP 7). Present worth costs range from \$1.8 million (SED 2/FP 1) to \$300 million
26 (SED 8/FP 7). The costs for all alternatives, except for SED 9/FP 4 MOD, are based on the
27 information available at the time of the estimate and are based on GE's cost estimates provided
28 in GE's RCMS. The cost estimate for SED 9/FP 4 MOD is detailed in Attachment 8. EPA
29 generally believes that GE may have under-estimated all costs. However, because all costs were
30 estimated by the same methodology, they are acceptable for comparing costs relative to each
31 alternative, including the proposed alternative. In addition, the actual costs of remediation depend
32 on many variables, including the quantity of material removed, disposal fees, health and safety
33 regulations, ARARs, actual labor, equipment, fuel and material costs, and the final project scope.

1

Table 22 Cost Summary for Alternatives

Total Cost	SED 2/ FP 1	SED 3/ FP 3	SED 5/ FP 4	SED 6/ FP 4	SED 8/ FP 7	SED 9/ FP 8	SED 10/ FP 9	SED 9/ FP 4 MOD
Capital (\$ M)	0	167	307	384	900	381	84	314
OMM (\$ M)	5	10	12	13	17	13	10	12
Total (\$ M)	5	177	319	397	917	394	94	326
Present Worth (\$M)	1.8	133	193	219	300	251	78	228

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Notes:

1. All costs are in 2010 dollars. \$ M = million dollars.
2. Total capital costs are for engineering, labor, equipment, and materials associated with implementation.
3. Total OMM costs include costs for monitoring, post-construction inspections and repair activities (if necessary), long-term monitoring (fish, sediment, water column, visual), and for the maintenance of institutional controls and EREs.
4. Total present worth cost is based on using a discount factor of 7%, considering the length of the construction period and an OMM period of 100 years on a reach-specific basis.
5. Estimates do not include costs for treatment or disposition of any soil/sediment removed; those costs are outlined in Section 3.

11 **2.11 OVERALL CONCLUSION FOR REMEDIATION ALTERNATIVES**

12 For the reasons discussed above, EPA believes that of all the remediation alternatives, SED 9/FP
13 4 MOD is best suited to meet the General Standards in consideration of the Selection Decision
14 Factors.

15 **3 COMPARATIVE ANALYSIS OF TREATMENT/DISPOSITION**
16 **ALTERNATIVES**

17 This section presents a comparative evaluation of the five alternatives for treatment and/or
18 disposition of excavated contaminated river sediment and floodplain soil that were presented in
19 GE’s RCMS, plus an additional alternative that was developed by EPA in consultation with the
20 states of Massachusetts and Connecticut subsequent to the RCMS. The treatment/disposition
21 alternatives were evaluated using the same criteria that were used for the sediment/floodplain
22 remediation alternatives.

23 This comparative analysis evaluates the relative performance of the various treatment/disposition
24 alternatives under the permit criteria to identify the relative advantages and disadvantages of
25 each alternative. The tables present information from GE’s RCMS for the five alternatives
26 included in that document. Information for a new sub-alternative (TD 1 RR) was developed by
27 EPA using, where possible, GE’s underlying cost assumptions.

28 **3.1 OVERVIEW OF ALTERNATIVES**

29 All five alternatives would involve some disposition of the sediment and floodplain soil in a
30 disposal facility, either directly or after treatment. The three alternatives involving disposal only
31 are: (1) disposal in off-site permitted landfills (TD 1); (2) disposal in an on-site confined disposal
32 facility (CDF) in a local waterbody, e.g., Woods Pond or one or more backwaters (TD 2); and (3)

1 disposal in an on-site upland disposal facility, for which three potential locations have been
2 identified by GE (TD 3). The other two alternatives would involve treatment, either by a
3 chemical extraction process (TD 4) or by thermal desorption (TD 5). EPA also evaluated an
4 additional alternative based on TD 1 but specifying transport of excavated material by rail be
5 maximized; this variation is termed TD 1 RR.

6 The results of a bench-scale test of a representative chemical extraction process indicate that
7 PCB concentrations in the treated sediment and soil would not be sufficiently low to allow reuse
8 on-site; therefore, the treated sediment and soil resulting from TD 4 would have to be transported
9 to a landfill for disposal. For TD 5, it is assumed that the thermal desorption process would
10 reduce the concentrations of PCBs in the treated solid materials to levels (around 1 to 2 mg/kg)
11 that could allow reuse in the floodplain¹¹ and that it would not increase the leachability of metals
12 from those materials so as to preclude such use. However, due to uncertainties regarding the
13 ultimate effectiveness of the treatment process (as well as issues relating to the reuse of the
14 treated soil), TD 5 has also been evaluated based on the additional alternate assumption that all
15 the treated material would be transported to an off-site landfill for disposal.

16 All of the treatment/disposition alternatives except TD 2 were evaluated considering the same
17 range of sediment and soil volumes that could be removed under any combination of the
18 individual sediment and floodplain alternatives, not just the combinations of alternatives
19 evaluated in Section 2. This range extends from 191,000 cy, based on a combination of SED 3
20 and FP 2, to 2.9 million cy, based on a combination of SED 8 and FP 7. Under TD 2, however,
21 the in-water CDF(s) would be used only for the disposition of hydraulically dredged sediment
22 from Reaches 5C and 6, which would be generated only under SED 6, SED 7, SED 8, or SED 9.
23 Thus, TD 2 was evaluated for a range of hydraulically dredged sediment volumes from 300,000
24 cy for SED 6 to 1,240,000 cy for SED 8. For cost comparison purposes, the TD 2 analysis
25 assumes that the sediment and soil not placed in the CDF(s) would be transported off-site for
26 disposal. Under this assumption, the lower-bound costs for TD 2 are based on the combined
27 volumes from SED 6 and FP 2, and the upper-bound costs are based on the combined volumes
28 from SED 8 and FP 7.

29 All five alternatives were evaluated against the nine criteria discussed in Section 2.1. There is no
30 comparison or evaluation of attainment of IMPGs because this is not applicable to material
31 treatment/disposition.

32 **3.2 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT**

33 As with the SED and FP alternatives, the evaluation of whether the treatment/disposition
34 alternatives would provide overall human health and environmental protection draws on the
35 evaluations under several other permit criteria, notably long-term effectiveness and permanence
36 (including long-term adverse impacts), and short-term effectiveness.

37 TD 1 (off-site disposal) would provide protection of human health and the environment by
38 providing for permanent disposal of the PCB-contaminated sediment and soil in permitted off-

¹¹ For reuse as backfill in the floodplain, only 50% of the volume is assumed to be the treated material because following thermal treatment the material would be sterile, requiring amendments to be suitable for floodplain restoration.

1 site landfills. Relative to other alternatives, only minor on-site short-term impacts would occur
2 under TD 1.

3 TD 1 RR (off-site disposal with rail transport) would provide protection of human health and the
4 environment equivalent to TD 1 with respect to PCB-contaminated sediment and soil, with some
5 additional protection afforded by the rail transport component, which would reduce the effects on
6 surrounding neighborhoods from truck traffic. There would be somewhat greater on-site short-
7 term impacts due to the need to construct a small rail yard and loading facility at some point
8 along the existing rail right-of-way.

9 TD 2 (disposition in on-site CDF[s]) would provide protection of human health by permanently
10 isolating the hydraulically dredged sediment from Reaches 5C and 6 in covered in-water CDF(s),
11 which would be subject to monitoring and maintenance to verify their long-term integrity.
12 However, this alternative would not provide for disposition of any remaining sediment or the
13 excavated floodplain soil, which would need to be disposed of elsewhere. Although CDFs have
14 been successfully implemented in other settings, implementation of TD 2 in the Housatonic
15 River could cause significant long-term environmental impacts because the CDF(s) would result
16 in a permanent loss of the aquatic habitat in a large portion of Woods Pond and/or one or more of
17 the backwaters where the CDF(s) would be constructed, and potentially could be breached in the
18 future should a catastrophic event occur. TD 2 would result in a permanent loss of flood storage
19 capacity in those areas (assuming that sufficient compensatory flood storage could not be
20 provided).

21 TD 3 (on-site upland disposal) would provide protection of human health and the environment
22 by permanently isolating the PCB-contaminated sediment and soil in an upland disposal facility,
23 which would be constructed with an appropriate double liner, cover, and double leachate
24 collection system. Although this alternative would cause a change in existing habitat within the
25 operational footprint of the upland disposal facility, the capped landfill area would be replanted
26 with grass, and the support areas that are no longer needed after closure would be restored. The
27 significance of the long-term or permanent change in habitat would depend on the existing
28 habitat at the selected location and the size of the facility. This alternative would have additional
29 short-term impacts such as truck transport of landfill leachate over public roads to GE's
30 groundwater treatment plant (GWTP) located in Pittsfield, and the operation of the landfill for
31 the duration of the remedy. Alternatively, GE would have to construct, operate, and maintain a
32 treatment facility at each of the upland disposal facilities. If these treatment facilities were not
33 operated properly, there would be the potential for releases of PCBs into the area where the
34 facility is located or into the Housatonic River.

35 TD 4 (chemical extraction) would provide protection of human health and the environment by
36 reducing the PCB concentrations in the sediment and soil, followed by off-site disposal of the
37 treated material. However, the long-term reliability and effectiveness of the chemical extraction
38 process have not been demonstrated for Housatonic River sediment. A bench-scale study for this
39 technology using material from Rest of River failed to demonstrate that site sediment and soil
40 can be treated effectively, in part due to a failure to achieve reasonable mass balance calculations
41 as well as acceptable residual concentrations.

1 TD 5 (thermal desorption) would provide human health protection by reducing the PCB
2 concentrations in the sediment and soil, followed by on-site reuse and/or off-site disposal of
3 those treated materials and off-site disposal/destruction of the liquids containing the condensed
4 PCBs. On-site reuse of a portion of the treated soil would be protective of human health because
5 the treated solids would be sufficiently characterized to ensure that residual PCB concentrations
6 would not cause adverse human health effects. However, if a portion of the treated soil is reused
7 as backfill in the floodplain, that reuse would potentially result in long-term adverse
8 environmental impacts in the forested floodplain and other wetland areas due to the differences
9 in soil characteristics between those materials and the existing natural soil in those wetland areas
10 unless the treated soil is properly amended. In addition, regardless of whether treated soil is
11 reused in the floodplain, TD 5 would produce the greatest amount of GHG emissions of any of
12 the alternatives.

13 **3.3 CONTROL OF SOURCES OF RELEASES**

14 All of the treatment/disposition alternatives would control the potential for PCB-contaminated
15 sediment and soil to be released and transported within the river or onto the floodplain, although
16 some alternatives would provide more effective control of such releases than others. TD 1 (or
17 TD 1RR) best meet this criterion, followed by TD 3.

18 Under both TD 1 and TD 1 RR, placement of the removed PCB-contaminated sediment and soil
19 in a permitted off-site landfill or landfills would effectively isolate those materials from being
20 released into the environment.

21 Under TD 2, placement of the PCB-contaminated sediment and soil into CDF(s) would most
22 likely effectively isolate the removed materials from being released into the environment.
23 However, there is a potential for releases of sediment into the river during the CDF construction
24 process.

25 TD 3 would address future releases through the placement of the materials in an upland disposal
26 facility and the implementation of a long-term monitoring and maintenance program. Placement
27 of the PCB-contaminated sediment and soil into an upland disposal facility would most likely
28 effectively isolate the removed materials from being released into the environment. However,
29 the potential remains for releases to occur to the Housatonic River watershed both during
30 operations and in the long term if the facility, including potentially a water treatment plant, was
31 not properly operated and maintained.

32 Under TD 4 and TD 5, the potential for the PCB-contaminated sediment and soil to be released
33 within the river or onto the floodplain during treatment operations would be minimal. However,
34 the potential remains for releases to occur to the Housatonic River watershed both during
35 operations and in the long term if the facilities were not properly operated and maintained.
36 Under TD 4, the treated solid materials would be transported to an off-site landfill for disposal,
37 the wastewater would be subject to treatment prior to discharge to the river, and the water
38 treatment sludge would also be transported to an off-site landfill for disposal. Under TD 5, to the
39 extent that some of the treated solids are used as backfill in the floodplain, chemical
40 characterization sampling would be performed to verify that those materials would not present
41 concerns regarding future releases or exposure. The remainder of the treated solids, or all such

1 solids if none are reused as floodplain backfill, would be transported to an off-site landfill for
2 disposal, and the concentrated PCB-contaminated liquid condensate from the thermal desorption
3 process would be sent off-site for incineration.

4 **3.4 COMPLIANCE WITH FEDERAL AND STATE ARARs**

5 Each of the TD alternatives would involve moving the sediment, bank soil, and floodplain soil
6 from the point of excavation to the treatment/disposition point, and each TD alternative would
7 attain the ARARs, except as discussed below.

8 TD 1, with disposal off-site at one or more permitted disposal sites, would have fewer additional
9 ARARs than the other treatment/disposition alternatives, and would attain the requirements.
10 TD 1 RR would have all the same ARARs as TD 1. TD 2, an in-water CDF, would be
11 considered a hazardous waste and solid waste disposal site, and would have ARARs associated
12 with its location in the river, and with being in a potential habitat area for state-listed species.
13 TD 2 would not meet wetland and floodplain requirements. TD 3, on-site landfiling, has
14 ARARs associated with being a hazardous waste and solid waste disposal site, and possibly
15 impacts on wetland areas. In addition, two of the potential locations for the TD 3 upland
16 disposal facility, along with the CDFs, are in, or in close proximity to, a state-designated Area of
17 Critical Environmental Concern (ACEC). As such, not all potential locations of TD 2 or TD 3
18 will meet the requirements of 310 CMR 30.708 or the site suitability criteria in the
19 Commonwealth's Site Assignment Regulations for Solid Waste Facilities, 310 CMR 16.40(3)(4),
20 which prohibit hazardous waste and solid waste facilities in an ACEC, or adjacent to or in close
21 proximity to an ACEC such that it would fail to protect the outstanding resources of an ACEC.
22 Furthermore, certain locations of TD 3 would not meet the Massachusetts Hazardous Waste
23 Facility Site Safety Council Regulations (990 CMR 5.04), which provide criteria for evaluation
24 of a notice of intent for siting a hazardous waste facility, including that it is not within an ACEC.

25 TD 4 and TD 5 have ARARs related to the treatment of toxic substances/hazardous waste, and
26 depending on their location, would have wetland, floodplain, and/or species habitat ARARs to
27 attain.

28 Additional information on federal and state ARARs is provided in Attachment 13.

29 **3.5 LONG-TERM RELIABILITY AND EFFECTIVENESS**

30 The assessment of long-term reliability and effectiveness for the treatment/disposition
31 alternatives included an evaluation of the magnitude of residual risk, the adequacy and reliability
32 of the alternatives, and the potential long-term adverse impacts on human health or the
33 environment.

34 **3.5.1 Magnitude of Residual Risk**

35 Placement of PCB-contaminated sediment/soil in off-site permitted landfills (TD 1 and TD 1
36 RR), in one or more CDF(s) (TD 2), or in an upland disposal facility (TD 3) would permanently
37 isolate those materials from direct contact with human and ecological receptors. Under TD 2, as
38 noted above, there is a greater potential for releases and resulting risk than under TD 1 and TD 3,
39 although there is some risk of releases from TD 3.

1 Under TD 4 and TD 5, it is not expected that there would be any significant residual risks,
2 because: (1) all treatment operations would be performed within secured areas, and residual
3 PCBs associated with the operations would be removed following completion of the treatment
4 operations; (2) all treated materials would be subject to verification sampling and successfully
5 and unsuccessfully treated material would be transported off-site for disposal, except for any
6 such material reused on-site under TD 5; and (3) any such treated materials reused on-site under
7 TD 5 would be sampled to verify that the material to be reused would not pose a residual risk.

8 In summary, all of the treatment/disposition alternatives would minimize future residual risk
9 from exposure to the PCB-contaminated materials, although there would be a greater potential
10 for such exposure under TD 2 and TD 3 than under the other alternatives, for the reasons noted
11 above.

12 **3.5.2 Adequacy and Reliability of Alternatives**

13 There are considerable differences in the adequacy and reliability of the five
14 treatment/disposition alternatives. Based on these differences, the adequacy and reliability
15 criterion favors either TD 1, TD 1 RR, or TD 3 for disposal of the excavated materials under all
16 alternatives.

17 Use of off-site disposal facilities (TD 1 and TD 1 RR) is a common and effective means for
18 permanent disposition of PCB-contaminated material. As the volume of materials requiring
19 disposal increases, multiple facilities may be required, but that is not expected to be a major
20 consideration.

21 In-water CDFs (TD 2) have been used to dispose of dredged PCB-contaminated sediment at
22 some sites. In this case, as discussed above, there is a somewhat greater potential for releases
23 from the CDF(s) than from off-site or local upland disposal facilities.

24 On-site disposal of PCB-contaminated materials in an upland facility (TD 3) has been used as
25 part of a final remedy at a number of sites and is an effective and reliable means for permanently
26 isolating such materials, provided the facility is properly constructed, monitored, and maintained.
27 However, the potential extended duration of the operation of such a facility for the range of
28 volumes of sediment and soil and the length of remedy implementation could necessitate that the
29 facility operate for an extended period of time. In addition, GE proposes to truck the leachate
30 generated under TD 3 to its water treatment facility located in Pittsfield. This involves a one-
31 way trip of between 10 and 20 miles along public roads for the foreseeable future. The proposed
32 facility near Woods Pond could generate as much as 600,000 gallons of leachate per month
33 (based on its maximum size of 18 acres for 2,000,000 cy) for 10 to 20 years, requiring over 1,000
34 truck trips per year (120 per month) while the facility is still receiving material. Based on
35 SED 8/FP 7, which has a volume of 2,900,000 cy, the amount of leachate could be as high as
36 1,000,000 gallons per month (based on the maximum landfill footprint at the site near Rising
37 Pond). This volume could occur for up to 52 years and would require 200 truck trips per month
38 or 2,400 per year. Alternatively, GE would have to construct, operate, and maintain a treatment
39 facility at each of the upland disposal facilities. If these treatment facilities were not operated
40 properly, there would be the potential for releases of PCBs into the area where the facility is

1 located or into the Housatonic River. TD 3 relies heavily on proper long-term operation,
2 maintenance, and monitoring activities.

3 The use of chemical extraction (TD 4) has not been demonstrated at full scale on sediment and
4 soil representative of the Rest of River. The results of bench-scale testing using site sediment
5 and soil did not demonstrate that this technology would be effective. As a result, there are
6 uncertainties about the long-term reliability and effectiveness of operating such a system for a
7 project of the size and duration, and with the range of PCB concentrations, that would be
8 involved at the Rest of River. These and other factors create uncertainties regarding the
9 effectiveness and reliability of using the chemical extraction process in a full-scale application.

10 Thermal desorption (TD 5) has been used at several sites to treat PCB-contaminated soil;
11 however, there is only limited precedent for use of this technology on sediment due in part to the
12 time and cost of removing moisture from the sediment prior to treatment. At the sites identified
13 where thermal desorption has been used, the volumes of materials that were treated were
14 substantially smaller and the duration of the treatment operations was substantially shorter than
15 the volumes and duration that could be required at the Rest of River. Furthermore, when on-site
16 reuse of treated materials has occurred, the materials have typically been placed in a small area
17 and covered with clean backfill. For these reasons, the adequacy and reliability of this process
18 for a long-term treatment operation with a large volume of materials such as sediment/soil from
19 the Rest of River is uncertain.

20 **3.5.3 Potential Long-Term Adverse Impacts on Human Health or the Environment**

21 Implementation of TD 1, TD 1 RR, TD 2, and TD 3 would isolate the removed sediment/soil
22 from potential human and ecological exposure because the material would be contained in
23 structures designed specifically for that purpose. Under TD 4, removed material would first be
24 treated, and then disposed of off-site. For TD 5, materials would be treated, and then a portion
25 might be reused in the floodplain, assuming that it has acceptable residual levels of
26 contaminants, with the remainder disposed of off-site. Thus, under all the treatment/disposition
27 alternatives, no long-term adverse impacts on humans or ecological receptors from exposure to
28 the PCB-contaminated materials are expected, with the potential exception of TD 2 if a release
29 were to occur (e.g., during an extreme storm event).

30 TD 1 would not cause any adverse long-term environmental impacts in the Rest of River area
31 because it would involve off-site transport and disposal of the PCB-contaminated materials.

32 TD 1 RR would also not result in adverse long-term environmental impacts in the Rest of River
33 area. The rail yard and loading facility would be demobilized following completion of the
34 remedy and the area restored to its former condition.

35 For TD 2, the placement of an in-water CDF in Woods Pond and/or one of the two identified
36 backwaters would have the most significant long-term adverse environmental impacts, including
37 a permanent loss of the aquatic habitat in those areas. Depending on the location and size of the
38 CDF(s), TD 2 could adversely affect the priority habitat of up to nine state-listed species. In
39 addition, the CDF(s) would raise the topography of the CDF area(s), reduce available
40 shoreline/wetland habitat, and produce a loss of the existing flood storage capacity.

1 For TD 3, the construction of the upland disposal facility, which, for the Woods Pond site, is
2 located within an Area of Critical Environmental Concern, would result in the alteration of
3 existing habitat within the operational footprint of that facility. In the landfill area itself, as well
4 as any support areas (e.g., access roads) that would remain after closure, the habitat alteration
5 would be permanent, although the landfill would be capped and planted. The significance of the
6 change in habitat would depend on the existing habitat at the location of the facility, as well as
7 the size of the facility.

8 Under TD 4 and TD 5, the construction and operation of a 5-acre treatment facility at the former
9 DeVos property would result in some loss of the relatively low-quality habitat within that area (a
10 former agricultural area that is now open grassland with scattered shrubs) during the period of
11 treatment operations and for a few years thereafter. That loss, as well as increased noise and
12 human presence in the area, would affect the wildlife in the area (which includes the priority
13 habitat for some state-listed species) during that period. However, given the relatively small size
14 of the facility, the altered nature of the habitat, and the planned reseeded of the area with a
15 grassland mix following removal of the facility, long-term ecological impacts associated with
16 construction and operation of the facility would be minimal.

17 Based on this analysis of the treatment/disposition alternatives, TD 2, and to a lesser extent TD 3
18 (depending on the actual landfill location selected), would have the greatest long-term adverse
19 environmental impacts. TD 4 and TD 5 would have similar environmental impacts, but less than
20 TD 3 because they would be in place only for the duration of the remedial construction. TD 1
21 and TD 1 RR would have the least long-term impacts.

22 **3.6 ATTAINMENT OF IMPGs**

23 Attainment of IMPGs is not applicable to evaluation of treatment and disposition alternatives.

24 **3.7 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME**

25 The degree to which the treatment/disposition alternatives would reduce the TMV of PCBs is
26 discussed below.

27 **3.7.1 Treatment Process Used and Materials Treated**

28 TD 1 through TD 3 (including TD 1 RR) would not include any treatment processes that would
29 reduce the toxicity of, or directly affect, PCB concentrations in the removed sediment and soil.
30 TD 4 and TD 5 would incorporate treatment processes that can, to varying degrees, reduce
31 concentrations of PCBs. Under TD 4, the chemical treatment process would reduce the toxicity
32 of the sediment and soil by permanently removing some PCBs from these materials, although the
33 effectiveness of this technology is questionable. Under TD 5, the indirect-fired thermal
34 desorption system would reduce the toxicity of the PCB-contaminated sediment and soil by
35 permanently removing PCBs from these materials, and the PCBs in the liquid stream would be
36 sent to a permitted off-site disposal facility for destruction. The volume and nature of the
37 materials to be treated would be determined by the selected remediation alternative and are,
38 therefore, identical for all treatment/disposition alternatives.

1 **3.7.2 Amount of Hazardous Materials Destroyed or Treated**

2 As noted above, only TD 4 and TD 5 specify the treatment and/or destruction of PCBs. TD 4
3 would remove PCBs from contaminated soil and sediment via chemical treatment but would not,
4 in itself, destroy any of the PCBs so removed. In addition, the effectiveness of this process on
5 site materials has not been demonstrated. TD 5 would similarly not destroy PCBs on-site, but
6 only separate them from the site soil and sediment. Subsequent destruction of PCBs could be
7 accomplished on-site via further treatment of the waste stream from either TD 4 or TD 5, but is
8 not an inherent component of either alternative.

9 **3.7.3 Degree of Expected Reductions in Toxicity, Mobility, or Volume**

10 Reduction of Toxicity: TD 1 through TD 3 (including TD 1 RR) would not include any treatment
11 processes that would reduce the toxicity of, or directly affect, PCB concentrations in the removed
12 sediment and soil. TD 4 and TD 5 would incorporate treatment processes that can, to varying
13 degrees, reduce concentrations of PCBs and therefore reduce toxicity, as discussed above.

14 Reduction of Mobility: All of the alternatives would reduce the mobility of PCBs in the sediment
15 and soil. In TD 1, TD 1 RR, TD 2, and TD 3, these materials would be removed and disposed of
16 in off-site permitted landfill(s) (TD 1 and TD 1 RR) or permanently contained within on-site
17 CDF(s) (TD 2) or an upland disposal facility (TD 3). TD 4 and TD 5 would reduce the mobility
18 of PCBs present in the sediment/soil via chemical extraction or thermal desorption.

19 Reduction of Volume: TD 1, TD 1 RR, TD 2, and TD 3 would not reduce the volume of PCB-
20 contaminated material. For TD 4, treatment of sediment/soil would reduce the volume of PCBs
21 present in those materials by transferring some of the PCBs to an aqueous waste stream for
22 subsequent treatment. PCB-contaminated sludge would be generated from the wastewater
23 treatment system and would be sent to a permitted off-site facility for disposal. For TD 5,
24 treatment of sediment/soil in the thermal desorption system would reduce the volume of PCBs
25 present in those materials, with the liquid condensate transported to an off-site facility for
26 destruction.

27 **3.7.4 Degree to Which Treatment Is Irreversible**

28 This criterion is not applicable to TD 1 through TD 3 because these alternatives do not involve
29 treatment. For TD 4 and TD 5, off-site treatment of the extracted PCB waste streams would
30 result in the permanent and irreversible destruction of PCBs.

31 **3.7.5 Type and Quantity of Residuals Remaining After Treatment**

32 This criterion applies only to alternatives TD 4 and TD 5. Because the materials to be treated
33 would be determined by the remediation alternative selected and the details would be determined
34 in the final design of the remediation, both treatment alternatives would begin with the same type
35 and quantity of material. As discussed above, thermal absorption (TD 5) is a more proven
36 technology than chemical extraction and, recognizing that dewatering of sediment may present
37 additional technical complexity for this process, it is believed that TD 5 will result in residual
38 materials that may be sufficiently low in PCB concentration to be reused on-site. In the case of

1 TD 4, the chemical extraction process is believed to result in residuals of PCB concentration that
2 will require landfilling following treatment.

3 **3.8 SHORT-TERM EFFECTIVENESS**

4 Evaluation of the short-term effectiveness of the treatment/disposition alternatives includes
5 consideration of the short-term impacts of implementing these alternatives on the environment
6 (considering both ecological effects and increases in GHG emissions), on the local communities
7 (as well as communities along truck transportation corridors), and on the workers involved in the
8 treatment and disposition activities.

9 **3.8.1 Impacts on the Environment**

10 All the treatment/disposition alternatives would produce some short-term adverse impacts on the
11 environment, but to varying degrees depending on the duration and scope of the alternative.
12 TD 1 would have the least impacts of all the TD alternatives, requiring only access roads and
13 staging areas for loading of vehicles for off-site transport. TD 1 RR would require the
14 construction of a rail yard and loading facility at some point along the existing rail right-of-way
15 and would require approximately the same amount of access roads and staging areas as TD 1.
16 The short-term impacts of TD 2 through TD 5 would include loss of habitat and loss or
17 displacement of aquatic biota and other wildlife in the areas where the disposition or treatment
18 facilities are located, as well as in adjacent areas, during construction and operations. TD 2
19 would affect a portion of Woods Pond and/or one of the two backwaters identified for a CDF, as
20 well as the adjacent floodplain. Specific short-term impacts associated with TD 3 would depend
21 on the habitat at the selected location and the operational footprint of the facility. Construction
22 of a treatment facility for TD 4 or TD 5 on the former DeVos property would result in the
23 temporary reduction of open field habitat on that property.

24 All of the treatment/disposition alternatives could also have short-term effects on the
25 environment due to the potential for accidental releases of PCB-contaminated materials. In
26 particular, TD 3 has the risk of the release of leachate during its transport from the upland
27 disposal facility(s) to the GE GWTP in Pittsfield if an alternate treatment facility is not
28 constructed. In addition, TD 4 and TD 5 have the potential for failure of process and control
29 equipment during operations, which could result in a release of PCB-contaminated materials.
30 The potential for these types of effects would increase with the volume of materials removed and
31 the length of the implementation period.

32 **3.8.2 Carbon Footprint – GHG Emissions**

33 GHG emission estimates were developed based on the ranges of the potential volumes of
34 sediment and soil that would require disposal or treatment. Table 23 summarizes the resulting
35 ranges of total GHG emissions associated with each TD alternative. To provide context
36 regarding the emissions reported, the number of passenger vehicles that would emit an
37 equivalent quantity of CO_{2-eq} in 1 year is also presented in the table.

38 As shown in Table 23 for the TD alternatives evaluated in the RCMS (excluding TD 2, which is
39 not comparable, and TD 1 RR for which estimates were not available), TD 5 would have the
40 greatest amount of total GHG emissions for the range of volumes; TD 4 would have the next

1 largest amount; followed by TD 1. TD 3 would have lowest amount of total GHG emissions for
 2 the range of volumes, approximately 3 to 5 times less than the next lowest alternative (TD 1).
 3 TD 1 RR would have significantly lower GHG emissions than TD 1 because the emissions due
 4 to off-site truck transport would be replaced by the much lower emissions resulting from off-site
 5 transport via rail. It should be noted, however, that the magnitude of the differences among
 6 alternatives varies with the removal volume. For example, the lower-bound estimates for TD 1
 7 and TD 3 are 19,000 and 5,500 tonnes, respectively, a difference of 13,500 tonnes. However, the
 8 upper-bound estimates are 290,000 tonnes for TD 1 and 61,000 tonnes for TD 3, a difference of
 9 229,000 tonnes (17 times more than the difference at the lower bound). The differences in GHG
 10 emissions between TD 1 and TD 3 are due to the distance that materials need to be trucked
 11 before ultimate disposition. Such differences are even more pronounced when comparing TD 3
 12 with TD 4 and TD 5.

13 **Table 23 Calculated GHG Emissions Anticipated to Result from**
 14 **Treatment/Disposition Alternatives**

Alternative	Total GHG Emissions (tonnes)	No. Vehicles with Equivalent Emissions
TD 1	19,000 – 290,000	3,600 – 55,400
TD 2	See Note 1	See Note 1
TD 3 (see Note 2)	5,500 – 61,000	1,100 – 11,700
TD 4	27,000 – 370,000	5,200 – 70,700
TD 5 (with reuse)	66,000 – 1,000,000	12,600 – 191,200
TD 5 (without reuse)	66,000 – 1,100,000	12,600 – 210,300

15 Notes:
 16 1. Emissions estimated for TD 2 range from 2,700 to 8,800 tonnes and do not include the emissions that would be necessary
 17 for off-site transport and disposal of materials that are not placed in the CDF(s). As such, these estimates are not
 18 comparable to the emissions listed for the other alternatives.
 19 2. The lower bound of this range for TD 3 is based on disposal of the minimum potential removal volume at the Woods Pond
 20 site (which would have the lowest GHG emissions of the identified sites) and the upper bound is based on disposal of the
 21 maximum potential removal volume at the Rising Pond site, which is the only one of the identified local disposal sites that
 22 could accommodate that maximum volume. Note also that the Woods Pond site is located within the State-designated Area
 23 of Critical Environmental Concern.

24 **3.8.3 Impacts on Local Communities**

25 All the alternatives would also result in short-term impacts to the local communities in the Rest
 26 of River area. These impacts would include disruption, noise, and other impacts resulting from
 27 the increased truck traffic and from the construction and operation of the on-site disposition or
 28 treatment facilities. TD 1 RR, due to its use of rail transport, would result in a significant
 29 decrease in impacts to local communities due to reduced off-site truck traffic. In addition,
 30 unique to TD 3, leachate potentially being transported via truck from the upland disposal
 31 facility(s) could be released en route due to malfunctioning equipment or an accident, creating
 32 impacts to the local communities, and the operation of the landfill for the duration of the remedy.

1 The estimated numbers of off-site truck trips for each alternative, based on the estimated range of
 2 volumes that could be involved, are shown in Table 24.¹²

3 **Table 24 Estimated Off-Site Truck Trips for Treatment/Disposition Alternatives**

Alternative	Off-Site Truck Trips for Lower-Bound Volume	Off-Site Truck Trips for Upper-Bound Volume
TD 1	15,900 (2,000)	243,000 (6,100)
TD 2	See Note 3	See Note 3
TD 3 (see Note 4)	1,450 (180)	68,000 (3,600)
TD 4	15,900 (2,000)	243,000 (6,100)
TD 5 (with reuse)	13,300 (1,700)	190,500 (4,800)
TD 5 (without reuse)	14,300 (1,800)	218,900 (5,500)
TD 1 RR	0 (0) Note 7	0 (0)

4 Notes:

- 5 1. Truck trips estimated assuming 16-ton capacity trucks for importing material and equipment to the site, 20-ton capacity
 6 trucks for transporting excavated materials, and 20% bulking factor in the trucks.
- 7 2. The number in parentheses represents average annual truck trips.
- 8 3. Truck trips estimated for TD 2 range from 5,600 to 19,500 and do not include the truck trips that would be necessary for off-
 9 site transport and disposal of materials that are not placed in the CDF(s). As such, these estimates are not comparable to the
 10 numbers of truck trips listed for the other alternatives.
- 11 4. The lower bound of this range for TD 3 is based on construction of an upland disposal facility at the Woods Pond site and
 12 the upper bound is based on construction of such a facility at the Forest Street site. Note that the Woods Pond site is located
 13 in a State-designated Area of Critical Environmental Concern, and Forest Street is in close proximity to the ACEC.
- 14 5. A 10% volume reduction of sediment/soil after treatment has been assumed for thermal desorption treatment (TD 5).
- 15 6. For TD 5 with reuse, it is assumed that approximately 50% of the floodplain soil treated by thermal desorption would be
 16 reused on-site and that all remaining materials would be transported off-site for disposal.
- 17 7. It was assumed for the purpose of this analysis that there would be zero off-site truck trips; however, use of trucks may be
 18 necessary under certain conditions.

19 As shown in this table, excluding TD 2, which is not comparable, TD 3 would involve the fewest
 20 off-site truck trips for the range of volumes, whereas those for the other alternatives are roughly
 21 comparable, with somewhat more for TD 1 and TD 4 than for TD 5. TD 1 RR will maximize the
 22 transport of the contaminated soil via rail; therefore, off-site truck traffic will be minimized.
 23 Again, however, the magnitude of the differences among alternatives varies with the removal
 24 volume. The additional truck traffic would also increase the risk of traffic accidents along
 25 transport routes. An analysis of potential risks from the increased off-site truck traffic that would
 26 be associated with the treatment/disposition alternatives in terms of potential fatalities and non-
 27 fatal injuries is presented in Table 25.

28 The incidence of potential injuries and fatalities resulting from accidents associated with
 29 increased off-site truck traffic would be the greatest for TD 1 and TD 4, followed closely by

¹² For comparability among alternatives, this table shows only off-site truck trips, i.e., those for importation of construction materials and equipment to the site over public roads for construction and closure of a local disposal or treatment facility, as well as those for transport of excavated or treated soil/sediment to off-site disposal facilities. It does not include transport of excavated materials from the staging areas to the local disposal or treatment facility.

1 TD 5, and would be far lower for TD 3. As with the number of off-site truck trips, the
 2 differences in estimated injuries and fatalities resulting from such traffic become more
 3 pronounced as the removal volumes increase. Because TD 1 RR would require no off-site truck
 4 traffic, no injuries or fatalities are associated with this alternative because it was assumed for the
 5 purpose of this analysis that there would be zero off-site truck trips; however, it may be
 6 necessary to use trucks instead of rail under certain conditions.

7 **Table 25 Incidence of Accident-Related Injuries/Fatalities**
 8 **Due to Increased Off-Site Truck Traffic**

Impacts	TD 1	TD 2	TD 33	TD 4	TD 5 (with Reuse)	TD 5 (without Reuse)	TD 1 RR
Non-Fatal Injuries							
Number	4.34 – 67.03	See Note 2	0.03 – 1.60	4.11 – 62.87	3.44 – 49.24	3.70 – 56.59	Note 4
Average Annual Number	0.45 – 1.28	See Note 2	0.0002 – 0.084	0.51 – 1.57	0.43 – 1.23	0.46 – 1.41	0
Probability ¹	99 – 100%	See Note 2	3 – 80%	98 – 100%	97 – 100%	98 – 100%	-
Fatalities							
Number	0.20 – 3.14	See Note 2	0.002 – 0.07	0.19 – 2.94	0.16 – 2.31	0.17 – 2.65	0
Average Annual Number	0.02 – 0.06	See Note 2	0.0002 – 0.004	0.02 – 0.07	0.02 – 0.06	0.02 – 0.07	0
Probability ¹	18 – 96%	See Note 2	0.2 – 7%	18 – 95%	15 – 90%	16 – 93%	-

9 Notes:

- 10 1. Probability indicates the probability of at least one injury/fatality.
 11 2. The estimated risks of accidents for TD 2 are based only on the truck trips necessary to transport materials to the site for the
 12 construction of the CDF(s) and do not consider the truck trips for off-site transport of the materials that would not be placed
 13 in the CDF(s). As such, those risks are not comparable to the estimated risks for the other treatment/disposition alternatives
 14 (which consider all removed materials). Under the scenario evaluated, the risks estimated for TD 2 are 0.01 to 0.02
 15 fatalities (with a 1% to 2% probability of at least one fatality) and 0.13 to 0.46 non-fatal injuries (with a 12% to 37%
 16 probability of at least one injury).
 17 3. The lower bound of this range for TD 3 is based on construction of an upland disposal facility at the Woods Pond site and
 18 the upper bound is based on construction of such a facility at the Forest Street site.
 19 4. It was assumed for the purpose of this analysis that there would be zero off-site truck trips; however, use of trucks may be
 20 necessary under certain conditions.

21 **3.8.4 Potential Measures to Avoid, Minimize, or Mitigate Short-Term**
 22 **Environmental and Community Impacts**

23 A number of measures would be employed in an effort to avoid, minimize, or mitigate the short-
 24 term impacts of the treatment/disposition alternatives on the environment and the affected
 25 communities. As would be expected, the level of impact and thus the scope and duration of

1 mitigation measures are related to the scale/scope of the alternative and the duration of
 2 implementing the alternative. For TD 1, the mitigation measures would relate to the increased
 3 truck traffic, whereas for the other TD alternatives, mitigation measures would address the
 4 increase in truck traffic as well as the impacts associated with the construction and operation of
 5 the different facilities.

6 **3.8.5 Risks to Remediation Workers**

7 There would also be health and safety risks to site workers implementing each of these
 8 alternatives. For TD 1 and TD 1 RR, these risks would consist of risks to the truck drivers and,
 9 in the case of TD 1 RR, railroad employees, and to the employees of the off-site disposal
 10 facilities, rather than to on-site remediation workers, and thus, were not quantified. For TD 2
 11 through TD 5, an analysis of estimated risks to site workers is summarized in Table 26.

12 Estimated risks to site workers for the range of volumes would be lowest for TD 2 (due to its
 13 fewer years of operation) and higher for the other alternatives, with TD 3 slightly higher than
 14 TD 4 and TD 5. In this case, there are no substantial differences among TD 3, TD 4, and TD 5 at
 15 the same volumes, but there are significant differences between the lower and upper bounds.

16 **Table 26 Incidence of Potential Accidents/Injuries Due to**
 17 **Implementation of Alternatives TD 2 through TD 5**

Impacts	TD 2	TD 3 ^a	TD 4	TD 5
Labor-hours (hours)	73,000 – 259,000	306,000 – 1,836,000	160,600 – 1,673,600	160,600 – 1,673,600
Years of Operation	6 – 20	8 – 40	8 – 40	8 – 40
Non-Fatal Injuries				
Number	0.70 – 2.50	2.69 – 16.4	1.27 – 13.1	1.27 – 13.1
Average Annual Number	0.12 – 0.13	0.34 – 0.41	0.16 – 0.33	0.16 – 0.33
Probability ^b	50 – 92%	93 – 100%	72 – 100%	72 – 100%
Fatalities				
Number	0.01 – 0.03	0.02 – 0.11	0.007 – 0.08	0.007 – 0.08
Average Annual Number	0.0012 – 0.0013	0.002 – 0.003	0.0009 – 0.002	0.0009 – 0.002
Probability ^b	1 – 3%	2 – 11%	0.7 – 8%	0.7 – 8%

18 ^a The lower bound of this range for TD 3 is based on disposal of the minimum potential removal volume at the Woods Pond
 19 site, and the upper bound is based on disposal of the maximum potential removal volume at the Rising Pond site, which is
 20 the only one of the identified local disposal sites that could accommodate that maximum volume and thus, has the longest
 21 period of operations.

22 ^b Probability indicates the probability of at least one injury/fatality.

23 **3.8.6 Summary of Short-Term Effectiveness**

24 All of the treatment/disposition alternatives would have some short-term negative impacts on the
 25 environment, local communities, and communities along transport routes. TD 2 through TD 5
 26 would cause a loss of habitat and loss or displacement of wildlife in the area where the disposal
 27 or treatment facility is located, as well as in adjacent areas, during construction and operation of

1 the facility. In addition, all alternatives would involve the potential for accidental releases of
2 various PCB-contaminated materials during transportation to off-site or local disposal or
3 treatment facilities. This potential would increase with TD 2, TD 3, TD 4, and TD 5 because
4 those alternatives would pose additional risks associated with the potential for failure of process
5 and control equipment during operations, and releases of process byproducts/chemicals/leachate
6 to the environment. Although all alternatives would generate GHG emissions, for the range of
7 volumes (excluding TD 2, which is not comparable), TD 5 would produce the most such
8 emissions and TD 3 would produce the least.

9 Estimates of off-site truck trips and traffic accident risks from that truck traffic indicate that, for
10 the range of volumes (excluding TD 2), TD 1 and TD 4 would involve the most off-site truck
11 trips and cause the most injuries related to such transport, followed closely by TD 5, with far
12 fewer off-site truck trips and transport-related injuries for TD 1 RR and TD 3. In terms of risks
13 to on-site workers, excluding TD 1 (which would not affect site workers) and TD 2 (which is not
14 comparable), the estimated injuries for the other three TD alternatives are roughly comparable
15 for the same volumes.

16 **3.9 IMPLEMENTABILITY**

17 The relative implementability of the treatment/disposition alternatives is evaluated below using
18 the eight specific components of this criterion specified in the RCRA Permit.

19 **3.9.1 Ability to Construct and Operate the Technology**

20 Each of the technologies under evaluation can be constructed and operated as necessary. For the
21 alternatives involving landfilling, hazardous materials landfills are routinely constructed and
22 operated and the techniques involved are well known and of demonstrated effectiveness. Any
23 necessary transportation infrastructure, including construction of a small rail yard and loading
24 facility in the case of TD 1 RR, would similarly present no difficulties.

25 In the case of TD 2, the construction and operation of in-water CDFs has also been implemented
26 at many locations, particularly in the Great Lakes. Although construction and operation of a
27 CDF in a flowing river is less common, the locations proposed for the CDF(s) in the Rest of
28 River are in non-flowing, or very slightly flowing, areas.

29 Although the effectiveness of thermal desorption and of chemical extraction technology has not
30 yet been demonstrated for Housatonic River soil and sediment, both basic processes are in use in
31 other locations. Construction and operation of facilities in the Rest of River area may present
32 some minor logistical issues, but none of these issues is believed to present unusual problems.

33 **3.9.2 Reliability of the Technology**

34 For the alternatives involving landfilling, hazardous waste landfills have been proven to be
35 reliable in reducing and/or eliminating exposure to hazardous materials placed in them.
36 Similarly, transportation of hazardous materials via truck or rail is a routine and accepted
37 technology with appropriate controls to safeguard the public and workers. CDFs have similarly
38 been shown to be reliable when constructed and operated properly. In the case of TD 2,
39 construction of CDFs in an area that could be subject to flooding and stronger river flow in the

1 case of extreme storm events makes this technology less reliable than it would be when applied
2 to non-riverine situations.

3 Chemical extraction is of unknown, but somewhat questionable, reliability in the case of PCB-
4 contaminated soil and sediment from Rest of River. A pilot-scale study of one technology using
5 site-specific materials failed to demonstrate the effectiveness of chemical extraction for these
6 materials; therefore, chemical extraction cannot be considered reliable at this time. Thermal
7 desorption, although generally accepted as a reliable technology for removing contaminants from
8 soil, has similarly not been demonstrated on Housatonic River materials and, in addition, would
9 involve prior dewatering of contaminated sediment. Although sediment dewatering is a
10 generally proven and accepted technology, its effectiveness in conjunction with thermal
11 desorption has not been demonstrated on sediment from Rest of River. Accordingly, thermal
12 desorption cannot be considered a reliable technology for the proposed application at this time.

13 **3.9.3 Regulatory and Zoning Restrictions**

14 TD 1 and TD 1 RR would be conducted in accordance with the requirements of applicable
15 federal, state, and local regulations relating to the off-site transport and disposal. The four other
16 alternatives would be “on-site” activities for the purposes of the permit exemption set forth in
17 Section 121(e) of the Comprehensive Environmental Response, Compensation, and Liability Act
18 (CERCLA) and Paragraph 9.a of the Consent Decree. As such, no federal, state, or local permits
19 or approvals would be required. However, implementation of these alternatives would need to
20 comply with the substantive requirements of applicable or relevant and appropriate regulations
21 (i.e., ARARs) (unless waived), and as noted above, two of the three sites proposed for an upland
22 disposal landfill would likely be affected by ACEC and Massachusetts regulations restricting
23 siting of such facilities within or in close proximity to an ACEC.

24 Implementation of TD 1 would not require access agreements beyond those necessary to conduct
25 the remediation. Implementation of TD 2 and TD 3 would require permanent access to the
26 location(s) selected for the disposal facility(ies). Implementation of TD 4 and TD 5 would
27 require access to the location selected for the treatment facility; GE is the current owner of the
28 potential location identified for TD 4 and TD 5, as well as one potential location for TD 3. It is
29 EPA’s understanding that GE has negotiated the right to acquire the other two sites identified as
30 potential locations for TD 3. Therefore, assuming use of one or more of these locations, no site
31 access agreements would be required for implementation of TD 3 through TD 5, but such
32 agreements may be required for TD 2. TD 1 RR would require an access agreement for the rail
33 siding and loading facility, which would be assumed to be temporary.

34 In conclusion, there is a clear distinction among the alternatives with respect to this criterion:
35 TD 1 would be easiest to implement, followed closely by TD 1 RR, with TD 2 and TD 3 being
36 the most difficult and time consuming to implement from an administrative perspective, whereas
37 TD 4 and TD 5 would experience similar difficulties from a technical perspective. Construction
38 of either an in-water CDF (TD 2) or an on-site hazardous waste landfill (TD 3) would face
39 considerable public opposition and would also potentially conflict with the designation of the
40 area as an ACEC.

1 **3.9.4 Ease of Undertaking Additional Corrective Measures**

2 The primary constraint on the ability of any of the treatment/disposition alternatives to
3 accommodate additional corrective measures relates to their ability to deal with increased
4 volumes of contaminated material. In the case of TD 1 and TD 1 RR, there is some uncertainty
5 regarding the future availability of the necessary capacity in off-site landfills, which could
6 present issues if it was deemed necessary to undertake additional corrective measures that would
7 require removal of additional volumes of contaminated soil and/or sediment. Capacity would be
8 an even greater issue with TD 2 because there is some question whether the proposed CDF(s)
9 have sufficient capacity to deal with the volume of material that would be generated by the
10 remedial alternatives already under consideration.

11 In the case of TD 3, the capacity of the proposed on-site landfills is known and is sufficient to
12 receive a volume of material considerably greater than the most extensive remedial alternative
13 under consideration (SED 8/FP 7). However, the capacity is finite, and if additional remediation
14 well beyond that alternative is proposed, landfill capacity would represent a constraint on the
15 ability to undertake such an expanded remediation.

16 TD 4 (chemical extraction) does not appear to be capable of lowering PCB concentrations in
17 treated material to a level that would allow treated materials to be reused on site. Because such
18 material would require removal to an off-site landfill and would not be decreased in volume as
19 compared with non-treated material, TD 4 is subject to the same potential issues discussed for
20 TD 1 and TD 1 RR. It is believed that TD 5 (thermal desorption) may produce material that
21 could be reused on-site, so there is decreased concern over landfill capacity limitations, but it
22 remains uncertain that such low concentrations can be achieved.

23 **3.9.5 Ability to Monitor Effectiveness of Remedy**

24 All of the treatment/disposition alternatives can readily be monitored with existing and well-
25 established techniques, and such monitoring would be part of any comprehensive OMM program
26 for the remediation of the river. For an in-river CDF (TD 2), more intensive monitoring to
27 ensure the integrity of the facility would likely be required, but no special techniques would be
28 necessary. Similarly, in the case of TD 4 or TD 5, additional monitoring of the treatment process
29 performance would presumably be part of the monitoring program, but such additional
30 monitoring presents no unique technical challenges.

31 **3.9.6 Coordination with Other Agencies**

32 All alternatives would require coordination with EPA, as well as state and local agencies. TD 2
33 and TD 3 would require extensive coordination with local government and the public. Based on
34 past public input received, these options could encounter substantial local and state opposition,
35 likely rendering these alternatives difficult, and potentially not feasible, to implement. TD 4 and
36 TD 5 would require similar coordination; however, the level of coordination would likely be less
37 than that for TD 2 and TD 3. The Commonwealth of Massachusetts has expressed a strong
38 preference for treatment/disposition alternatives that will permanently relocate contaminated
39 materials in licensed out-of-state facilities, with a strong preference for the use of rail. Of the
40 evaluated alternatives, only TD 1 and TD 1 RR could satisfy this requirement.

1 **3.9.7 Availability of On-Site or Off-Site Treatment, Disposal, and Storage**
2 **Facilities**

3 For TD 1 and TD 1 RR, there are uncertainties regarding the future availability of the necessary
4 capacity in off-site landfills for the alternatives that have the larger volumes and longer
5 durations. In addition, TD 1 RR has some additional uncertainty related to the timing and
6 availability of rail transport capacity.

7 For TD 2, it would likely not be feasible to obtain sufficient flood storage compensation at the
8 appropriate elevations/areas to provide for construction of a CDF(s) large enough to hold the
9 necessary sediment disposal volumes. For TD 3, construction and use of an upland disposal
10 facility would be technically implementable, but practically very difficult, if not impossible, to
11 implement. Three potential locations for such a facility, with varying maximum capacities
12 (ranging from 1.0 to 2.9 million cy), have been identified.

13 TD 4 and TD 5 would be implementable provided that vendors are available to operate the
14 treatment process. The former DeVos property could be used as a potential area to locate a
15 treatment facility. However, there are several uncertainties regarding full-scale application of
16 both chemical and thermal processes to sediment (e.g., moisture content), particularly with some
17 of the volumes associated with the sediment alternatives.

18 **3.9.8 Availability of Prospective Technologies**

19 The availability of additional and/or innovative treatment/disposition technologies during the life
20 of the project is possible, but at this time, none has been demonstrated. In general, any
21 technologies that become available during the implementation of the remediation would be
22 evaluated in a manner similar to that discussed above for Alternatives TD 4 and TD 5. Such an
23 ex situ technology has been proposed and may be tested during the implementation of the
24 preferred remedy.

25 **3.10 COST**

26 The estimated cost ranges for each treatment/disposition alternative, including total capital cost,
27 estimated annual OMM cost, and total estimated present worth are summarized in Table 27 and
28 are taken from GE's RCMS, except for TD 1 RR, which is summarized in Attachment 8. Note
29 that, in this case, the costs presented for TD 2 include not only the costs for disposition in the
30 CDF(s) of the hydraulically dredged sediment from Reaches 5C and 6 under SED 6 through SED
31 9, but also the estimated costs for off-site transport and disposal of the remaining sediment
32 removed under those alternatives, as well as the excavated floodplain soil (lower-bound costs
33 consider SED 6 and FP 2, and upper-bound costs consider SED 8 and FP 7). In addition, for
34 TD 3, the range of costs presented are for an upland disposal facility constructed at the Rising
35 Pond site because that is the only single location with the capability to hold the maximum
36 potential volume of 2.9 million cy. As shown in Table 27, TD 3 is the least costly alternative.
37 At the low end of the volume range, it would cost about 2 to 4 times less than the other
38 alternatives; and at the high end of the range, it would cost about 2 to 10 times less. TD 1,
39 TD 1RR, and TD 2 are more costly than TD 3, but less costly than TD 4 and TD 5. TD 5 is the
40 most expensive alternative.

1 **3.11 OVERALL CONCLUSION FOR TREATMENT/DISPOSITION ALTERNATIVES**

2 For the reasons discussed above, EPA believes that of all the treatment/disposition alternatives,
3 TD 1 RR is best suited to meet the General Standards in consideration of the Selection Decision
4 Factors.

Table 27 Cost Summary for Treatment/Disposition Alternatives

	TD 1	TD 2	TD 3	TD 4	TD 5 (with reuse)	TD 5 (without reuse)	TD 1 RR
Total Capital Costs	0	\$6 – 20 M	\$10 – 67 M	\$17 – 20 M	\$20 – 232 M	\$20 – 232 M	\$300,000
Total Disposal, Operations, Monitoring and Maintenance Cost	\$55 – 832 M	\$94 – 490 M	\$26 – 134 M	\$72 – 979 M	\$83 – 1,216 M	\$86 – 1,293 M	\$52 – 787 M
Total Cost for Alternative	\$55 – 832 M	\$100 – 510 M	\$36 – 201 M	\$89 – 999 M	\$103 – 1,450 M	\$106 – 1,530 M	\$52 – 787 M
Total Present Worth	\$40 – 220 M	\$46 – 131 M	\$17 – 49 M	\$70 – 286 M	\$81 – 569 M	\$83 – 590 M	\$38 – 210M

Notes:

1. All costs are in 2010 dollars, except total present worth values. \$ M = million dollars,
2. The fraction of TSCA material has been assumed to be 35%. A density of 1.62 tons per cubic yard was assumed.
3. The Massachusetts hazardous waste transport fee is not included in these estimates. The fee would potentially apply to TSCA material transported off-site via truck. This fee would potentially apply to TD 1, and portions of TD 2, TD 4, and TD 5. The fee is currently \$56.25 per ton, including a vehicle identification fee. For TD 1 for Combination 9, the total fee is estimated to be \$31.3 million. The fee is not applicable to off-site disposal via rail (TD 1 RR).
4. With the exception of TD 2, the ranges of costs presented are the minimum and maximum anticipated costs based on the potential range of volumes that would be potentially removed under the sediment and floodplain soil alternatives (191,000 cubic yards to 2.9 million cubic yards). For TD 2, the lower-bound costs are based on the combined volume of SED 6 and FP 2 and the upper-bound costs are based on the combined volume of SED 8 and FP 7, with material not placed in the CDF(s) assumed to be transported off-site for non-TSCA disposal. Thus, the upper-bound costs, but not the lower-bound costs, for TD 2 are comparable to the costs for the other alternatives.
5. Total capital costs are for engineering, labor, equipment, and materials associated with implementation.
6. Total operations costs consist of the total of the average annual costs for operation, placement, and/or treatment of sediment and/or soil, estimated for the range of durations for implementing the alternatives.
7. Total monitoring and maintenance costs are for performance of post-closure monitoring and maintenance programs of 100 years for TD 2 and TD 3 and 5 years for TD 4 and TD 5.
8. Total present worth cost is based on using a discount factor of 7%, considering the range of total potential durations for the alternative, and post-closure monitoring and maintenance periods of 100 years for TD 2 and TD 3 and 5 years for TD 4 and TD 5.
9. For TD 5 with reuse, it is assumed that approximately 50% of the floodplain soil treated by thermal desorption would be reused on-site and that all remaining materials would be transported off-site for disposal.
10. Costs for TD 3 do not include the very likely extensive costs associated with the approval process required for an on-site landfill.