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THIRD FIVE-YEAR REVIEW REPORT FOR THE HUDSON RIVER PCBs SUPERFUND SITE

Prepared by

U.S. Environmental Protection Agency
Region 2
New York, NY

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LIST OF ABBREVIATIONS AND ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
BERA	Baseline Ecological Risk Assessment
CAG	Community Advisory Group
CCC	Criteria Continuous Concentration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CIP	Community Involvement Plan
CTE	Central Tendency Exposed
CU	Certification Unit
CY	Cubic Yards
ERT	Environmental Response Team
FWQC	Federal Water Quality Criteria
FYR	Five-Year Review
g/m^2	grams per square meter
GE	General Electric Company
HHRA	Human Health Risk Assessment
IC	Institutional Controls
IRIS	Integrated Risk Information System
kg	kilogram
LOAEL	Lowest Observed Adverse Effect Level
MCY	Million cubic yards
mg/kg	milligrams per kilogram
mg/kg-ww	milligrams per kilogram wet-weight
µg/L	micrograms per liter
MNA	Monitored Natural Attenuation
MNR	Monitored Natural Recovery
MPA	Mass Per Unit Area; typically expressed as grams per square meter (g/m^2)
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

ng/L	nanograms per liter
NOAEL	No Observed Adverse Effect Level
NMPC	Niagara Mohawk Power Corporation
NPL	National Priorities List
NYC	New York City
NYS	New York State
NYSCC	New York State Canal Corporation
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
OLEM	EPA Office of Land and Emergency Management
OM&M	Operation, Maintenance, and Monitoring
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit; an officially designated portion of a CERCLA site for investigation and remediation purposes
PCB	Polychlorinated Biphenyl
PCMP	Post-Closure Maintenance Plan
ppm	parts per million
PRG	Preliminary Remediation Goal
RAF	Risk Assessment Forum
RAO	Remedial Action Objective
RI/FS	Remedial Investigation and Feasibility Study
RM	River Mile
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RS	River Section
RSA	Recoverable-Sediment Area
RWA	River-Wide Area
Site	Hudson River PCBs Superfund Site
STRA	Short-Term Response Actions

TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEFs	Toxicity Equivalence Factors
TPCB	Total PCB
$TPCB_{HE}$	Total PCB Homologue Equivalent
Tri+ PCBs	Sum of all measured PCB congeners with three or more chlorine atoms per molecule
UE	Unrestricted Exposure
UHR	Upper Hudson River
USGS	United States Geological Survey
UU	Unlimited Use

EXECUTIVE SUMMARY

Background

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy to determine if the remedy is and will continue to be protective of human health and the environment. The review was conducted pursuant to Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 U.S.C. § 9621(c), and 40 C.F.R. § 300.430(f)(4)(ii) and undertaken in accordance with EPA's Comprehensive Five-Year Review Guidance, OSWER Directive 9355.7-03B-P (June 2001). The last FYR included data through 2016 and EPA initiated this FYR when five additional years of data (2017 to 2021) were available. The preliminary fish data from 2022 has also been included in Appendix 3 of this report, however, this data did not change the findings in this report. This statutory FYR has been prepared because hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use (UU) and unrestricted exposure (UE).

The Hudson River Superfund Site encompasses a nearly 200-mile stretch of the Hudson River from Hudson Falls, NY to the Battery in New York City (NYC). From approximately 1947 to 1977, the General Electric Company (GE) discharged polychlorinated biphenyls (PCBs) into the Hudson River from its capacitor manufacturing plants at Hudson Falls and Fort Edward. The discharged PCBs were transported downriver and adhered to sediments which settled in downstream depositional areas including the pool behind the Fort Edward Dam. In 1973, the Fort Edward Dam was removed due to its deteriorating state, resulting in the further downstream distribution of PCBs that had accumulated behind the dam. The removal of the dam exposed former river bottom contaminated with PCBs; these areas are known as the Remnant Deposits. During subsequent floods, PCB-contaminated sediments from the Fort Edward Dam area were scoured and transported downriver.

The U.S. Environmental Protection Agency (EPA) is addressing the Site in discrete phases or components known as operable units (OUs). The Hudson River Superfund Site is currently divided into 5 OUs; FYRs address OUs for which a remedy has been selected and where identified contamination has been left behind:

- OU1: Remnant Deposits, is addressed in this FYR;
- OU2: sediments of the Upper Hudson River (UHR), is addressed in this FYR;
- OU3: Rogers Island, work complete, is not addressed in this FYR;
- OU4: UHR Floodplains, under investigation, is not addressed in this FYR; and
- OU5: sediments of the Lower Hudson River (LHR), under investigation, is not addressed in this FYR.

There are currently two RODs for the Hudson River PCBs Superfund Site, the 1984 ROD (EPA 1984) that called for the capping of the remanent deposits (OU1)[1] which was completed in 1991 and the 2002 ROD (EPA 2002) for the UHR sediments (OU2) that called for a two-part remedy: dredging followed by monitored natural recovery. Dredging was performed between 2009 and 2015 (with no dredging occurring in 2010). In total, EPA calculated that 2.7 million cubic yards (MCY) of sediment were dredged from the river, processed, and shipped via train to approved landfills for disposal. This volume (2.7 MCY) was consistent with the estimated 2.65 MCY presented in the 2002 ROD (EPA, 2019a), and the estimated Total PCB (TPCB) mass removed (156,000 kilograms [kg]) was 123 percent more than the estimated 69,800 kg. Although the remedy did not call for capping, during dredging 107 acres of caps were installed where dredging could not fully remove the PCB contaminated sediment.

Monitoring of the UHR and Remnant Deposits is ongoing. Regular Remnant Deposit inspections are conducted to evaluate the remediation activities' performance and identify potential problems and maintenance requirements in a timely and consistent manner. Monitoring of the UHR includes regular sampling and analysis of water, sediment and fish to track recovery of the river and progress toward ROD targets and goals. Regular monitoring of post-construction habitat reconstruction is also conducted. The OM&M program also includes monitoring of the caps placed during dredging.

FYR Community Involvement

EPA guidance allows for different levels of outreach and public engagement during the FYR process, depending on the nature of the site and the level of community interest. Community involvement activities during a FYR typically include notifying the community that the FYR will be conducted and, again, when it is completed. Because the Hudson River PCBs Site covers a large geographic area and has significant public interest, the EPA expanded its community involvement activities for this Site.

The agency provided opportunities for project stakeholders to be involved throughout the process by establishing an active and robust FYR team, communicating with stakeholders face-to-face and via conference call and providing updates at regularly scheduled Community Advisory Group (CAG) meetings. Additionally, EPA project staff at the Hudson River Office in Albany, N.Y., have been accessible and available throughout the FYR process to answer questions from stakeholders and members of the public. EPA will also provide an opportunity for the public and

[1] The 1984 ROD evaluated remedial alternatives for the PCB-contaminated sediments in the UHR. However, a “no action” alternative was deemed appropriate at the time, as there existed a lack of data on effective and reliable methods for addressing the contaminated sediment. The 1984 ROD also called for a detailed evaluation to assess whether the domestic water supply at Waterford, NY required additional treatment due to the presence of PCBs.

project stakeholders to provide input on the findings of the review during a 90-day comment period.

Summary of Technical Assessments

Question A: Is the Remedy Functioning as Intended by the Decision Documents?

OU1

The Remnant Deposits remedy is functioning as intended by the 1984 ROD. In-place containment of the formerly exposed Remnant Deposits (Remnant Deposits 2, 3, 4, and 5[2]) was completed in 1991 and prevents direct public contact with PCB-contaminated sediments and potential volatilization of the PCBs. The water column PCB concentrations immediately downstream of the Remnant Deposits at the Rogers Island monitoring station during the post-dredging period (2016 to 2021) have averaged approximately 0.87 nanograms per liter (ng/L) or parts per trillion (ppt). The low PCB level in the river immediately downstream of the Remnant Deposits suggests that the Remnant Deposits are not a significant source of PCBs to the river. While the OU1 remedy is functioning as intended by the 1984 ROD, it should be noted that the 1984 ROD did not identify ICs for the Remnant Deposits. In order for the remedy to be protective in the long-term, ICs should be implemented that would restrict future use of the remnant properties to uses and activities that would not compromise the integrity of the cap system or result in unacceptable risks of exposures to contaminants.

OU2

The remedial action was implemented consistent with the expectations of the ROD, and while human health and ecological remedial goals have not yet been achieved, progress is being made toward Remedial Action Objectives (RAOs) presented in the ROD. Based on analyses presented in this FYR, at least eight or more years of data (i.e., at least two or more years of data beyond the current post-dredging dataset) are needed before a meaningful time trend in PCB concentrations for water column and fish data can be determined. This time frame is supported by studies of fish at other contaminated sediment sites which indicate that more than 10 years of data are optimal for use in estimating time trends.

EPA anticipated at the time of the ROD that post dredging reach-averaged PCB (Tri+) concentrations in the surface sediment would decline at an annual rate of approximately seven to nine percent, consistent with long-term historical trends (EPA, 2000a), and that these rates of decline would be similar in water and fish tissue. As time progresses and concentrations decrease, it is assumed these rates will decline. It is EPA’s expectation that short-term post-dredging rates

[2] Remnant Deposit 1 originally appeared as an island, but due to flooding in 1976 and 1983 most of the exposed sediment associated with this deposit was scoured.

will be at least 5 percent per year in all three media and has designed the long-term monitoring program for fish, water and sediment to being able to detect a 5 percent annual rate of decline with 80 percent power and 95 percent confidence in 10 years. Therefore, it is likely that 10 years of data may be necessary before there are sufficient data to establish whether, and at what rate, PCBs are declining in all three media. Evaluating all three media together provides additional confidence relative to an evaluation of a single medium, as all three media are expected to recover together. EPA estimates that as many as eight or more years of post-dredging fish tissue data are needed to establish a statistically relevant trend.

The evaluations in this report focus on the six years (2016 to 2021) of post-dredging data. Pre-dredging baseline and dredging period data were collected for different objectives and are used in this report when necessary and appropriate. The following summarizes the major conclusions and evaluations presented in the report:

- The most recent bathymetric surveys conducted in 2016 and 2018 indicate the isolation caps installed during dredging are physically stable and chemical monitoring of the caps will be conducted in 2026 to confirm caps are working as designed. If the isolation caps are not functioning as intended GE is required to make the appropriate repairs.

- During the post-dredging period, the average water column Tri+ PCB[3] concentration entering OU2 from upstream (as measured at the Rogers Island monitoring station) is 0.87 ng/L, which is below the ROD expectation of 2 ng/L. About 95 percent of samples collected at Rogers Island had water column Tri+ PCB concentrations less than 2 ng/L.

- Water column, sediment and fish concentrations on average are less than the pre-dredging period and remain within expectations.
    - Post-dredging water column PCB concentrations at the monitoring stations within the project area (i.e., Thompson Island Dam, Schuylerville, and Waterford) decreased relative to both the pre-dredging and dredging periods, with annual geometric mean Tri+ PCB concentrations less than 10 ng/L and TPCB concentrations typically less than 20 ng/L.
    - During the most recent (2021) sediment sampling event, Recoverable Sediment Area- (RSA) weighted average concentrations were 1.1 mg/kg, 1.9 mg/kg, and 0.64 mg/kg in RS 1, RS 2 and RS 3, respectively, a decrease compared to pre-dredging conditions.

[3] The Tri+ PCB concentration represents the sum of all measured PCB congeners with three or more chlorine atoms per molecule. The higher chlorinated PCB congeners are more readily accumulated in fish tissue compared with the lower chlorinated congeners (mono- and di-homologues).

  - The post-dredging period geometric mean wet-weight and lipid-normalized TPCB data for brown bullhead, yellow perch and pumpkinseed were generally at or below pre-dredging levels.

- Institutional controls in the form of fish consumption restrictions and fish consumption advisories are in place for the UHR to help limit fish consumption and inform the public of the health risks associated with consuming fish contaminated with PCBs.

- Habitat reconstruction and replacement were conducted as anticipated to mitigate impacts from the dredging operations. OM&M of reconstructed habitats will continue until benchmark and Success Criteria project metrics are met.

The following summarizes progress being made toward RAOs presented in the 2002 ROD:

- RAO #1: Reduce the cancer risks and non-cancer health hazards for people eating fish from the Hudson River by reducing the concentration of PCBs in fish.

  - The fish species-weighted[4] average TPCB concentration for the UHR as of 2021 was 0.71 milligrams per kilogram wet-weight (mg/kg-ww). The preliminary 2022 average was 0.58 mg/kg-ww. Modeling results presented in the ROD estimated that the first human health target for protection of human health (0.4 mg/kg-ww) would be reached five years after the completion of dredging. Similarly, model results presented in the ROD estimated the second target PCB tissue concentration for the UHR (0.2 mg/kg-ww) would be reached 16 years after the completion of dredging. Although the first target was not achieved within the five-year time period, overall concentrations are declining and are approaching the first target. Additional years of data collection are necessary to assess if the second target will be achieved in the timeframe estimated by the modeling. The percentage of sport fish below the 0.4 mg/kg-ww threshold has increased from 21 percent in the pre-dredging period to 37 percent in the post-dredging period.

- RAO #2: Reduce the risks to ecological receptors by reducing the concentration of PCBs in fish.

  - The ROD target for fish tissue PCB concentrations for the protection of ecological receptors has not yet been achieved. Targets were set for whole body largemouth bass and spottail shiner.

[4] The species-weighted average represents the average TPCB fish tissue concentrations for species expected to be commonly caught throughout the UHR for consumption and was the basis for ROD targets and goals.

  - The ROD ecological target for whole-body largemouth bass is 0.3 to 0.03 mg/kg-ww. In the post-dredging period, 6 percent of the estimated whole-body largemouth bass PCB concentrations were below the 0.3 mg/kg-ww criterion, and no results are below the 0.03 mg/kg-ww criterion. The whole-body largemouth bass concentrations were estimated by multiplying fillet concentrations by a conversion factor of 2.5. As discussed with NYSDEC, rather than estimating the concentration, EPA plans to collect whole-body data from smaller largemouth bass in future monitoring events. This data will provide information on the current risk exposure for river otter.

  - ROD ecological targets for spottail shiner (whole-body) range from 0.7 to 0.07 mg/kg-ww. As part of the ecological risk assessment, spottail shiner was used as an indicator species to represent forage fish less than 10 cm in length (EPA, 2000a). Between 2016 and 2020, the fish collection program collected a variety of forage fish species, including spottail shiner. Since the forage fish collection in the post-dredging period include other forage fish, in addition to the spottail shiner, a comparison to the ecological targets is made for the forage fish. During the post-dredging period, approximately 20 percent of the forage fish collected are below the 0.7 mg/kg-ww criterion and no results are below the 0.07 mg/kg-ww criterion. While a comparison of the forage fish data as a whole to the ecological risk criteria is appropriate, in 2021 EPA modified the fish collection program to focus solely on spottail shiner. This will reduce uncertainty in time trends (e.g., avoids uncertainty introduced by combining different species) and a direct comparison to the ROD RAO can be made.

- RAO #3: Reduce PCB levels in sediments in order to reduce PCB concentrations in river (surface) water that are above applicable or relevant and appropriate requirements (ARARs).

  - The percentage of post-dredging water column PCB measurements meeting the most stringent water column TPCB ARAR standard of 14 ng/L was 76, 44, and 57 percent at the Thompson Island Dam, Schuylerville, and Waterford monitoring stations, respectively, an improvement compared to the pre-dredging period.

- RAO #4: Reduce the inventory (mass) of PCBs in sediments that are or may be bioavailable.

  - As discussed in the Second FYR, it is estimated that 76 percent of the overall PCB mass from the UHR was removed by the dredging, exceeding the 65 percent reduction assumed in the ROD.

- RAO #5: Minimize the long-term downstream transport of PCBs in the river.
    - As discussed in the Second FYR, EPA successfully implemented resuspension performance standards during the in-water remedial activities. Additionally, relative to the pre-dredging period, the Tri+ PCB loads to the LHR have decreased.

Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Still Valid?

OU1

In 1984, when the Remnant Deposits remedy was selected, guidance on the development of risk assessment was only beginning at EPA and, as a result, a risk assessment was not conducted, and a threshold of 5 mg/kg for PCBs was used for determining areas to be capped. Remediation of the Remnant Deposits consolidated these exposed sediments greater than 5 mg/kg and capped them. Sections of this former river bottom that remain uncapped are limited and are being evaluated under the floodplain RI/FS to determine if any further work is necessary in these areas.

OU2

Human Health

The risk-based remedial goal (RG) for the protection of human health is 0.05 mg/kg PCBs in fish fillet based on the non-cancer hazard index for the Reasonable Maximum Exposure (RME) adult fish consumption rate of one half-pound meal per week (this level is protective of cancer risks as well).

Since the release of the 2002 ROD, EPA has updated guidance documents used in human health risk assessments based on the current state of the science. In 2011, Chapter 11 of the Exposure Factors Handbook was updated regarding fish consumption (EPA 2011). Additionally, exposure assumptions were updated with the release of the 2014 Office of Solid Waste and Emergency Response (OSWER) Directive No. 9200.1-120 *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors* (EPA 2014). Updates from this document include changes in exposure assumptions for body weight for the adult, skin surface area for the adult and child, drinking water ingestion rate for the young child and adult, and other parameters. These updates were documented and reviewed in the Second FYR and discussed in Appendix 11 of that document. These changes did not impact the conclusions of the Revised HHRA risk assessment or the protectiveness of the selected remedy. No exposure updates have been made since the Second FYR.

For human health risk assessments, EPA relies on toxicity values from the Integrated Risk Information System (IRIS) for the cancer slope factor and the non-cancer toxicity values. The IRIS webpage indicates that the non-cancer toxicity information for PCBs will be updated. In 2019, EPA released the *Systematic Review Protocol For The Polychlorinated Biphenyls (PCBs) Non-cancer IRIS Assessment (Preliminary Assessment Materials) (Report)* for public review and comment (Federal Register Notice, 2019). The IRIS Outlook Page indicates that the draft release of the document is planned for Fiscal Year 2024 with external review anticipated in Fiscal Year 2025. Associated changes in non-cancer toxicity values will be evaluated in the next FYR, as appropriate.

A subset of PCB congeners are dioxin-like in their structure and toxicity and are considered the most toxic of the PCB congeners. To evaluate this subset of PCBs EPA uses toxicity equivalent factors (TEFs). In 2010, The IRIS program updated the dioxin Toxicity Equivalent Factors (TEFs) for dioxin-like PCBs and issued a non-cancer toxicity value for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) (EPA, 2010a). The changes in these toxicity values and the addition of the non-cancer TEF were evaluated, and results showed that the dioxin-like PCBs do not enhance risks from TPCB exposure (EPA, 2019a).

Ecological Risks

In the Second FYR (EPA, 2019a), EPA reviewed recent toxicity data for effects of PCBs on wildlife and updated the LOAEL and NOAEL toxicity values used in the Revised BERA to 0.033 and 0.011 mg/kg/day, respectively. The refinements to the LOAEL and NOAEL toxicity values and, to a lesser degree, the otter and mink exposure parameters ultimately would result in narrower risk-based concentration ranges for PCBs in largemouth bass and spottail shiner for protection of the otter and mink. The recalculated risk-based concentration range for largemouth bass consumed by the river otter is 0.2 to 0.07 mg/kg PCBs in fish compared to 0.3 to 0.03 mg/kg PCBs in fish in the Revised BERA. The recalculated risk-based concentration range for spottail shiner consumed by the mink is 0.34 to 0.11 mg/kg PCBs in fish compared with 0.7 to 0.07 mg/kg PCBs in fish in the Revised BERA. Therefore, these recalculated ranges do not change the metrics described in the ROD.

The exposure assumptions associated with the ecological RAOs in the 2002 ROD (i.e., reduce the risks to ecological receptors by reducing the concentration of PCBs in fish) were evaluated for this FYR. A review of relevant literature was conducted, and no new information was identified that would change the validity of conclusions made in the Second FYR. As no substantial changes were identified as compared to values used in the Revised BERA, EPA concluded that the exposure assumptions supporting the RAO for ecological protection remained valid. While the review was limited to piscivorous mammalian receptors, it was assumed that this trophic level remained the most sensitive to PCBs in the UHR and that the remediation goals developed for them would also be protective of other ecological receptors.

Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

In July 2022, EPA reached an agreement with GE and Niagara Mohawk Power Corporation (NMPC), which is owned by National Grid, to dismantle the Powerhouse and Allen Mill structures located next to the former GE plant in Hudson Falls, NY. The agreement required NMPC and GE to submit detailed plans to EPA outlining how the structures will be safely removed, with measures in place to minimize the potential for a release of hazardous substances into the Hudson River. The plans included air, surface water and groundwater monitoring, and this monitoring is intended to provide the data needed to assess potential impacts. The deconstruction work started in August 2022 and will continue through 2025. The deconstruction activities are being performed under direct oversight by EPA. EPA is closely monitoring the deconstruction activities to identify any potential impacts to the OU2 Hudson River remedy.

No other information has been identified that calls into question the remedy.

Issues and Recommendations

During the five-year review process, issues were identified that could potentially affect the protectiveness of the remedy. The inclusion of an item does not necessarily indicate that the issue has an impact on the remedy, but for each issue identified, recommendations and follow-up measures are included to resolve the issue. EPA identified six issues during the five-year review process:

OU1

Issue: The 1984 ROD does not contain requirements for institutional controls. An institutional control to ensure that future use of the Remnant Deposits does not compromise the integrity of the OU1 cap system or result in unsafe exposures should be selected and implemented.

Recommendation: EPA will continue to coordinate with New York State (NYS) to determine land ownership, which would be needed for institutional controls to be properly established. Currently, fences installed at the Remnant Deposits restrict access to the sites.

EPA will coordinate as appropriate with the municipalities about potential recreational use plans for the Remnant Deposits. Any use of Remnant Deposit properties would need to be limited to non-intrusive activities that would not compromise the integrity of the cap system.

OU2

Issue 1 of 6

Issue: There are not enough sets of annual data available since the completion of sediment dredging to establish rates of decline in fish with statistical confidence. A protectiveness determination of the OU2 remedy cannot be made until the rate of decline in fish tissue can be determined from post-dredging data.

Recommendation: Once statistically relevant rates of decline in fish tissue post-dredging PCB data can be established, EPA will report the rates of recovery and determine if they are reasonably consistent with those anticipated by the ROD. Additional years of surface water and sediment data will contribute to EPA's evaluation of fish recovery.

Issue 2 of 6

Issue: Based on existing data, certain fish species and sections of the river appear to be recovering differently. Although this circumstance is not unexpected, it does require further evaluation.

Recommendation: Special studies will be conducted to provide insight into why different species and certain portions of the river appear to be recovering differently. Multiple special studies are anticipated to help understand this observation, including a fish aging study.

Issue 3 of 6

Issue: Post-dredging sampling and subsequent surface sediment sampling indicated that the dredging phase of the remedy met design requirements. This work was certified as completed in 2019 by EPA. The dredging phase of the remedy resulted in the removal of 76 percent of the PCB-contaminated sediment mass in the river, which was greater than the ROD removal estimate of 65 percent.

There is potential that areas with elevated PCBs, including the examples described below, could contribute to localized delays in recovery.

- Three surface sediment "areas of interest" were identified during surface sediment sampling in 2016/2017 and are being monitored. Based on the 2021 surface sediment data, these areas have decreased in PCB concentrations. The caps and these select sediment areas are being monitored and maintained as required by the Consent Decree.

- As approved by EPA, several considerations resulted in engineering offsets (for example near bridge piers and retaining walls), cultural resource offsets and safety offsets (primarily immediately above dams) that prevented sediment from being dredged in those areas.

- Additionally, sampling has indicated that there are elevated PCB levels in soil within certain limited areas of the floodplain that are underwater during high flow portions of the year.

Recommendation: These limited and localized areas of elevated PCBs concentrations in sediment/soil should be evaluated for their potential impact on water and/or fish recovery.

<u>Issue 4 of 6</u>

Issue: In order for NYSDOH to adjust fish consumption advisories and restrictions, additional species of fish (not currently routinely collected) will need to be collected and tested for PCBs.

The Upper Hudson River long-term monitoring program has provisions for collection and analysis of supplemental and whole-body fish data.

Recommendation: EPA will continue to coordinate with NYSDOH and NYSDEC regarding the scope and timing of this data collection. GE will conduct these data collection events.

<u>Issue 5 of 6</u>

Issue: Since 2005, the State's implementation of fish consumption advisories has been supported by Health Research, Inc., of Rensselaer, New York. In 2008, NYSDOH established the Hudson River Fish Advisory Outreach Project. The goal of this initial 20-year initiative is for all people who consume Hudson River fish and crab to be aware of and follow the Hudson River fish advisories and restrictions.

This work supports the NYSDOH Hudson River advisory and NYSDEC restriction ICs in various ways including encouraging anglers and other fish consumers to follow health advisories, promoting awareness of advisories by posting signs, maintaining advisory awareness through education and promotional activities, and identifying reasons that anglers or other fish consumers may not follow the fish advisories.

The funding will run out in the near future.

Recommendation: EPA will coordinate funding to support the program into the future. The EPA supports the important work NYSDOH is doing with the outreach program.

<u>Issue 6 of 6</u>

Issue: The 2002 ROD specifies two targets for protection of ecological resources: 1) largemouth bass based on a whole-body largemouth bass of the size range typically consumed by river otter (4 to 7 inches) and 2) spottail shiner as representative of forage fish of the size range typically consumed by mink (less than 10 cm in length). During the post-dredging period, largemouth bass samples of a size larger than typically consumed by river otter have been analyzed on a fillet basis. Additionally, during the post-dredging period, forage fish collection has focused on collection of a variety of forage fish species, including spottail shiner.

EPA identified the lack of PCB data on appropriately sized whole-body largemouth bass as a data gap. For forage fish, while a comparison of the existing forage fish data to the ecological risk criteria is appropriate, combining different species presents challenges when evaluating PCB concentration trends through time.

Recommendation: Whole-body largemouth bass which is representative of the size targeted by river otter will begin to be collected in 2024 or 2025. This data will provide information on the current risk exposure for river otter and allow an evaluation of time trends in PCB concentrations.

For forage fish, beginning in 2021, EPA has modified the forage fish collection program to focus solely on spottail shiner. This will reduce uncertainty in time trends (e.g., avoids uncertainty introduced by combining different species) and a direct comparison to the ROD RAO can be made. The frequency of spottail shiner collection will be implemented such that time trends can be further established.

Other Findings

The following are findings related to OU2 that are not expected to impact protectiveness but may inform future work:

- **IRIS Database**: The IRIS (Integrated Risk Information System) database provides information on potential human health effects from long-term exposure to chemicals in air, water, or land. The IRIS webpage identifies PCBs for update of non-cancer toxicity information and the IRIS Program Outlook indicates that the draft release of the document is planned for Fiscal Year 2024 with external review anticipated in Fiscal Year 2025. The EPA will continue to review new or updated information about PCBs in IRIS for future assessments of risk at the Site.
- **Capping Institutional Controls**: During dredging, workers placed subaqueous caps on some areas of the river bottom to isolate PCBs from the surrounding environment. ICs are needed to protect the subaqueous caps and to protect areas of habitat reconstruction and restoration. ICs may include restrictions on anchoring and other activities that may damage the caps or planted areas. EPA will continue to coordinate with the state (including the NYSCC), the U.S. Army Corps of Engineers and GE regarding establishing ICs to limit the potential for disturbances of these areas.
- **Additional Monitoring to Support the Operations, Maintenance and Monitoring (OM&M) Program**: OM&M of water, sediment, fish, caps, and habitat is an important component of the remedy. EPA is overseeing GE's development and implementation of the OM&M program in consultation with NYS. It is necessary that the OM&M plans

reflect the current understanding of the system and have the flexibility to be adjusted periodically. This allows for further evaluation of the river system while accounting for changes in data variability.

- **Rogers Island High Flow Study**: The Rogers Island water monitoring station is located upstream of where dredging was conducted and downstream of the former GE plant sites and remnant sites. Understanding PCB concentrations entering the upstream portion of the UHR is important for assessing the recovery of the river. This area is currently monitored regularly during normal river flows; however, studies of PCB load at Waterford indicate that a few high-flow events may carry the majority of the annual load. Given the importance of high-flow events in transporting PCBs within the UHR, a future special study will include water sampling at Rogers Island during high-flow conditions.
- **Mohawk River Sampling Study**: The Mohawk River is a tributary that flows into the Upper Hudson River at its downstream end, near Waterford, New York. It has been sampled periodically in the past, but more sampling is needed to support the EPA's evaluation of the recovery of the river.
- **Passive Sampler Study**: The spatial pattern of post-dredging water column PCB concentrations appears to be generally consistent with that in the surface sediment and fish tissue. To evaluate spatial patterns, it is important to identify areas or sources that may contribute PCBs to the river and help the EPA with its evaluation of uneven recovery. Passive sampling devices produce a time-averaged representation of PCB concentrations in the environment and are generally more representative of concentrations to which receptors are exposed. GE began a passive sampler study in 2023 and the EPA is evaluating that data to determine appropriate next steps.
- **Dissolved and Particulate Organic Carbon Study**: Hydrophobic compounds such as PCBs readily bind to dissolved and particulate organic carbon found in the surface water of the UHR. Organic carbon-bound PCBs play an important role in the bioaccumulation of PCBs in biota. Additional particulate organic carbon measurements are needed to improve our understanding of how reductions in post-dredging sediment and surface-water PCB concentrations relate to changes in PCB accumulation in fish.
- **Lipid Normalization and Observed Recovery Trends**: PCBs preferentially accumulate in fatty tissue (lipids) in fish. Long-term monitoring of fish indicates lipid content varies over time and appears to be declining overall. The EPA is evaluating variations in lipid and other constituents of fish (including non-lipid organic matter) over time to better understand the role of lipid in the recovery of the river.

Protectiveness Statement

OU1

Protectiveness Determination: Short-term Protective.

The remedy at OU1 currently protects human health and the environment in the short term, as the in-place containment and cap system prevent human exposure. Perimeter fencing and signage continue to be maintained. In order for the remedy to be protective in the long-term, an institutional control needs to be implemented to ensure that the future use of the Remnant Deposits areas does not compromise the integrity of the cap system or result in exposures. EPA, in coordination with NYSDEC, is in the process of determining ownership of the Remnant Site properties so that the institutional controls can be established.

OU2

Protectiveness Determination: Protectiveness Deferred.

A protectiveness determination for the OU2 remedy cannot be made until further information is obtained. In the last FYR, EPA indicated that as many as eight or more years of post-dredging data are needed to establish rates of decline for fish with an appropriate level of statistical confidence. Since sediment dredging activities were completed in 2015, EPA has gathered and evaluated fish data up to 2022. EPA does not yet have sufficient sets of annual fish data to make a protectiveness determination and, therefore, is deferring such determination.

Based on the analysis conducted during this FYR and consistent with the last FYR, once statistically relevant rates of decline in post-dredging fish tissue PCB levels can be established, EPA will estimate the rates of fish recovery and determine if they are reasonably consistent with those anticipated by the ROD and make a protectiveness determination. EPA will issue a protectiveness determination through an addendum to this FYR report. It is anticipated that the results of the annual 2024 fish data could provide the information that results in determining statistically relevant rates, allowing EPA to make a protectiveness determination, and issuing an addendum in 2025. If not, EPA will report out its analysis and continue to actively monitor the river and evaluate data until sufficient data is available to determine statistically confident rates of decline in fish. At that point, when such sufficient data is available to make such statistically sound determination, but no later than 2027, EPA will issue the addendum with a protectiveness determination.

The sediment, surface water and fish data, coupled with the special studies to further evaluate fish recovery and potential impacts associated with localized areas of elevated PCBs in sediments, will help inform EPA's understanding of fish recovery and support any additional recommendations regarding remedy performance.

In the interim, the NYSDOH has in place a fishing restriction in the Upper Hudson River, the area subject to this FYR, prohibiting the possession of fish. This Upper Hudson River fishing restriction and advisory (i.e., take no fish and eat no fish) are effective in controlling exposure when followed. Extensive outreach to inform the public about these advisories and restrictions is in place as part of the OU2 institutional controls. EPA will continue to support fishing advisories and restrictions through the collection and testing of supplemental fish and appropriate funding for the outreach program.

In addition, in the Mid and Lower Hudson River, which is currently under further investigation by EPA and not the subject of this FYR, fish consumption is also limited by fish advisories established by NYSDOH. These advisories allow for certain fish and crab consumption for the general public and advises against fish consumption for sensitive members of the population.

I. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) has prepared this five-year review (FYR) for the Hudson River PCBs Superfund Site (Site) pursuant to Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations Section 300.430(f)(4)(ii)), and EPA guidance and policy.

The purpose of a FYR is to evaluate the implementation and performance of a remedy to determine if the remedy is and will continue to be protective of human health and the environment. FYR reports document the methods, findings, and conclusions of the review. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them. As discussed below in Section 1.1, FYRs address Operable Units (OUs) for which a remedy has been selected and where identified contamination remains; therefore, OUs 1 (Remnant Deposits) and 2 (Upper Hudson River [UHR]) of the Site are addressed as part of this FYR.

This is the third FYR for the Site and has been conducted because hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure (UU/UE). CERCLA requires EPA to review certain types of remedial actions no less often than every five years. The last FYR included data through 2016 and EPA initiated this FYR when five additional years of data (2017 to 2021) were available. The preliminary fish data from 2022 has also been included in Appendix 3 of this report, however, this data did not change the findings in this report.

This third FYR for the Site was led by EPA Project Director Gary Klawinski. Participants also included other EPA staff within EPA Region 2's Superfund and Emergency Management Division and EPA Headquarters Office of Land and Emergency Management (OLEM), as appropriate. This document was prepared following EPA's OLEM Guidance 9211.0-89 – Five-Year Review Recommended Template.

1.1 Site Background

1.1.1 Site Location

The Site encompasses a nearly 200-mile stretch of the Hudson River from Hudson Falls, New York, to the Battery in New York City (NYC). The northern 40 miles (the UHR) of the Site, from Fort Edward to Troy, is freshwater and is comprised of a series of locks and dams that are part of the New York State Champlain Canal System. This portion of the Site also includes the adjacent floodplains and remnant deposits. The southern 160 miles (the Lower Hudson River [LHR]) of the Site from the Federal Dam in Troy to the Battery in NYC is a tidal estuary. The LHR is not the subject of this review.

1.1.2 History of Contamination at the Site

From approximately 1947 to 1977, the General Electric Company (GE) discharged polychlorinated biphenyls (PCBs) into the Hudson River from its capacitor manufacturing plants at Hudson Falls and Fort Edward. The two plants were located adjacent to or near the Hudson River. The discharged PCBs were transported downriver and adhered to sediments which settled in downstream depositional areas including the pool behind the Fort Edward Dam. In 1973, due to its deteriorating state the Fort Edward Dam was removed, resulting in the further downstream distribution of PCBs that had accumulated behind the dam. The removal of the dam exposed former river bottom contaminated with PCBs; these areas are known as the Remnant Deposits. During subsequent floods, PCB-contaminated sediments from the Fort Edward Dam area were scoured and transported downriver.

PCBs include 209 organic chemical compounds consisting of carbon, hydrogen, and chlorine atoms. The 209 PCB chemical compounds are referred to as congeners, with each congener having a unique combination of number of chlorine atoms (between one and 10) and the position of the chlorine atoms within the PCB molecule. The number of chlorine atoms and their location in the PCB molecule determines the congeners' physical and chemical properties. PCB molecules are also commonly grouped into one of 10 homologue groups. Each homologue group is defined by the total number of chlorine atoms in their molecular structure, regardless of the position of the atoms. PCBs were developed as mixtures known as Aroclors. Generally, the Aroclor number refers to the average degree of chlorination of the PCB mixture. For example, Aroclor 1254 is 54 percent chlorinated, and Aroclor 1242 is 42 percent chlorinated. Aroclor 1016 is very similar to 1242, with some small differences in PCB composition. GE used PCBs at both the Hudson Falls and Fort Edward Plants, which were the sources of releases to the Hudson River, to produce capacitors with PCBs as the dielectric fluid. Originally, Aroclor 1254 was used at these plants. As production continued, PCB use changed to Aroclor 1242, and eventually included Aroclor 1016. Once PCBs are in the environment they are subject to factors that change the mixture. These factors include dechlorination, preferential uptake by biota, and solubility. These processes change the observed pattern of PCBs from those originally released to the UHR. EPA considers PCBs a probable carcinogen for both humans and animals and is associated with non-cancer health effects from Aroclors 1016 and 1254, such as reduced birth weight (Aroclor 1016) and impaired immune function, distorted finger and toenail beds, and occluded meibomian glands located in the eyelid (Aroclor 1254).

1.1.3 Site Operable Units (OUs)

EPA is addressing the Site in discrete phases or components known as Operable Units (OUs). FYRs address OUs for which a remedy has been selected and where identified contamination remains. The two OUs evaluated in this FYR are OU1, which addresses the remnant deposit areas of the Site, and OU2, which addresses the PCBs in the sediments of the Upper Hudson River (UHR) area. The following is a discussion of each Site OU.

OU1 - Remnant Deposits

OU1 consists of the deposits of PCB-contaminated sediment that were exposed after the river water level dropped following the removal of the Fort Edward Dam in 1973. There are four areas of deposits that cover a total of 56 acres and are located along the banks of the first 3 miles of the Hudson River downstream of Bakers Falls and the former GE plants. The remedy for this OU was selected in the 1984 Record of Decision (ROD) that included in-place containment consisting of a cover system, perimeter fencing, and signage. The in-place containment was completed in 1991 and Operation, Maintenance, and Monitoring (OM&M) activities are ongoing.

OU2 – Upper Hudson River

OU2 consists of the sediments in the UHR. This 40-mile section of river is immediately downstream of OU1 and runs from Fort Edward, New York, to the Federal Dam in Troy, New York. This section of the river includes a series of locks and dams (the New York State Champlain Canal operated by New York State Canal Corporation [NYSCC]) which form a series of pools. The UHR is divided into three main segments identified (upstream to downstream) as River Section 1 (RS 1), River Section 2 (RS 2), and River Section 3 (RS 3) (Figure 1). Each river section encompasses one or more discrete pools, also known as "reaches," separated by run-of-the-river dams and locks of the Champlain Canal system. Starting at the downstream end of the UHR at the Federal Dam, Reaches 1 through 5 constitute RS 3, Reaches 6 and 7 comprise RS 2, and Reach 8 (also known as the Thompson Island Pool) is coincident with RS 1. The 2002 ROD selected targeted environmental dredging to address PCB-contaminated sediment in the UHR, followed by monitored natural recovery (MNR), described in the 2002 ROD as monitored natural attenuation (MNA).[5] Dredging occurred between 2009 and 2015 and removed 2.7 million cubic yards (MCY) of sediment which were dewatered and transported by rail for disposal. Long-term monitoring of sediment, fish, and water is being conducted to track the recovery of the OU2 study area over time.

OU3 – Rogers Island

OU3 consists of several properties along the shoreline of Rogers Island, which lie at the very northern end of OU2 and just downstream of OU1. Between June and December 1999, EPA conducted a removal action to excavate 4,400 tons of PCB and lead-contaminated soil from nine properties and disposed of the soil off-site under CERCLA's removal authority to address risks to human health from direct contact. After excavation, areas were backfilled with clean materials, and erosion controls were installed. Since the removal action did not leave contamination above the levels that allow for UU/UE, OU3 is not evaluated in this FYR.

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[5] The term MNA became obsolete for sediments with the publication of EPA's sediment remediation guidance in 2005 (EPA 2005), three years after the ROD was published.

OU4 – UHR Floodplain

OU4 is the floodplain of the 43-mile section of river that runs from Bakers Falls to the Federal Dam in Troy, New York. Portions of the floodplain are contaminated with PCBs from flooding events. The floodplain encompasses approximately 6,000 acres and 1,700 individual properties. A Remedial Investigation and Feasibility Study (RI/FS) of the floodplain is being conducted currently. Short-term response actions (STRAs), which typically involve a vegetated soil cover and/or signage, are being implemented to address the potential for people to be exposed to PCBs in soil and/or sediment in these areas until a final remedy is implemented. As of the end of 2023, STRAs have been implemented in the floodplain on 67 properties. These temporary actions include the installation of 51 isolation covers and 97 warning signs. Inspections of the STRAs are conducted annually and maintenance is performed as necessary as determined by EPA. EPA plans to submit a separate ROD for the floodplain after the completion of the RI/FS; since a remedy has not yet been selected, OU4 is not evaluated in this FYR.

OU5 – Lower Hudson River

OU5 consists of the sediments in the LHR. This approximately 160-mile section of river runs from the Federal Dam in Troy, New York, to the Battery in NYC. Sampling of the LHR is being implemented to support EPA's decision-making and planning of next steps to evaluate PCB contamination in the lower river. Since a remedy has not yet been selected, OU5 is not evaluated in this FYR.

1.1.4 Physical Characteristics

Remnant Deposits – OU1

The Remnant Deposits are located in the first three miles of the Site, upstream from RS 1 in a section of the river with very steep banks. When the Fort Edward Dam was removed in 1973, it resulted in the water surface elevation dropping by approximately 20 feet, exposing portions of the former river bottom. The newly exposed areas are referred to as the "Remnant Deposits" (Figure 2). The Remnant Deposits generally consist of organic silty sand and gravel and contain sawdust, wood chips, and other debris associated with historical lumber industry activities (EPA, 1984; GE, 1992). Initially, five Remnant Deposits were identified. However, Remnant Deposit 1, which originally appeared as an island centered at river mile (RM) 196.3 opposite the GE Fort Edward Plant, had most of its exposed sediment scoured away due to flooding in 1976 and 1983. As observed in April 2012 (EPA, 2012), there is no longer sufficient material remaining from this feature to characterize. Remnant Site 1 is under continued observation to confirm the island has not reemerged.

Remnant Deposit 2 (RM 196.0; approximately 3.5 acres in size) and Remnant Deposit 4 (RM 195.1; approximately 24 acres) are located on the west side of the Hudson River, in the Town of Moreau. Remnant Deposit 3 (RM 196.0; approximately 17 acres) and Remnant Deposit 5 (RM 194.8; approximately 3.5 acres) are situated on the east side, in the Town of Fort Edward. The

Remnant Deposits caps have been constructed with relatively steep banks to the river's edge (3:1 to 1:1 [H:V]) ending at least 5 feet beyond a 5-part-per-million (ppm) PCB boundary and reinforced with riprap extending 2 feet above the elevation of the 100-year floodplain of the river. Landward of Remnant Deposits 2 through 4, the riverbanks rise steeply (3.3:1 to 1.8:1 [H:V] slopes) some 80 to 100 feet above them in a gorge-like formation. At Remnant Deposit 5, the top of the bank is about 30 feet above the top of the cap. Low-lying areas immediately adjacent to the Remnant Deposits are being addressed as part of the floodplain RI/FS.

Upper Hudson River Sediments – OU2

OU2 consists of the sediments in the UHR. This 40-mile section of river is immediately downstream of OU1 and runs from Fort Edward, New York, to Waterford, New York. The UHR is freshwater and non-tidal. Downstream of Fort Edward, the river is joined by several tributaries, the largest of which are the Fish Creek (RM 181.2) and Mohawk River (RM 156.2 and 154.5) entering from the west, and Batten Kill (RM 182.1) and the Hoosic River (RM 167.5) entering from the east. The flow in the UHR is primarily controlled by several reservoirs above Glens Falls, including the Great Sacandaga Lake. The UHR has an average depth of less than 8 feet in the shoal areas and approximately 18 feet in the channel, with a maximum depth of more than 45 feet. The Champlain Canal navigation channel is generally identified as being a minimum of 12 feet deep by design in the project area. NYSCC historically maintained the navigation channel through dredging; however, widespread conventional navigational dredging has not occurred since the early 1980s due to the presence of sediments contaminated with PCBs (NYSCC, 2011). Some minor navigational dredging has occurred in areas that tend to fill in over time, such as the confluence of the Hudson and Hoosic Rivers.

The Champlain Canal is coincident with portions of the Hudson River, extending from Waterford to Fort Edward and from there, departing the river in a north-northeasterly direction, on to Whitehall, Vermont, at the southern end of Lake Champlain. Bedrock, cut away to form the Champlain Canal, is exposed in some areas of the river, while lacustrine silts and clays of glacial age are exposed in other areas. Coarser-grained sediments are often observed in the river channel, while finer-grained sediments are more common in shallow water.

Areas adjacent to the UHR are primarily residential and agricultural with some commercial/ industrial land. Floodplain land categories include forested shoreline wetlands, transitional uplands, and vegetated backwaters such as emergent marsh and scrub-shrub wetlands.

1.1.5 Land and Resource Use

Remnant Deposits – OU1

The Remnant Deposits are located along the east and west banks of the River between Bakers Falls and Rogers Island in Washington and Saratoga counties. Currently, access to the Remnant Deposits is restricted by perimeter fencing and impeded by the relatively steep slopes in the deeper gorge section of the UHR, as well as by similar slopes at the water's edge. Therefore, the Remnant Deposits are not currently used for any authorized recreational, residential, agricultural or commercial activities. Local municipalities have previously expressed interest in constructing a passive use type park on portions of the Remnant Deposits. Details of any future park proposal have not yet been established but could entail light recreation activities such as walking and cycling. Development of the area, including any additional measures designed to limit potential exposure to PCBs, would need to be planned in close consultation with EPA, NYS, and the parcel owners.

Upper Hudson River Sediments - OU2

In the UHR, land use is primarily residential and agricultural with some commercial and industrial activities. Such uses of the river and lands surrounding the river are anticipated to remain the same into the future. Four counties (Albany, Washington, Rensselaer, and Saratoga) lie adjacent to the UHR. Within these four counties, forest and farmlands surround urban centers and historic villages. In addition to the former GE Hudson Falls and Fort Edward plants, the area is home to other businesses including technology, oil service, and food companies. Neither the GE Hudson Falls Plant nor the Fort Edward Plant is actively used any longer by GE for industrial purposes and the majority of plant buildings have been removed. Remedial activities associated with PCB contamination in the soils and groundwater at the GE Hudson Falls Plant site are being completed under New York State Department of Environmental Conservation (NYSDEC) oversight.

The Towns of Waterford and Halfmoon, closer to the downstream end of the UHR, have historically used the Hudson River for their municipal water supply but currently obtain potable water from Troy. The Town of Moreau and Village of Stillwater source their water from the Saratoga County Water Authority, which obtains its water from the Hudson River upstream of the former GE plants. Both private and municipal wells adjacent to the river are used for drinking water by some populations including the Village of Schuylerville. The river has been utilized for hydroelectric power, as well as for manufacturing processes, cooling, and fire protection. The river is also used for irrigating agricultural lands and watering domestic lawns and gardens.

The UHR supports a variety of water-based recreational activities including sport fishing, waterfowl hunting, swimming, and boating. However, at present, NYSDEC regulations limit fishing in the UHR to catch-and-release only. See Appendix 8 for detailed information regarding NYS's Hudson River regulations.

1.1.6 Site Chronology

A chronology of events in the Site's history is included as Appendix 9.

1.1.7 Initial Response

NYSDEC surveyed UHR sediments from 1976 to 1978 and again in 1984. Areas with average Total PCB (TPCB)[6] concentrations of 50 ppm or greater were mapped and became known as the PCB "hot spots." NYSDEC identified 40 individual PCB hot spots, located between RM 194 at Rogers Island and Lock 2 at RM 163. Hot Spots 1 through 4 were dredged by NYS for navigational purposes in the 1970s.

NYSDEC brought legal action against GE in 1975, which resulted in a $7 million program for the investigation of PCBs and the development of methods to reduce or remove the threat of PCB contamination in the river. In 1975, the New York State Department of Health (NYSDOH) began to issue health advisories recommending that people limit their consumption of fish from the Hudson River. In 1976, NYSDEC issued a ban on all fishing in the UHR from Hudson Falls to the Federal Dam at Troy, due to the potential risk from consuming PCB-contaminated fish. NYSDEC reopened the UHR to "catch-and-release" sport fishing in 1995.

In 1974, the New York State Department of Transportation (NYSDOT) dredged approximately 250,000 cubic yards (CY) of PCB-contaminated sediment in the vicinity of Rogers Island for navigational purposes. The dredged materials were placed in a disposal area known as Special Area 13, which is located along the west bank of the river just south of Rogers Island. Another approximately 380,000 CY of sediment were dredged from the east and west channels around Rogers Island in 1974 and 1975 and disposed of in the Old Moreau Dredge Spoil Area, located on the west shore of the river opposite the southern end of Rogers Island and north of Special Area 13. In 1978, NYSDEC removed approximately 14,000 CY of highly contaminated sediments from Remnant Deposit Area 3A and placed these sediments in a secure encapsulation site in Moreau, along with approximately 215,000 CY of sediment that had been dredged by NYSDOT from the east channel of Rogers Island to clear the navigational channel just below the location of the former Fort Edward Dam. These dredge disposal areas have been investigated and are maintained under the NYSDEC remedial program.

Additionally in 1978, unstable riverbanks at two of the Remnant Deposits were reinforced. Three remnant sites were re-vegetated to prevent public contact with the sediments and to minimize erosion and release of PCBs into the environment.

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[6] Total PCBs represents the sum of all measured PCB congeners.

1.2 FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Hudson River PCBs Superfund Site		
EPA ID: NYD980763841		
Region: 2	**State:** NY	**City/County:** Hudson Falls to Battery in NYC
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: EPA		
Author name (Federal or State Project Manager): Gary Klawinski		
Author affiliation: EPA		
Review period: 4/11/2019 – 2/29/24		
Date of site inspection: OU1 (8/30/2022) and OU2 (10/5/2022)		
Type of review: Statutory		
Review number: 3		
Triggering action date: 4/11/2019		
Due date *(five years after triggering action date)*: 4/11/24		

II. RESPONSE ACTION SUMMARY

2.1 Basis for Taking Action

OU 1

In 1984, EPA signed a ROD for the Hudson River that selected a remedial action for OU1 and presented a detailed evaluation of Waterford Water Works, the Town of Waterford's water treatment facilities. The 1984 ROD (EPA, 1984) also included an interim no-action decision for PCB-contaminated sediments in the UHR.

EPA determined that the Remnant Deposit sites posed an unacceptable risk that warranted remediation to protect human health and the environment. Without remediation, discharges from these sites through bank scouring during periods of high flow would continue to transfer PCBs to the Hudson River. The remediation required sediment PCB concentrations greater than 5 milligrams per kilogram (mg/kg) to be capped. Adjacent soils on top of the deposits were included in the cap.

OU2

In December 1989, EPA announced its decision to initiate a detailed Reassessment RI/FS to reconsider the 1984 ROD interim no-action decision for the sediments. The Reassessment RI/FS was divided into three phases. Phase 1 consisted primarily of a review of existing data and was completed in August 1991. Phase 2, which included the collection and analysis of new data as well as modeling studies and human health and ecological risk assessments and peer reviews, began in December 1991 and concluded in November 2000. Phase 3, known as the FS, formally began in September 1998 and was released concurrently with the Proposed Plan in December 2000.

The Reassessment RI/FS indicated that the primary contaminants and chemicals of concern were as follows:

- *Sediments:* Once introduced to the river, the PCBs adhered to the sediments. Physical, chemical, and biological release mechanisms allow PCBs in the sediment to be available for redistribution and to be a source of PCB contamination to the water column. Sediments would continue to release contamination to the water column and to biota, through aquatic and benthic food chains, unless they were managed or remediated.
- *Surface water*: Some fraction of PCBs is carried in the water column.

The Human Health Risk Assessment (HHRA; EPA, 2000c) determined that, under the baseline conditions, the cancer risks and the non-cancer health hazards from ingestion of fish from the UHR were expected to exceed EPA's generally acceptable levels for a 40-year exposure duration beginning in 1999.

- The total cancer risk for the reasonable maximum exposed (RME) individual assuming an ingestion rate of 51 half-pound meals/year with appropriate adjustments based on age was 1 x 10^{-3} or 1,000 times higher than the goal for protection of human health and 10 times higher than the highest risk level generally allowed under the federal Superfund law.
- Non-cancer health hazards for the RME young child, adolescent, and adult, respectively, are 104, 71, and 65 times higher than the level considered protective of public health (i.e., a Hazard Index of 1).
- Ingestion of one half-pound fish meal every two months, the average ingestion rate, results in cancer risks to the central tendency exposed (CTE) individual that are within the cancer risk range.
- The non-cancer health hazards for the CTE individual, with appropriate modifications for ingestion rates based on body weight for the individual age groups, are 7, 8, and 12 times higher for the adult, adolescent, and young child, respectively, than the level considered to be protective (i.e., Hazard Index = 1).

EPA's 2000 Baseline Ecological Risk Assessment (BERA) evaluated assessment endpoints across the multiple trophic levels of the Hudson River aquatic environment (EPA, 2000b). The BERA showed elevated, unacceptable risks to ecological receptors, namely mink and river otter (piscivorous mammals), from the consumption of PCB-contaminated fish.

2.2 Response Actions

2.2.1 OU1:

The 1984 ROD states that the OU1 remedy was intended to address direct physical contact with PCBs on the Remnant Deposit sites and exposure of adjacent communities to PCBs through dust particles and volatilization; and address the continuous discharge of PCBs from the Remnant Deposits into the river. The 1984 ROD was issued prior to the formalization of Remedial Action Objectives (RAOs) as part of current ROD guidance. Therefore, EPA has adopted this stated goal as the RAO for OU1.

Selected Remedy

The major components of the selected remedy as described in the 1984 ROD for OU1 consisted of the following:

- In-place capping of the four exposed remnant deposits (sites 2, 3, 4, and 5), consisting of a soil cover using 18 inches of subsoil placed in 6-inch lifts and a final 6 inches layer of topsoil;
- Upgrading the riprap stabilization system to extend above the 100-year flood level;

- Construction of perimeter drainage channels to divert runoff around the site and installation of stream transfer channels for conveyance of surface water flow across the OU1 Site area; and
- Installing fencing and posting to prevent public access.

Following issuance of the 1984 ROD, the design of the cap was refined to achieve the objectives described in the ROD. The final cap design included a sand/fill bedding layer, a gas collection/venting system, a composite layer (consisting of a reinforcing geotextile and low permeability bentonite clay layer), a sand drainage layer, a topsoil layer, and a vegetative cover. The 1984 ROD did not identify the need for implementing institutional controls (ICs).

2.2.2 OU2:

The selected remedy for OU2 was identified in the ROD issued on February 1, 2002. The RAOs and major components of the selected remedy for OU2, as described in the 2002 ROD, are as follows:

RAOs

1. Reduce the cancer risks and non-cancer health hazards for people eating fish from the Hudson River by reducing the concentration of PCBs in fish.

   The risk-based preliminary remediation goal (PRG) for the protection of human health is 0.05 mg/kg PCBs in fish fillet based on non-cancer hazard indices for the RME adult fish consumption rate of one half-pound meal per week (this level is protective of cancer risks as well). Other target concentrations are 0.2 mg/kg PCBs in fish fillet, which is protective at a fish consumption rate of one half-pound meal per month and 0.4 mg/kg PCBs in fish fillet, which is protective of the CTE or average angler, who consumes one half-pound meal every two months.

2. Reduce the risks to ecological receptors by reducing the concentration of PCBs in fish.

   The risk-based PRG for the ecological exposure pathway is a range from 0.3 to 0.03 mg/kg PCBs in fish (largemouth bass, whole body), based on the Lowest Observed Adverse Effect Level (LOAEL) and the No Observed Adverse Effect Level (NOAEL) for consumption of fish by the river otter. The ecological PRG is considered protective of all the ecological receptors evaluated because it was developed for the river otter, the piscivorous mammal calculated to be at greatest risk from PCBs at the Site. In addition, a range from 0.7 to 0.07 mg/kg PCBs in spottail shiner (whole fish) was developed based on the LOAEL and NOAEL for the mink, which is a species known to be sensitive to PCBs. Other species, such as the bald eagle, were considered but are at less risk than the river otter.

3. Reduce PCB levels in sediments in order to reduce PCB concentrations in river (surface) water that are above applicable or relevant and appropriate requirements (ARARs).

The ARARs for PCBs in surface water are: 0.5 µg/L [500 ng/L] TPCBs, the federal maximum contaminant level for drinking water; 0.09 µg/L [90 ng/L] TPCBs, the standard for protection of human health and drinking water sources; 1 ng/L TPCBs, the federal Ambient Water Quality Criterion; 0.12 ng/L TPCBs, the NYS standard for protection of wildlife; 0.001 ng/L TPCBs, the NYS water quality standard for the protection of the health of human consumers of fish; 0.014 µg/L [14 ng/L] TPCBs, the criteria continuous concentration (CCC) Federal Water Quality Criterion (FWQC) for freshwater; and 0.03 µg/L [30 ng/L] TPCBs, the CCC FWQC for saltwater[7].

4. Reduce the inventory (mass) of PCBs in sediments that are or may be bioavailable.

   PCBs in sediments may become bioavailable by various mechanisms (e.g., groundwater advection, pore water diffusion, scour, benthic food chains, etc.). Reducing the inventory of PCBs in sediments that are susceptible to such mechanisms will ultimately reduce PCB levels in fish and the associated risks to human health and the environment.

5. Minimize the long-term downstream transport of PCBs in the river.

   PCBs that are transported downstream in the water column are available to biota, contributing to the risks from the Site. Downstream transport also moves PCBs from highly contaminated areas to lesser contaminated or clean areas.

Additional information about the remedial goals can be found in the 2002 ROD.

Selected Remedy

The remedy selected in the 2002 ROD called for dredging to remove PCB-contaminated in-place sediments of the UHR, and MNR of PCB contamination remaining in the river after dredging. The selected remedy assumes separate source control action near the GE Hudson Falls Plant and Fort Edward facilities, which are under NYSDEC oversight. The major components of the selected remedy as stated in the 2002 ROD are:

- Removal of sediments based primarily on a mass per unit area (MPA) of 3 grams per square meter (g/m^2) Tri+ PCBs[8] or greater (approximately 1.56 MCY of sediments) from RS 1;
- Removal of sediments based primarily on an MPA of 10 g/m^2 Tri+ PCBs or greater (approximately 0.58 MCY of sediments) from RS 2;

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[7] In the ROD, EPA waived three chemical-specific ARARs pertaining to water column concentrations because of technical impracticability: the 1 ng/L TPCBs federal Ambient Water Quality Criterion; the 0.12 ng/L TPCBs NYS standard for protection of wildlife; and the 0.001 ng/L TPCBs NYS standard for protection of human consumers of fish.

[8] Tri+ PCBs represents the sum of all measured PCB congeners with three or more chlorine atoms per molecule. The higher chlorinated PCB congeners are more readily accumulated in fish tissue compared with the lower chlorinated congeners (mono and di-homologues).

- Removal of selected sediments with high concentrations of PCBs and high erosional potential (NYSDEC *Hot Spots* 36, 37, and the southern portion of 39) (approximately 0.51 MCY) from RS 3;
- Dredging of the navigation channel, as necessary, to implement the remedy and to avoid hindering canal traffic during implementation. Approximately 341,000 CY of sediments will be removed from the navigation channel (included in volume estimates in the first three components, above);
- Removal of all PCB-contaminated sediments within areas targeted for remediation, with an anticipated residual of approximately 1 mg/kg Tri+ PCBs (prior to backfilling);
- Performance standards for air quality and noise are included in this ROD consistent with state and federal law;
- Other performance standards (including but not necessarily limited to resuspension rates during dredging, production rates during dredging, and residuals after dredging) will be developed during the design with input from the public and in consultation with the state and federal natural resource trustees. These performance standards will be enforceable and based on objective environmental and scientific criteria. The standards will promote accountability and ensure that the cleanup meets the human health and environmental protection objectives of the ROD;
- Independent external peer review of the dredging resuspension, PCB residuals, and production rate performance standards and the attendant monitoring program, as well as the report prepared at the end of the first phase of dredging that will evaluate the dredging with respect to these performance standards;
- Performance of the dredging in two phases whereby remedial dredging will occur at a reduced rate during the first year of dredging. This will allow comparison of operations with pre-established performance standards and evaluation of necessary adjustments to dredging operations in the succeeding phase or to the standards. Beginning in Phase 1 and continuing throughout the life of the project, EPA will conduct an extensive monitoring program. The data EPA gathers, as well as the Agency's ongoing evaluation of the work with respect to the performance standards, will be made available to the public in a timely manner and will be used to evaluate the project to determine whether it is achieving its human health and environmental protection objectives;
- Backfill of dredged areas with approximately one foot of clean material to isolate residual PCB contamination and to expedite habitat recovery, where appropriate;
- Use of rail and/or barge for transportation of clean backfill materials within the UHR area;
- MNA (EPA currently refers to this as MNR per 2005 guidance) of PCB contamination that remains in the river after dredging;

- Use of environmental dredging techniques to minimize and control resuspension of sediments during dredging;
- Transport of dredged sediments via barge or pipeline to sediment processing/transfer facilities for dewatering and, as needed, stabilization;
- Rail and/or barge transport of dewatered, stabilized sediments to an appropriate licensed off-site landfill(s) for disposal. If a beneficial use of some portion of the dredged material is arranged, then an appropriate transportation method will be determined (rail, truck, or barge);
- Monitoring of fish, water, and sediment to determine when remediation goals are reached, and also monitoring the restoration of aquatic vegetation; and,
- Implementation (or modification) of appropriate ICs such as fish consumption advisories and fishing restrictions by the responsible authorities, until relevant remediation goals are met.

In a dispute resolution proceeding that followed GE's submission of the draft Phase 1 Dredge Area Delineation Report (GE, 2004) and draft Phase 1 Target Area Identification Report (GE, 2004a), EPA resolved a dispute regarding the criteria used to delineate the spatial extent of dredging and the mass of PCB removed by dredging. The decision clarified that, unless an area is otherwise eliminated from the delineated dredge areas based on EPA-approved criteria, the conditions stated in the Feasibility Study (EPA, 2000a) and ROD hold, namely that: 1) the criteria for delineation of dredge areas in RS 3 include a MPA of 10 g/m^2 Tri+ PCBs and, 2) the criteria for delineation of dredge areas include surface (0 to 12 inch) sediment Tri+ PCB concentrations of 10 mg/kg or greater in RS 1 and 30 mg/kg or greater in RS 2 and 3.

2.3 Status of Implementation

2.3.1 OU1

The in-place containment for the Remnant Deposits was completed in May 1991. Maintenance of the OU1 remedy, including access restrictions, is ongoing in accordance with the Site 1990 Consent Decree with GE.

2.3.2 OU2

The OU2 remedy is comprised of two primary components, targeted dredging of PCB-contaminated sediments of the UHR, and MNR of PCB contamination remaining in the river after dredging. GE completed dredging activities on October 3, 2015, and backfilling on November 5, 2015. In total, EPA calculated that 2.7 MCY of sediment were dredged from the river, processed, and shipped via train to approved landfills for disposal during Phase 1 and Phase 2. This volume (2.7 MCY) was consistent with the estimated 2.65 MCY presented in the 2002 ROD (EPA, 2019a), and the estimated TPCB mass removed (156,000 kilograms [kg]) was 123 percent more than the estimated 69,800 kg.

The implementation of the dredging remedy included limited capping in areas with high residual concentrations and areas where contaminated sediment could not be fully removed. The capping was limited as defined by EPA's Residuals Performance Standard. In total, 107 acres of caps were installed to isolate PCBs that remained in place after dredging was completed.

Table 2-1 shows the volume and mass of sediment removed each year and the duration of the dredging season during each year of Phase 1 and Phase 2. Demobilization of the sediment processing facility was largely completed in December 2016, although certain demobilization activities, including sampling associated with the filter presses and their removal, were not completed until April 2017. GE's other land support facilities were demobilized early in 2016. The habitat reconstruction portion of the remedial action continued until August 8, 2016. EPA issued a Certification of Completion of the Remedial Action (dredging) on April 11, 2019 (around the same time as the last FYR).

Table 2-1 Phases 1 and 2 Sediment Removal Volumes and Dredging Season Durations

Year	Dredging Season Duration		Approximate Volume Removed (CY)	Approximate TPCB Mass Removed (kg)
	Dates	No. Days		
Phase 1				
2009	May 15-Oct 27	166	268,000	20,000
Phase 2				
2011	Jun 6 – Nov 8	156	352,000	25,200
2012	May 9 – Nov 16	192	542,000	36,800
2013	Apr 29 – Nov 3	189	622,000	34,500
2014	May 7 – Nov 4	182	611,000	29,100
2015	May 7 – Oct 3	150	237,000	10,100
Total		**1,035**	**2,700,000**	**156,000**

The second component of the remedy, MNR, is ongoing. Fish, water, and sediment are monitored on a regular basis to track the recovery of the river and progress towards the ROD goals and targets.

2.4 Institutional Controls

2.4.1 OU1:

The 1984 ROD did not identify ICs for the Remnant Deposits. As called for in the 2012 FYR, an IC should be implemented that would restrict future use of the remnant properties to uses and activities that would not compromise the integrity of the cap system or result in unacceptable risks of exposures to contaminants. EPA is working with NYS to determine ownership of the properties to facilitate the implementation of the appropriate ICs.

2.4.2 OU2:

The 2002 ROD included ICs in the form of fishing restrictions and fish consumption advisories until the relevant remediation goals are met (Table 2-2). The restrictions regulate the possession of fish and are enforceable with fines. The advisories provide health-based information regarding the risks associated with consuming fish. Together these ICs help to limit fish consumption and inform the public of the health risks associated with consuming fish contaminated with PCBs from the UHR.

In 1976, due to PCB contamination in the Hudson River, NYSDEC banned all fishing in the Upper Hudson. In 1995, NYSDEC reopened the UHR (from Bakers Falls in the Village of Hudson Falls to the Federal Dam in Troy) to sport fishing on a catch-and-release basis only. This regulation applies to all tributaries in this section of the Hudson River up to the first barrier (dam or waterfall) that is impassable for all fish species. Fines for violation of this regulation carry a maximum penalty of $250 per violation.

The NYSDOH Hudson River Fish Advisory Outreach Project has been established to promote awareness of the fish advisories and regulations and to encourage people to follow them. These outreach activities include working with newcomers to the area, as well as disadvantaged, immigrant, and minority communities. NYSDOH involves a number of partners who are actively engaged with these local communities (Appendix 8).

The objectives of the outreach project include:

- Encouraging anglers and other fish consumers to follow health advisories;
- Promoting awareness of advisories by posting signs at major fishing access sites on the river;
- Maintaining advisory awareness through education and promotional activities for all targeted and impacted populations; and
- Identifying reasons that anglers or other fish consumers may not follow the fish advisories and modifying outreach activities, so they are more effective.

Details regarding NYSDOH's enhanced outreach techniques implemented since 2012, are covered in detail in Appendix 8.

Table 2-2 Summary of Implemented Institutional Controls

Media, Engineered Controls, and Areas That Do Not Support UU/UE Based on Current Conditions	Institutional Control Needed	Description of Institutional Control	Impacted Parcel(s)	Institutional Control Objective	Title of Institutional Control Instrument Implemented and Date (or planned)
All fish species	Yes	Fishing Advisory and Regulation (Eat None - Catch-and-Release Only)	Upper Hudson (Bakers Falls to Federal Dam at Troy)	Fish advisories are in place and regulations have been implemented and are performing as anticipated by the ROD.	Current NYS Fish Consumption Advisories and Freshwater Fishing Regulation. Regulations in effect since 1976 and modified in 1995.

ICs to protect the subaqueous caps installed by GE during the dredging are needed to limit the potential for disturbances to these areas. EPA is coordinating with the state and GE regarding their establishment.

2.5 Systems Operations/Operation and Maintenance

2.5.1 OU1

Regular Remnant Deposit inspections are conducted to evaluate the performance of the remediation activities and identify potential problems and maintenance requirements in a timely and consistent manner. Currently, the Remnant Deposits are monitored under the Post-Closure Maintenance Plan (PCMP) for the PCB Remnant Site Remediation Project (GE, 1992). Follow-up activities which are documented in the semi-annual Remnant Deposit inspections have generally included maintenance of the vegetative cover, access roadways, diversion ditches, culverts, vent pipes, and site security. Areas of settlement at the four Remnant Deposit sites are monitored and addressed as needed. In addition to regular inspections, the Remnant Deposits are inspected after each significant rain event, defined as a two-year storm, which produces at least 2-1/2 inches of rain in a 24-hour period.

2.5.2 OU2

The 2002 ROD remedy for OU2 includes an MNR component, which began after the completion of dredging in 2015. Regular monitoring of water, sediment, and fish has been conducted to track the recovery of the river and progress toward ROD targets and goals. Regular monitoring of post-construction habitat reconstruction is also conducted. The sampling programs for these media have been designed to detect a 5 percent or greater annual rate of decline over a 10-year period on a river section basis, with additional consideration of the individual reaches. If the actual rate of decline is less than 5 percent, it may take additional years of data to establish the specific rate with statistical confidence. The OM&M program also includes monitoring of the caps placed during dredging. A brief description of each program is discussed below, with additional details regarding each sampling program provided in its respective appendix (Appendix 1 (Evaluation of Water Column PCB Concentrations and Loads), Appendix 2 (Evaluation of Surface Sediment Concentrations) and Appendix 3 (Evaluation of Fish Tissue PCB Concentrations), or Appendix 4 (Capping Evaluation)). The OM&M work plan is in the process of being finalized. The scope of work requested by EPA and contained in the draft final workplan is currently being implemented. Habitat reconstruction efforts are an important and major component of the ROD remedy but are not directly related to the ROD RAOs and associated goals. An in-depth description of habitat reconstruction and monitoring activities has been included in this FYR (Section 2.5.2.5). Reports that document and track these habitat Monitoring, Maintenance and Adaptive Management (MM&AM) activities are available separately and referenced in this report.

2.5.2.1 Water

Water column data are collected from five monitoring stations in the UHR: Bakers Falls, Rogers Island, Thompson Island Dam, Schuylerville, and Waterford (Appendix 1, Figure A1-1). Three of the long-term UHR monitoring stations (Thompson Island Dam, Schuylerville, and Waterford) are located within the portion of OU2 that was dredged between 2009 and 2015, and two (Bakers Falls, Rogers Island) are located upstream of the project area. The overall goal of the monitoring program is to capture the seasonal fluctuations in PCB concentrations and impacts associated with flow, allowing for the development of a robust estimate of the annual PCB load to the LHR. Load is the amount of mass of PCBs that flow downriver.

The two primary variables that influence PCB concentrations in the Hudson River are time of year (seasonality) and river flows. Thus, the two main components of the water column sampling program are: (1) a routine sampling component and (2) a high-flow sampling component. Results from the routine and high-flow sampling programs allow for the development of the relationship between flow and PCB concentration within the year, which are used for the estimation of annual PCB load to the lower river. Each is described briefly below:

Routine Sampling

The routine monitoring program is designed to monitor typical PCB concentrations in the water column. Samples are collected on a pre-determined schedule that spans seasonal fluctuations in PCB concentrations and flows. Routine water column monitoring is conducted at all five long-term monitoring stations in the UHR.

High-Flow Sampling

The high-flow program is designed to supplement the routine sampling program by specifically targeting sample collection across the range of observed high-flows within a year that the routine sampling program may not capture. The high-flow program monitors PCB concentrations at two stations (Schuylerville and Waterford, New York) during high-flow events. High-flow samples are collected during the rising, peak, and falling portions of the storm hydrograph, to the extent possible. Sampling for this program is triggered by river flows exceeding the following thresholds as monitored at the Fort Edward and Waterford, New York, United States Geological Survey (USGS) gauging stations:

- 11,000 cubic feet per second (cfs) at the Fort Edward USGS Station (No. 01327750).
- 15,000 cfs at the Waterford USGS Station (No. 01335754).

2.5.2.2 Sediment

The sediment OM&M program is comprised of two primary programs, the surface sediment sampling program and Beryllium-7 (Be-7) sampling program.

Surface Sediment

Surface sediments (0 to 2 inches) are collected once every five years to assess changes in concentrations over time in both the dredged and non-dredged areas. The initial sampling event was conducted in 2016/2017, and the most recent round in 2021 (GE, 2021). Although PCBs deeper than 2 inches contribute to potential exposure, the top 2-inch interval was selected for monitoring as it provides a more sensitive indicator of how recent perturbations to the river system are impacting surface sediment PCB concentrations. The sampling program is designed to provide an unbiased estimate of the mean PCB concentration for dredged and non-dredged areas both by river section and by River Reach, as well as to yield sufficient data to monitor changes in concentration over time.

Be-7 Sediment Sampling Program

The Be-7 sampling program is designed to monitor changes in PCB concentration in recently deposited sediment in the UHR. Be-7 is a radioisotope with a short half-life (53 days), and sediment with detectable levels of Be-7 indicate the material was deposited within the previous 6 to 12 months. Recently deposited sediment provides information on current PCB solids transport within the Hudson River. The initial round of Be-7 data was collected in 2022 and its processing is underway. Therefore, it is not evaluated in this FYR. This data will be incorporated in future FYRs and the planned addendum.

2.5.2.3 Fish

Fish are routinely collected from RS 1, RS 2, RS 3, and one upstream background station (Feeder Dam) (Appendix 3, Figure A3-1 and Table A3-1). Within each river section, fish are collected from four to five different monitoring stations to provide spatially representative data. There are several species of fish that are routinely collected and analyzed for PCBs in the UHR, representing different trophic levels and habitats. Sample collection is completed twice per year. Sport fish, including largemouth bass, smallmouth bass, brown bullhead, and yellow perch, are collected in the spring. Forage fish (spottail shiner) and pumpkinseed are collected in the fall. Additional fish data will be collected when appropriate and in consultation with NYSDEC and NYSDOH to support adjustments to fishing advisories and the potential removal of the fishing restriction.

2.5.2.4 Caps

During dredging, 107 acres of caps were installed to isolate elevated PCB concentrations that remained after dredging was complete. The monitoring program for these caps is comprised of bathymetric surveys and chemical isolation layer monitoring. In addition to the engineered caps installed during the remedial action, there are Select Areas identified during the design which exceeded the removal criteria but were not targeted for removal because the top 12 inches were relatively low (below 5 mg/kg) and the peak concentration was deeper than 24 inches (GE, 2005, 2007). These areas are also being monitored as part of the OM&M program. The following is a brief description of the three monitoring programs for caps.

Bathymetric Surveys

Bathymetric surveys are generally conducted at 1-, 5- and 10-year intervals after cap construction, and then every 10 years thereafter.[9] Surveys are also conducted following a flood event with a magnitude at or exceeding the design recurrence interval for the caps (i.e., a 10-year recurrence interval for Type A caps installed in Phase 1, and a 100-year recurrence interval for Phase 2 caps). Tier 1 bathymetric surveys are conducted to determine if the caps have remained in place over time. Specifically, these surveys are intended to evaluate whether there has been a "Measurable Loss" of cap material (see Section 5.1.4 for the definition of "Measurable Loss"). If a "Measurable Loss" of cap material is observed during the Tier 1 bathymetric surveys, Tier 2 follow-up visual (and, as necessary, physical) investigations are to be conducted to confirm whether there has been

[9] In accordance with consolidated survey schedule (letter from GE to EPA dated January 30, 2017), surveys scheduled for staggered years have been consolidated. The five-year Tier 1 surveys for Phase 2 caps installed from 2011 to 2015 and the 10-year Tier 1 surveys for Phase 1 caps installed in 2009 were completed in 2018, and the next set of Tier 1 bathymetric surveys for Phase 2 and Phase 1 caps was performed in 2023. The next cap survey is scheduled for 2028.

a “Significant Loss” of cap material. A “Significant Loss” of cap material is defined by the same criterion as a Measurable Loss; however, the additional lines of evidence serve to confirm that the observed loss has indeed occurred. Areas of cap with “Significant Loss” will be repaired, as required by EPA.

Chemical Isolation Monitoring

The effectiveness of the Phase 2 caps with respect to chemical isolation will be evaluated via a limited coring program in EPA-selected areas referred to as “sentinel areas.” The monitoring program is anticipated to be conducted in 10-year intervals starting in 2026; the objective is to generate data to verify the basic design assumptions for the caps and evaluate their integrity with regard to preventing contaminant migration upwards and through the caps into the river.

Select Area Monitoring Program

Bathymetric surveys of Select Areas (i.e., areas that exceeded the MPA removal criteria but were not targeted for removal because they are covered/buried by cleaner sediments) are conducted to confirm these areas have not eroded. The first survey of these areas was completed in 2023 and will be conducted again in 2033. The results of the 2023 survey data are currently being processed. Therefore, they are not included in this FYR, but will be incorporated into future reviews.

2.5.2.5 Habitat Reconstruction

The 2002 ROD (EPA, 2002) anticipated that dredging activities associated with the selected remedy would disturb certain aquatic vegetation and other habitat areas, including federally and state-regulated wetlands. While there are no habitat reconstruction-specific RAOs or remedial goals, the selected remedy included backfilling of dredged areas and the monitoring of the restoration of aquatic vegetation where appropriate. To isolate residual PCB contamination and expedite habitat recovery, the remedy called for approximately one foot of clean backfill material to be placed upon completion of dredging (EPA, 2002). Additionally, Attachment A to the ROD (Statement of Findings: Floodplains and Wetlands) indicated that a habitat replacement program would be implemented in an adaptive management framework to replace submerged aquatic vegetation (SAV) communities, wetlands, and riverbank habitat, and that a shoreline stabilization program would be implemented (EPA, 2002). These requirements were reflected in the 2003 Habitat Delineation and Assessment Work Plan (GE, 2003), which indicated that the primary goal of the habitat reconstruction program is to replace the functions of the disturbed habitats of the UHR to within the range of functions found in similar physical settings in the UHR. Reconstruction of these aquatic habitats is a necessary component of the remedy.

Completed Activities

During remedial action, remedial design documents (GE, 2005a, 2007b, 2009b, 2011b, 2012, 2013a, 2013b and 2014) identified the location of in-river habitats and dredge areas for dredge target areas and the habitats impacted within each Certification Unit (CU). Certification Unit Form 3 contains figures which show the polygons of all reconstructed habitat areas and their acreages.

Immediately following dredging of each CU, the required cap and backfill materials were placed in accordance with project remedial design and work plan documents. The amounts and types of fill were documented in each CU's Certification Form 2 (GE, 2019b). In the year following dredging of each CU, the required stabilization materials, quantities of plants and seed installed, along with the quantities of unconsolidated river bottom (UCB), SAV, and riverine fringing wetland (RFW) habitats established were documented in each CU's Certification Form 3 (GE, 2019b).

Placement of backfill and cap materials was completed in 2015. Installation of shoreline stabilization measures was completed with habitat planting and seeding in 2016. Subsequent bathymetric surveys have confirmed that cap and backfill have remained stable and are functioning as designed. Continued bathymetric surveys will allow EPA to evaluate whether the placement of backfill remains stable. Shoreline stabilization monitoring was completed in 2018 when the shoreline areas met the criteria for stabilization. In addition, certain UCB areas were monitored for the presence of benthic organisms (GE, 2017, 2018, 2019a, and 2020).

The initial habitat reconstruction effort installed the species and quantities called for in the remedial design documents. The plant species installed as live plants and as seed mixes were based on extensive pre-dredge vegetation monitoring data collected between 2003 and 2008. In addition, summaries of SAV, RFW, and UCB habitat established within each CU (and by reach) were captured in a Habitat Ledger spreadsheet (letter from GE to EPA, dated October 3, 2016). Habitat reconstruction activities have been and continue to be implemented in an adaptive management context that allows for flexibility in approach and includes yearly monitoring, directed studies, and appropriate actions until EPA determines that habitat reconstruction is successful.

Benchmark Monitoring Phase

Monitoring benchmarks and reconstructed habitat success criteria are described in detail in the Phase 1 OM&M Plan (GE, 2011a). The purpose of benchmark monitoring is to assist in achieving successful habitat reconstruction by confirming that the material planted in those areas remains viable and increased in coverage, and to determine whether actions may be required. It was anticipated that benchmark monitoring could last 6 or more years. The benchmark monitoring phase includes annual evaluations of individual reconstruction areas using quantitative but non-destructive (non-harvesting) measures. Monitoring of reconstructed habitats, as described in the Phase 1 and Phase 2 Adaptive Management Plans and reported in annual Monitoring, Maintenance and Adaptive Management (MM&AM) reports under OM&M is on-going. Current benchmark monitoring results regarding species composition and coverage overall are good. At this time the habitat reconstruction areas remain in the benchmark monitoring phase but many are nearing the success criteria phase. The current status and progress of habitat reconstruction areas is described below.

Success Criteria Phase

The Success Criteria phase follows the benchmark monitoring phase. In the Success Criteria phase, groups of reconstructed SAV and wetlands will be assessed using quantitative comparisons to reference areas to determine if the habitat reconstruction areas have been successfully re-established. GE has proposed transitioning certain reconstruction areas into the Success Criteria phase, and discussions between EPA and GE regarding the transition are ongoing. This Success Criteria phase of monitoring is anticipated to last for approximately 2 to 5 years beyond the benchmark phase. As such, many individual CUs may be under observation (either under Benchmark or Success Criteria) for 10 or more total years after initial construction.

Current Status

Post-construction monitoring and maintenance of reconstructed habitat areas is on-going (under OM&M). The results of this monitoring are tracked regularly and reported annually in MM&AM reports for review by the involved agencies. Since habitat reconstruction efforts are not directly related to the project RAOs and do not have quantitative measures of success established in the ROD, habitat reconstruction is not part of the protectiveness evaluation conducted in the five-year review. However, since MM&AM activities are a major component of the remedy and important in terms of mitigating impacts to habitat resulting from the project implementation, they have been discussed in this report (period 2016 to 2021, see below). Specific post-construction habitat MM&AM activities conducted between 2016 and 2021 include:

- Monitoring of shoreline stabilization (requirements satisfied in 2018).
- Annual monitoring of RFW and SAV areas for growth of installed plantings and seeding as well as recruitment of native vegetation (natural recolonization).
- Implementation of a variety of actions including erosion control fabric maintenance, measures to protect newly installed plants against wave/boat wake action, invasive species removal, wetland delineations, and focused active planting of RFW emergent species.
- Implementation of various pilot studies beginning in 2019 to evaluate emergent plant species that are resilient under wave/boat wake action, the potential impacts of water depth on SAV percent cover, and the use of seeding buoys to encourage enhancement of SAV beds.
- For UCB areas, periodic monitoring of caps was conducted in 2016, 2018, and 2023, and macroinvertebrate recolonization surveys were conducted in 2014, 2018, 2019 and 2020.

Annual monitoring plans, focused studies, proposed actions, and the results of these studies and annual monitoring efforts are reported in the 2016 to 2021 annual MM&AM reports (GE, 2017, 2018, 2019a, 2020, 2021b, and 2022).

Progress and Challenges

A significant number of habitat areas are making good progress toward transition to the Success Criteria phase. However, there are certain areas experiencing challenges and are the subject of continued actions and special studies. Examples of such challenges include impacts from ice wrack, vessel-traffic induced wakes and wave action, herbivory, variable water-level fluctuations from year-to-year, competition with invasive species, and redistribution of sediment. Places that have experienced challenges include localized areas in Reach 8 (invasive species and low vegetative cover), Reach 7 (sediment redistribution), Reach 6 (herbivory and wave action), and Reach 3 (invasive species). Actions including additional planting, seeding, removal of loose coir fabric, installation of coir logs to reduce the impacts of wave action, and invasive species control. These actions were conducted in 2023 and are also planned for 2024. EPA will continue to coordinate all habitat related matters with NYSDEC.

2.6 Climate Change

Three climate change tools were considered when assessing potential climate impacts to the Site. The three tools considered were the National Oceanic and Atmospheric Administration *Sea Level Rise Viewer* (NOAA, 2023), the USGS *National Landslide Inventory* (USGS, 2019), and *The Climate Explorer* (NOAA, 2014). As detailed in Appendix 10 Table A10-1, the most applicable tool for the Site is *The Climate Explorer*.

The Climate Explorer indicated that the top climate concerns for Fort Edward, New York, and Waterford, New York, include changed seasonal weather patterns, greater frequency of extreme temperatures, and greater frequency of intense rainstorms. To the extent realized, such concerns could impact the Site as discussed below.

OU1

Potential climate-related impacts to the cover system may primarily occur from more-frequent intense rain events, which may increase the amount and duration of runoff, resulting in increased erosion and a greater likelihood of landslides at the steep slopes along the boundaries of the edges of the cover system. The cover system will continue to be inspected on a regular basis with additional inspections performed after significant rainfall events and repairs made as required.

OU2

Climate-related changes at OU2 could impact some of the mechanisms associated with MNR. Some examples of mechanisms that could be impacted include how much cleaner sediment moves into the river from the watershed, sediment stability and redistribution within the Site, physicochemical processes (desorption, diffusion, solubilization, volatilization), microbiological activity, bioturbation, food-web structure, ecology, and bioavailability. At this time, there is insufficient information to assess how climate change may affect these mechanisms as well as any potential impact, positive or negative, to the remedy. Long-term monitoring at the Site will continue as EPA assesses the effectiveness of the remedy. Monitoring data will be evaluated on a regular basis and special studies developed as needed to assess any potential climate impacts and results included in subsequent FYRs. The project Consent Decree requires GE to conduct studies and investigations (referred to herein as special studies) as required by EPA in connection with the periodic FYRs.

Several evaluations regarding the physical stability of the Phase 1 and Phase 2 caps are documented in the *Second Five-Year Review Report for the Hudson River PCBs Superfund Site* (EPA, 2019a), including an evaluation of the "Year 1" surveys, a survey triggered in response to a high-flow event that occurred in 2011, and the five-year Tier 1 surveys conducted in 2014. These evaluations assessed the short-term and long-term cap stability and provided insight into how well the Phase 1 caps withstood 100-year flood conditions.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the Second FYR (Table 3-1), as well as the recommendations from that review and the current status of those recommendations (Table 3-2).

Table 3-1 Protectiveness Determinations/Statements from the Second FYR

OU No.	Protectiveness Determination	Protectiveness Statement
1	Short-Term Protective	The remedy at OU1 currently protects human health and the environment as the in-place containment and cap system prevents human exposure, and as perimeter fencing and signage continue to be maintained. However, in order for the remedy to be protective in the long-term, an institutional control needs to be implemented to ensure that the future use of the areas with the Remnant Deposits does not compromise the integrity of the cap system or result in unsafe exposures.
2	Protectiveness Deferred	A protectiveness determination of the remedy at OU2 cannot be made until further information is obtained. There is not enough data available since the completion of dredging and related project activities in 2015 to determine if the remedy will be protective within the time frame anticipated by the ROD. There is also not sufficient data available to assess whether the interim targets identified in the ROD will be reached in the time frames estimated at the time the ROD was issued in 2002. A critical factor needed for the protectiveness determination is a reliable calculation of the rate of decline in post-dredging fish tissue PCB levels. It is necessary to examine the annual record over a longer period of time in order to calculate this rate with statistical certainty. EPA estimates that as many as eight or more years of post-dredging fish tissue data are needed. This information will be obtained through the collection and evaluation of fish tissue data along with the water and sediment data collected as part of the long-term monitoring program. Once statistically relevant rates of decline in post-dredging fish tissue PCB levels can be established, EPA will estimate the rates of recovery and determine if they are reasonably consistent with those predicted in the ROD. It is anticipated that this additional information will be obtained with the results of the 2024 fish data. EPA expects to complete its evaluation of that data in 2025, after which time a protectiveness determination could be made. Remedial activities completed to date have substantially reduced PCB source

Table 3-1 Protectiveness Determinations/Statements from the Second FYR

OU No.	Protectiveness Determination	Protectiveness Statement
		materials in the UHR. Natural recovery is ongoing within the UHR, and these processes are expected to result in the River eventually reaching the long-term remediation goal for the protection of human health with regard to fish consumption (0.05 mg/kg PCBs in species-weighted fish fillet). As EPA indicated in the ROD, EPA believes it likely that improvement will occur gradually over more than five decades. In the interim, the NYS has in place fishing restrictions and advisories against consumption of fish to control human exposure pathways that could result in unacceptable risks. EPA acknowledged in the ROD that the consumption advisories are not fully effective in that they rely on voluntary compliance in order to prevent or limit fish consumption. EPA will continue to work with NYS to ensure the ongoing maximum effectiveness of the advisories.

Table 3-2 Status of Recommendations from the Second FYR

OU No.	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date
1	The 1984 ROD does not contain any requirement for ICs. An IC to ensure that future use of the Remnant Deposits does not compromise the integrity of the OU1 cap system or result in unsafe exposures should be implemented.	EPA will coordinate as appropriate with municipalities about potential plans for accessing and/or utilizing the Remnant Deposits for recreational use. Use of properties as a park would need to be limited to uses and activities that would not compromise the integrity of the cap system. EPA will also coordinate with NYS to determine land ownership, which would be needed in order for ICs to be properly established. Currently, fences installed at the Remnant Deposits restrict access to the sites.	Ongoing	EPA, NYS, and GE are researching ownership of the remnant sites so that an appropriate IC can be permanently established.	N/A

Table 3-2 Status of Recommendations from the Second FYR

OU No.	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date
2	There are not enough data available since the completion of dredging and related project activities in 2015 to determine if the remedy will be protective within the general time frame anticipated by the ROD. EPA estimates that as many as eight or more years of post-dredging fish tissue data are needed to establish a statistically relevant trend.	Additional information will be obtained through the ongoing collection and evaluation of fish tissue data along with the surface water and sediment data collected as part of the long-term monitoring program. Once statistically relevant rates of decline in post-dredging fish tissue PCB levels can be established, EPA will estimate the rates of recovery and determine if they are reasonably consistent with those predicted in the ROD. Once this information is obtained a protectiveness determination will be made.	Ongoing	Data collection of fish, water and sediment continues on a regular basis, and data evaluation is ongoing. Data collected through 2021 and evaluated as part of this FYR are not sufficient to establish statically relevant trends. More years of data are necessary to establish these trends. Data will continue to be evaluated as they are collected to determine if an appropriate amount of data exists to establish a relevant rate of decline.	EPA estimates that as many as eight or more years of post-dredging data, excluding a one-year equilibration period (2016), are needed to establish statistically relevant rates of decline. Eight years of post-dredging data will be available in 2025 with the completion of the 2024 field collection activities, which is the earliest that EPA anticipates a trend can be reliably determined.

In addition to the issues and recommendations above, the Second FYR also included suggestions to help inform future Operations and Maintenance that did not impact protectiveness. Those suggestions and their current status updates are included in Table 3-3.

Table 3-3 Status of Other Findings from the Second FYR

Findings	Summary Description	Status
Integrated Risk Information System (IRIS) database	Some members of the five-year review team requested that EPA consider additional PCB toxicity information in order to re-evaluate human health risks at the Site.	EPA continues to monitor any updates or changes to the IRIS database. Relevant changes will be incorporated in future FYRs.
Outreach on NYSDOH Fish Advisories	EPA suggests that NYSDEC evaluate the extent to which advisory information is provided to anglers who register for the Recreational Marine Fishing Registry to fish in the Lower Hudson River.	According to NYSDEC, anglers are provided information on the advisories and restrictions when licenses are obtained or renewed. EPA continues to support NYSDEC and NYSDOH with the implementation of the fishing institutional controls.
Institutional Controls	EPA believes that additional institutional controls may be needed in order to protect the subaqueous caps installed by GE during the dredging and to protect areas in which GE conducted habitat reconstruction and replacement measures until, for example, the new plantings become established.	EPA continues to coordinate with NYS on ways to protect the caps installed during dredging. However, GE is responsible for repairing damaged caps, if necessary.
Fish Recovery	Observed PCB concentrations in fish tissue in the Upper Hudson River and upstream from the Green Island Bridge in Troy were declining more rapidly than in the rest of the Lower Hudson River, downstream from the Green Island Bridge. It will therefore be important to collect additional data and other information in order to better understand the PCB	As discussed in more detail below, EPA has entered into an order with GE to conduct supplemental studies of the Lower Hudson River. Additional fish water and sediment data was collected in 2023 and additional work is planned for 2024.

Findings	Summary Description	Status
	contamination in the Lower Hudson River.	EPA continues to collect fish water and sediment data as part of the long-term monitoring program. Although the first target was not achieved within the five-year time period predicted in the ROD, concentrations are approaching the first target and additional years of data collection are necessary to assess if the second target will be achieved in the anticipated timeframe.
Operation, Maintenance and Monitoring (OM&M) Adjustments	It is necessary that OM&M plans reflect the current understanding of the system being monitored and that monitoring plans have the flexibility to be adjusted as necessary during the ongoing MNR period of the remedy.	EPA has optimized the long-term monitoring program such that a 5 percent annual rate of decline can be detected in a 10-year time frame. EPA routinely evaluates the data to see if any adjustments to the program are necessary.

IV. FYR PROCESS

4.1 Community Notification, Involvement, and Site Interviews

Depending on the nature of the site and the level of community interest, EPA guidance allows for different levels of outreach and public engagement during the FYR process. Community involvement activities during a FYR typically include notifying the community that the FYR will be conducted and, again, when it is completed. Because the Hudson River PCBs Site covers a large geographic area and has significant public interest, the EPA expanded its community involvement activities for this Site.

The agency provided opportunities for project stakeholders to be involved throughout the process by establishing an active and robust FYR team, communicating with stakeholders face-to-face and via conference call, and providing updates at regularly scheduled Community Advisory Group (CAG) meetings. Additionally, EPA project staff at the Hudson River Office in Albany, New York, have been accessible and available throughout the FYR process to answer questions from stakeholders and members of the public. EPA will also provide an opportunity for the public and project stakeholders to provide input on the findings of the review during a 90-day comment period.

4.1.1 FYR Team

This third FYR was supported by a FYR team representing diverse perspectives. Upon initiation of the third FYR, EPA identified potential members and alternates and established a team (24 members plus alternates) which included representatives of state and federal agencies, CAG members, and EPA subject-matter experts. Between December 2022 and September 2023, a series of seven team meetings were held (Appendix 7) to discuss various topics and answer questions.

During these meetings, members of the team, including EPA technical experts, consultants, and representatives of other agencies, led technical discussions on topics ranging from interpretation of EPA's guidance documents on the performance of FYRs to detailed analyses of the data being considered. At each meeting, members of the team were given the opportunity to provide input on the technical presentations, ask questions, request additional analysis be done or provide additional information. Meetings were held virtually, and a teleconference phone line was available to allow those without a computer to participate in the discussions. EPA incorporated feedback from these discussions into the FYR report as appropriate.

Appendix 7 contains a list of team members and meeting topics.

4.1.2 Community Notification

On April 19, 2022, EPA issued a news release announcing that the agency had begun its third FYR of the cleanup of the Site. The news release was distributed to media outlets in the Upper and

Lower Hudson River regions, elected officials in the project area, and the Site email Listserv, which includes approximately 500 subscribers.

In addition, EPA published a public notice of the FYR in the *Glens Falls Post Star* and *Albany Times Union* on April 24, 2022 (Appendix 7).

4.1.3 Public Involvement

EPA maintained a robust outreach and public involvement program to keep the public aware and informed of the Site's progress throughout the design and implementation of the dredging project. In accordance with the NCP, EPA developed a Community Involvement Plan (CIP) early in the remedy design phase (EPA, 2003), and subsequently updated the CIP as Phase 1 dredging was underway (EPA, 2009), to facilitate two-way communication between EPA and the communities affected by and interested in the Site and to encourage community involvement in Site activities. In developing the plan, EPA made an extensive effort to gather public input and drew upon many information sources, including numerous and detailed community interviews, meetings, and Site files.

In 2004, EPA coordinated the development of a CAG to further ensure routine and consistent communication between EPA and the communities and stakeholder groups. CAGs are autonomous entities that rely on EPA for organizational and informational support. Key stakeholders are represented on the active CAG which sets meeting agendas and meets on an as-needed basis. The meetings are open to the public and publicized on a CAG website (hudsoncag.wspis.com), via the Hudson River Listserv email distribution list and using an email distribution list circulated by the CAG facilitators (Consensus Building Institute). The EPA provided updates on the progress of the FYR during each of the CAG meetings held during the period of the report development.

EPA continues to maintain a public website providing access to project information and data (www.epa.gov/hudsonriverpcbs).

4.1.4 Availability of the Third Five-Year Review Report & Public Comment Period

This FYR Report is available on the EPA's Hudson River website (www.epa.gov/hudsonriverpcbs).

As noted previously, EPA will provide a 90-day public comment period on the Third FYR Report. EPA will consider comments received on this report prior to issuing the final FYR report.

A news release regarding the availability of the Third FYR Report, and initiation of the public comment period, will be distributed to media outlets in the upper and lower Hudson River regions, elected officials in the project area, the email Listserv recipients, and the Hudson River CAG. EPA will also present to the CAG on the findings of the report during the public comment period.

4.2 Data Review

OU1

Data reviewed for this FYR include monitoring results for water samples collected at the Bakers Falls (upstream of OU1) and Rogers Island (downstream of OU1) monitoring stations, as well as applicable information collected (e.g., annual, and semi-annual site inspection reports) pursuant to the ongoing PCMP for the Fort Edward PCB Remnant Site Remediation Project. A detailed review of this data is included in Appendix 1.

OU2

Data reviewed for this FYR include monitoring results for water, sediment and fish, as well as other applicable information (e.g., cap monitoring data) collected as part of the remedial action program. These data have been collected throughout the various stages of the project, including the pre-design period, the baseline monitoring period, remedial design data collection events and the remedial action monitoring program period, as well as under the ongoing OM&M period.

Data utilized for the third FYR and discussed in detail in Section 5 (Technical Assessment) are discussed in further detail in the following appendices:

- Water – Appendix 1
- Sediment – Appendix 2
- Fish – Appendix 3
- Caps – Appendix 4

Section 6 describes issues identified during the data review and technical analysis that could potentially affect the protectiveness of the remedy.

4.3 Site Inspections

Site inspections for this FYR were conducted for OU1 on August 30, 2022, and for OU2 on Oct 5, 2022. The inspections were conducted by EPA and included representatives from GE.

During the OU1 inspection, a downed tree was noted along the upland edge of Remnant Deposit 2. The tree was subsequently removed, and GE reported no significant damage to the cap.

The inspection of OU2 involved visits to the former Fort Edward Dam, former dredging locations and OM&M monitoring locations along the river. No issues were noted during the OU2 inspection.

Inspection forms for OU1 and OU2 are included in Appendix 6.

V. TECHNICAL ASSESSMENT

5.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

There are currently two RODs for the Hudson River PCBs Superfund Site, the 1984 ROD (EPA, 1984) that called for the capping of the Remnant Deposits[10] (which was completed in 1991) and the 2002 ROD (EPA, 2002) for the UHR sediments that called for a two-part remedy: dredging followed by MNR. Dredging was performed between 2009 and 2015 (with no dredging conducted in 2010) and MNR is ongoing. This FYR assesses the current conditions of the river and progress towards the RAOs established in the RODs.

Monitoring of PCBs in the UHR began in the early 1970s, however, the data presented in this FYR represent three time periods with consistent data collection for water, sediment and fish. The three time periods are: the pre-dredging baseline period (2002 to 2008); the dredging period (2009 to 2015); and the post-dredging period (2016 to 2021). The evaluations in this report focus on the six years of post-dredging data. Preliminary post-dredging fish data from 2022 are also presented in this report. Pre-dredging baseline period and dredging period data were collected for different objectives and are used in this report when necessary and appropriate. Both TPCB and Tri+ PCB results are discussed here, as TPCB is the basis for the remedial targets established in the 2002 ROD and the identified ARARs, while Tri+ PCB represents the PCB homologue groups that are more readily accumulated in fish tissue and were the basis for determining the dredging footprint.

The following is a summary of the conclusions from the evaluations discussed in the referenced report sections and appendices:

- Habitat reconstruction and replacement were conducted as anticipated to mitigate impacts from the dredging operations. OM&M of reconstructed habitats will continue until project metrics are met (see Section 2.5.2.5).
- The caps on the Remnant Deposits are intact and functioning as intended to contain the PCBs and prevent potential exposure (see Section 5.1.1).
- ICs in the form of fish consumption advisories and fishing restrictions are in place for the UHR to help reduce the risk of PCB exposure to people caused by eating the fish (see Section 5.1.2).

[10] The 1984 ROD evaluated remedial alternatives for the PCB-contaminated sediments in the UHR. However, a “no action” alternative was deemed appropriate at the time, as there was a lack of data on effective and reliable methods for addressing the contaminated sediment. The 1984 ROD also called for a detailed evaluation to assess whether the domestic water supply at Waterford, New York, required additional treatment due to the presence of PCBs.

- The average water column Tri+ PCB concentration at Rogers Island during the post-dredging period is 0.87 nanograms per liter (ng/L), which is below the 2002 ROD expectation of 2 ng/L (see Section 5.1.3).
- The isolation caps installed during dredging remain physically intact, and chemical monitoring of the caps will be conducted in 2026 to confirm the caps are working as designed (see Section 5.1.4).
- Water column, sediment and fish concentrations on average are less than the pre-dredging period and remain within expectations (see Section 5.1.5).
- Progress is being made toward RAOs presented in the 2002 ROD (see Section 5.1.6).
  - The fish species-weighted average TPCB concentration for the UHR as of 2021 was 0.71 mg/kg. The preliminary 2022 average was 0.58 mg/kg. Modeling results presented in the ROD estimated that the first human health target for protection of human health (0.4 mg/kg) would be reached five years after the completion of dredging. Similarly, model results presented in the ROD estimated the second target PCB tissue concentration for the UHR (0.2 mg/kg) would be reached 16 years after the completion of dredging. Although the first target was not achieved within the five-year time period, concentrations are approaching the first target and additional years of data collection are necessary to assess if the second target will be achieved in the timeframe estimated by the modeling (see Section 5.1.6.1). The percentage of sport fish below the 0.4 milligrams per kilogram wet-weight (mg/kg-ww) threshold has increased from 21 percent in the pre-dredging period to 37 percent in the post-dredging period.
  - The ROD target for fish tissue PCB concentrations for the protection of ecological receptors has not yet been achieved. Targets were set for whole-body largemouth bass and spottail shiner (see Section 5.1.6.2).
    - The ROD ecological target for whole-body largemouth bass is 0.3 to 0.03 mg/kg-ww. In the post-dredging period, 6 percent of the estimated whole-body largemouth bass PCB concentrations were below the 0.3 mg/kg-ww criterion, and no results are below the 0.03 mg/kg-ww criterion. The whole-body largemouth bass concentrations were estimated by multiplying fillet concentrations by a conversion factor of 2.5. As discussed below, this estimation has limitations. EPA has identified the lack of PCB concentration data for whole-body largemouth bass of appropriate size for river otter consumption as a data gap. EPA plans to collect whole-body data from smaller largemouth bass in future monitoring events. This data will provide information on the current risk exposure for river otter.
    - ROD ecological targets for spottail shiner (whole-body) range from 0.7 to 0.07 mg/kg-ww. As part of the ecological risk assessment, spottail shiner

was used as an indicator species to represent forage fish less than 10 cm in length (EPA, 2000a). Between 2016 and 2020, the fish collection program collected a variety of forage fish species, including spottail shiner. Since the forage fish collection in the post-dredging period include other forage fish, in addition to the spottail shiner, a comparison to the ecological targets is made for the forage fish. During the post-dredging period, approximately 20 percent of the forage fish collected are below the 0.7 mg/kg-ww criterion and no results are below the 0.07 mg/kg-ww criterion. While a comparison of the forage fish data as a whole to the ecological risk criteria is appropriate, in 2021 EPA modified the fish collection program to focus solely on spottail shiner. This will reduce uncertainty in time trends (e.g., avoids uncertainty introduced by combining different species) and a direct comparison to the ROD RAO can be made.

- The percentage of post-dredging water column PCB measurements meeting the most stringent water column TPCB ARAR standard of 14 ng/L was 76, 44, and 57 percent at the Thompson Island Dam, Schuylerville, and Waterford monitoring stations, respectively, an improvement compared to the pre-dredging period (see Section 5.1.6.3).
- A ROD RAO was to reduce inventory (mass) of PCBs in the sediments that are or may become bioavailable. As discussed in the Second FYR, it is estimated that 76 percent of the overall PCB mass from the UHR was removed by the dredging, exceeding the 65 percent reduction assumed in the ROD (see Section 5.1.6.4).
- A ROD RAO was to minimize the long-term downstream transport of PCBs to the LHR. As discussed in the Second FYR, EPA successfully implemented resuspension performance standards during the in-water remedial activities. Additionally, relative to the pre-dredging period, the Tri+ PCB loads to the LHR have decreased (see Section 5.1.6.5).

A "moving window[11]" analysis indicates at least eight or more years of data (i.e., at least two or more years of data in addition to the current post-dredging dataset) are needed before a meaningful time trend in PCB concentration for water column and fish data can be determined (see Section 5.1.7). This finding is supported by studies of fish at other contaminated sediment sites which indicate that more than 10 years of data is optimal for use in estimating time trends (Gewurtz et al., 2011). Additionally, PCB concentrations in the starting and/or ending years of a time trend analysis can influence estimated time trends, particularly over shorter time periods (i.e., less than

[11] The moving window analysis presented in this FYR is based on the moving window analysis presented in the Second Five-Year Review Comment Response (EPA, 2019c) that indicated eight or more years of post-dredging data are needed to estimate an accurate time trend in the post-dredging fish tissue data.

10 years). This is particularly important for the water column and fish datasets, which exhibit substantial year-to-year variability in PCB concentration.

EPA anticipated at the time of the ROD that reach-averaged PCB (Tri+) concentrations in the surface sediment would decline post dredging at annual rate of approximately seven to nine percent, consistent with long-term historical trends (EPA, 2000a), and that these rates of decline would be similar in water and fish tissue. As time progresses and concentrations decrease it is assumed these rates will decline. It is EPA's expectation that short-term post-dredging rates will be at least 5 percent per year in all three media and has designed the long term monitoring program for fish, water and sediment is designed to detect a 5 percent annual rate of decline with 80 percent power and 95 percent confidence in about 10 years. Therefore, it is likely that about 10 years of data will be necessary before there are sufficient data to establish whether, and at what rate, PCBs are declining in all three media. When evaluating recovery of the system it is important to evaluate the system holistically. Evaluating all three media together provides greater confidence than an evaluation of a single medium, as all three media are expected to recover similarly (see Section 5.1.8). The number of years of data needed for each individual medium varies. Therefore, it is possible that less or more years are needed for any individual medium. The moving window analysis that indicates eight or more years of data are needed and the design of the long-term program to detect a 5 percent annual rate of decline in 10 years are separate analyses that provide insight into how many years it will take to establish a reliable rate of recovery.

The following appendices provide the technical analyses that support the results summarized in this section:

- Appendix 1 (Evaluation of Water Column PCB Concentrations and Loads) provides a detailed evaluation of water column PCB concentrations throughout the UHR and PCB loads over the Federal Dam at Troy.
- Appendix 2 (Evaluation of Surface Sediment Concentrations) provides a detailed evaluation of surface sediment PCB concentration levels, spatial distribution, and temporal change throughout the UHR, as well as an evaluation of the three areas of interest.
- Appendix 3 (Evaluation of Fish Tissue PCB Concentrations) provides a detailed discussion of fish tissue PCB concentrations over time and across different spatial scales.
- Appendix 4 (Capping Evaluation) presents an assessment of the physical stability of the caps installed in Phase 1 and Phase 2.

5.1.1 Remnant Deposit Cap System Functioning as Intended

The Remnant Deposits remedy is functioning as intended by the 1984 ROD. In-place containment of the formerly exposed Remnant Deposits (Remnant Deposits 2, 3, 4, and 5) was completed in 1991. A cap system consisting of a soil cover, geosynthetic clay liner, and a topsoil and vegetative layer was placed over materials with PCB concentrations greater than 5 mg/kg, with a buffer extending at least 5 feet beyond the 5 mg/kg concentration boundary. Riprap was use for stabilization along the banks of the river and in perimeter drainage channels. Low-lying areas immediately adjacent to the Remnant Deposits are being addressed as part of the floodplain RI/FS. This cap system prevents direct public contact with PCB-contaminated sediments and potential volatilization of the PCBs.

The 56th round of semiannual inspections was conducted in the fall of 2021 in accordance with the EPA-approved PCMP for the PCB Remnant Site Remediation Project (GE, 1992). Follow-up activities from the semi-annual Remnant Deposit inspections have generally included maintenance of the vegetative cover, access roadways, diversion ditches, culverts, vent pipes, and site security. Areas of settlement at the four Remnant Deposit sites are monitored and addressed as needed. EPA's observations made after a 100-year flood event in 2011 indicated no bank scouring or significant damage to the riprap. Also, a site inspection following the significant rain event related to Hurricane Irene in late August 2011 (where 3.67 inches of rain fell in a 24-hour period) revealed the containment systems for Remnant Deposits 2 through 5 to be in stable and generally good condition. Between 2017 and 2020, four area inspections were conducted after significant rainfall events (defined as 2.5 inches of rain in a 24-hour period) and the Remnant Deposit sites were generally observed to be in good condition.

The water column PCB concentrations immediately downstream of the Remnant Deposits at the Rogers Island monitoring station during the post-dredging period (2016 to 2021) have averaged approximately 0.87 ng/L. The low PCB level in the river immediately downstream of the Remnant Deposits suggests that the Remnant Deposits are not a significant source of PCBs to the river.

While the OU1 remedy is functioning as intended by the 1984 ROD, it should be noted that the 1984 ROD did not identify ICs for the Remnant Deposits. In the Second FYR, EPA determined that, in order for the remedy to be protective in the long-term, ICs in the form of deed restrictions need to be implemented to ensure that potential future use of the Remnant Deposits does not compromise the integrity of the cap system or result in unsafe exposures. EPA understands that there is interest in passive recreational use of the Remnant Deposits (i.e., Remnant Deposits 2 and 4) and is coordinating with local municipalities that are exploring potential park use. As part of this effort, EPA is working with NYS to determine the ownership of the parcels associated with the Remnant Deposits.

5.1.2 Fish Consumption Advisories and Fishing Restrictions Remain in Place

As described in the 2002 ROD, the OU2 remedy relies on ICs in the form of fishing advisories and restrictions until relevant remediation goals are met. These ICs are in place and implemented by two NYS agencies, NYSDOH and NYSDEC. The NYSDEC has a fishing regulation in place that requires that all fish caught within the UHR must be immediately returned to the water unharmed

(“Catch-and-Release Only – Take No Fish, Eat No Fish”). Fines for violation of this regulation carry a maximum penalty of $250 per violation. To supplement the UHR fishing regulation, NYSDOH has also issued a “Don’t Eat” advisory for all fish obtained from the UHR between the South Glens Falls Dam at Route 9 and the Federal Dam at Troy. As required by EPA in a Consent Decree, NYSDOH has received funding from GE to conduct outreach activities to inform the public about fishing restrictions throughout the Site. As noted below, EPA will continue to coordinate with NYSDOH and engage in discussions with GE regarding continued funding.

NYSDOH has sought to increase public awareness of fish regulations and advisories by improving signage at fishing point-of-access locations. NYSDOH has worked with private landowners to grant permission for signs to be posted on their properties. NYSDOH continues to utilize a database containing the GPS coordinates for each sign that, in conjunction with annual site visits, allows NYSDOH to determine if the signs are still posted and legible, or if new signs are required. This database is available as a Google map on the NYSDOH fish advisory website, which can be accessed by the public. NYSDOH incorporates emerging health education methods in its outreach efforts, including technology-based tools and resources.

There is a need to sustain the ongoing outreach efforts as NYSDOH continues to work to increase public knowledge of and compliance with fish consumption advisories and fishing restrictions. Human health risk reduction and the protectiveness of the selected remedy rely on the effective implementation of these ICs through ongoing public outreach efforts.

5.1.3 PCB Water Concentrations Entering the UHR Meet Expectations

PCBs entering the UHR from upstream impact both the rate of recovery and the concentrations that can ultimately be achieved in each of the media (water, sediment, and fish). Therefore, monitoring and minimizing PCBs entering the UHR from upstream is critical to the success of the remedy. The Rogers Island water column monitoring station is located at the upstream boundary of OU2 and the areas dredged during Phase 1 and 2 of the OU2 remedial action (referred to as the project area). This station is therefore considered to be the background station for OU2 and is used to assess surface water concentrations entering the project area and evaluate the ROD’s assumption regarding Tri+ PCB concentrations entering OU2 from upstream. The 2002 ROD anticipated that surface water Tri+ PCB concentrations entering the OU2 project area would average 2 ng/L Tri+ PCBs or less, following the completion of source control activities in the vicinity of the GE Hudson Falls Plant. Source control at the plant sites was substantially completed in 1995 by NYSDEC (EPA, 2019). Concentrations greater than 2 ng/L Tri+ PCBs may impact recovery rates and potentially the attainment of the ROD RAOs. Upstream of the Rogers Island monitoring station is the Bakers Falls monitoring station, which is also located upstream of the Remnant Deposits and former GE plant sites and is, therefore, unaffected by known GE-related PCB releases and represents background for OU1 and OU2.

At the Bakers Falls monitoring station (the background station for the entire Site) during the post-dredging years, Tri+ PCB concentration averaged 0.35 ng/L, with concentrations ranging between 0.01 and 1.7 ng/L. Long-term trends in the water column data at this station likely reflect changes to inputs of PCBs from upstream sources or regional background sources. Tri+ PCB and TPCB concentrations at Bakers Falls appear to be declining since 2015 from approximately 1 ng/L to less than 0.1 ng/L (Appendix 1, Figure A1-9).

At the Rogers Island monitoring station (background for OU2) during the post-dredge years, Tri+ PCB concentration averaged 0.87 ng/L, with concentrations ranging between 0.18 and 3.7 ng/L. About 95 percent of samples analyzed during the post-dredging period (2016 to 2021) had concentrations less than the 2 ng/L Tri+ PCB anticipated in the ROD.

As discussed in Section 2 of Appendix 1, high-flow events within the project area have a significant impact on water column concentrations and transport of PCBs throughout the system. The current sampling program at Rogers Island focuses on non-high-flow conditions and sampling does not occur during high-flow events. PCB loads entering the OU2 project area from upstream during high-flow events are not well understood. EPA has identified this as a data gap in the system understanding and plans to implement a special study to collect water samples at Rogers Island during high-flow events.

5.1.4 OU2 Caps Remain Intact

During Phase 1 and 2 of dredging, 107 acres of caps were installed to isolate PCBs that remained in place after dredging was completed. The caps typically consisted of a 6-inch armor layer composed of coarse gravel or cobble, a chemical isolation layer, and a 9- to 12-inch-thick layer of backfill, resulting in cap thicknesses that ranged from 12 to 16 inches. A cap monitoring program is in place to assess both the long-term physical stability and chemical isolation effectiveness of the constructed caps. The monitoring program includes regularly scheduled bathymetric surveys to determine if the caps have remained stable over time. Specifically, these surveys are intended to evaluate whether there has been a "Measurable Loss" of cap material. Measurable Loss is defined as a loss of greater than 3 inches of cap thickness over a contiguous 4,000-square-foot (ft^2) area or a contiguous area representing greater than 20 percent of the cap area, whichever is less. If Measurable Loss is identified, additional investigations will be conducted, and repairs made to the cap as necessary.

The most recent bathymetric surveys were conducted in 2016 and 2018. Analyses of these surveys indicate that the caps installed during Phase 1 and Phase 2 are physically stable, as no Measurable Loss was identified. As expected, some erosion was observed in most caps. The total capped area within each Certification Unit (CU) with greater than 3 inches of erosion ranged from 0 (CUs 3, 5, 15, and 49) to 10,289 ft^2 (CU 26). The majority of the capped areas showed very little erosion (on average, 2 percent of the total capped area within a CU was measured with greater than 3 inches of erosion). Although erosion was observed in limited areas, it should also be noted that the observed erosion to date is primarily limited to the top third of the cap thickness, indicating that even in areas with observed erosion most of the cap and chemical isolation layer remain intact.

Bathymetric surveys were completed in the Phase 2 areas in 2023. Those data are being processed and are, therefore, not included in this FYR. Caps installed during Phase 1 will be surveyed in 2028. In addition to the physical stability monitoring, an assessment of the chemical stability of the caps will be performed in 2026 by measuring PCB concentrations in the sediment that has accumulated above the caps as well as concentration profiles through the cap layers at select "sentinel areas," as discussed in Section 2.2.3 of Appendix 4.

5.1.5 Water, Sediment and Fish PCB Concentrations Are Below Pre-Dredging Levels

The reduction of PCB concentrations in water and fish (and a reduction in PCB mass in sediment) is a key item of the RAOs presented in the 2002 ROD. Reductions in PCB concentration in water, sediment, and fish reduce risks to humans and ecological receptors and minimize the transport of PCBs to the LHR. In this section, a brief overview of the water, sediment, and fish sampling program is presented. This overview is followed by a comparison of pre- and post-dredging PCB levels in each medium, demonstrating that water, sediment, and fish PCB concentrations in the post-dredging period to date are below pre-dredging levels and within expectations of the 2002 ROD.

5.1.5.1 Water Column

Water column data have been consistently collected since 2004 at five monitoring stations in the UHR: Bakers Falls, Rogers Island, Thompson Island Dam, Schuylerville, and Waterford (Appendix 1, Figure A1-1). Three of the long-term UHR monitoring stations are located within the portion of OU2 that was dredged between 2009 and 2015, and two are located upstream of the project area. The three stations within the project area are situated at the downstream end of each of the three river sections. Routine sampling is conducted at all stations, while high-flow sampling is conducted at the Schuylerville and Waterford monitoring stations. Routine sampling consists of the collection of samples on a weekly to monthly basis that represent non-storm event conditions, while the high-flow sampling program specifically targets sampling during high-flow events (see Section 2 of Appendix 1 for details).

When interpreting water column PCB concentrations, it is important to recognize the processes that can influence the measured concentrations. PCB concentrations in the UHR vary seasonally, with higher concentrations during the warmer summer months and lower concentrations during the colder fall and winter months under routine flow conditions (EPA, 1997, 1999). River flows can also significantly influence water column concentrations. Under low flow conditions, as flows in the river increase, PCBs concentrations decrease, likely a result of dilution. However, once a certain flow value is reached, concentrations begin to increase with increasing flow, likely a result of increased resuspension of sediment. The relationship between PCB concentration and flow follows a “V” shape, as shown in Appendix 1, Figures A1-2 and A1-3. As a result of this non-linear relationship, annual variations in flow can impact observed PCB concentrations in the water column under both routine and high-flow conditions. For example, in a particularly dry year with below average flows, it would be expected that routine samples would have generally higher PCB concentrations than routine samples collected during an average rainfall year. Natural variability in river flows and other factors controlling PCB concentrations will increase the year-to-year variability in the data and hence the number of years required to establish a meaningful time trend in the data. The need for additional years of data before meaningful time trends can be estimated in the water column data is described further in Section 5.1.7.

Figure 3 presents a comparison of geometric mean Tri+ PCB and TPCB concentrations for routine samples collected between May and November during the pre- and post-dredging periods, plotted against long-term monitoring stations ordered from upstream to downstream. Only routine water samples collected between May and November are presented in this figure due to differences in sample collection frequency during the pre- and post-dredging periods and recognizing that the high-flow sampling program was only implemented at the Schuylerville and Waterford stations. Figure 3 demonstrates that water column concentrations have decreased at all three long-term monitoring stations within the project area (Thompson Island Dam, Schuylerville, and Waterford) compared to the pre-dredging period. As discussed above, the time of sample collection and flow conditions can influence the measured PCB concentrations. Therefore, a regression model was developed that controls for these factors when comparing pre- and post-dredging geometric means (Appendix 1, Section 4.1.3). This analysis indicates the three stations within the project area exhibited a statistically significant reduction in Tri+ PCB and TPCB concentrations compared to the pre-dredging period.

5.1.5.2 Sediment

Surface (0 to 2-inch interval) sediment samples are collected every five years to assess post-dredging PCB levels and to track the recovery of PCBs in the surface sediment over time. To date, post-dredging sediment sampling events have been conducted in 2016/2017 and 2021. Both the 2016/2017 and 2021 sampling designs were developed using a statistically based sediment collection plan that support unbiased estimates of average PCB concentrations in surface sediments for a given area (e.g., dredged and non-dredged areas by reach or river section). The Tri+ PCB concentrations in surface sediment samples in 2016/2017 and 2021 ranged from non-detect to 43 mg/kg. Approximately 99 percent of the samples had Tri+ PCB levels below the most stringent ROD-specified surface sediment dredging criterion of 10 mg/kg. Although there is no cleanup level in the ROD for PCBs in surface sediments, a comparison to the post-dredging residual concentration goal of 1 mg/kg was also conducted to facilitate a comparison to a lower threshold. Approximately 70 percent of the samples had Tri+ PCB levels lower than this 1 mg/kg threshold (Appendix 2, Figure A2-3). Details on the sampling designs for the post-dredging sampling programs are included in Section 2 of Appendix 2 to this FYR.

Sediment PCB levels during the pre-dredging period were characterized by samples collected between 2002 and 2005 as part of the Sediment Sampling and Analysis Program (SSAP). The SSAP locations were defined by spatial grids of varying extent that were established in the different river sections. In RS 1, these grids extended virtually bank-to-bank, forming a spatially balanced representation of river-wide surface sediments and making the data suitable for obtaining nearly unbiased estimates of average surface sediment concentrations. In contrast, in RS 2 and RS 3, the sampling grids focused on areas of suspected contamination with sampling effort decreasing where contamination fell below the removal thresholds. As a result, the pre-dredging measurements in RS 2 and RS 3 are generally representative of contaminated areas in RS 2 and RS 3, and not the entire river section. As discussed in the Second FYR, to partially account for this biased sampling approach, an area-weighted average Tri+ PCB concentration was developed for each river section through segregating results by grain size (cohesive versus non-cohesive) (Second FYR, see Appendix 4 Table A4-5 of that document). However, this approach is not expected to completely resolve the biased high measurements in RS 2 and RS 3.

In this FYR, two different metrics are used to characterize overall post-dredging sediment concentrations: Recoverable-Sediment Area- (RSA-) and River Wide Area- (RWA-) weighted average concentrations (see Section 3.2.1 of Appendix 2 for more details). The RSA values are based solely on recoverable sediments, while the RWA values consider all river bottom features (i.e., recoverable, non-recoverable and bedrock areas). The post-dredging RSA-weighted average concentrations presented in this FYR more closely align with the pre-dredging area-weighted average concentrations reported in the Second FYR and are therefore the most appropriate basis for comparing pre- and post-dredging surface sediment concentrations. Because the 2016/2017 and 2021 sampling programs used different unbiased sampling designs, the RSA-weighted averages from these programs are provided separately in Appendix 2 (Tables A2-5a and b). To facilitate the comparison to pre-dredging levels in this section and consistency with the water and fish comparisons, the RSA-weighted averages in 2016/2017 and 2022 were combined to derive an overall average for each river section for the post-dredging period. The 95 percent confidence interval of the combined average was derived through a bootstrapping analysis. Bootstrapping is a method for assessing statistical accuracy related to the mean or other metrics.

Figure 3 compares the pre- and post-dredging RSA-weighted average Tri+ PCB concentrations in the surface sediments. Prior to dredging, the RSA-weighted average Tri+ PCB concentrations were 14 mg/kg, 12 mg/kg, and 4 mg/kg in RS 1, RS 2 and RS 3, respectively. These averages decreased to 1.1 mg/kg, 2.0 mg/kg, and 0.73 mg/kg during the post-dredging period in the respective river sections. These results demonstrate the significant reduction in surface sediment concentrations achieved between the pre- and post-dredging period as a result of both natural recovery and dredging activities.

5.1.5.3 Fish Tissue

Fish samples have been routinely collected from consistent locations within OU2 across the three time periods (pre-dredging, dredging and post-dredging). Fish samples have also been routinely collected from one location upstream of both OU2 and the former GE plant sites that is therefore unaffected by known GE-related PCB releases and represents background for OU1 and OU2. Fish are collected from four to five different areas or monitoring stations within each river section to provide representative data for the river sections. Sample collection is conducted twice per year, and targets several species of fish, representing different trophic levels and life histories. Sport fish, including largemouth bass, smallmouth bass, brown bullhead, and yellow perch, are collected in the spring. Pumpkinseed and spottail shiner[12] are collected in the fall. Fish are processed into samples for PCB and lipid analyses, with sport fish processed into fillets and pumpkinseed and spottail shiner typically processed into whole-body (individual or composite) samples.

Fish tissue PCB concentrations are a function of exposure to sediment and water, integrated through diet. Wet-weight TPCB concentrations provide one basis for evaluating changes in concentration through time and are the basis for estimating risk via ingestion to human health and the environment in the 2002 ROD. When evaluating changes in fish tissue PCB levels through time, it is important to account for confounding variables. One such variable is the lipid or fat content in fish. Because PCBs are lipophilic (PCBs readily adhere to fatty tissue), fish with higher fat levels will typically have more PCBs than fish with lower fat levels. Various environmental factors impact the lipid levels in fish on a year-to-year basis, and lipid levels can exhibit trends over time. Thus, it is possible that PCB concentrations can exhibit a decline through time solely as a result of declines of lipid levels in fish, even though the level of PCB exposure does not change. Therefore, when trying to understand how fish PCB concentrations are changing over time as a result of changes in PCB exposure, it is important to account for lipid content. One way to accomplish this is by expressing the PCB concentrations on a lipid-normalized basis. Lipid-normalized concentrations are calculated as PCB concentration in fish tissue divided by fraction of lipid.

Figure 3 compares the geometric mean of the wet-weight and lipid-normalized TPCB data in the pre- and post-dredging period for fish in the UHR. The geometric mean provides a better representation of the central tendency of log-normally distributed data. The fish selected for this analysis were brown bullhead, yellow perch and pumpkinseed because they are consistently collected every year and in all river sections. In general, TPCB concentrations in fish tissue in the post-dredging period were at or below pre-dredging levels. In the post-dredging period, there is

[12] Other forage fish, in addition to spottail shiner, have historically been collected in the UHR.

high variability in TPCB concentrations among fish species. These figures also demonstrate the interspecies variability in TPCB concentrations within the UHR.

Brown bullhead and pumpkinseed show statistically significant declines in the geometric mean of the wet-weight and lipid-normalized TPCB concentrations relative to the pre-dredging period. Brown bullhead show the largest decline in both wet-weight and lipid-normalized geometric mean TPCB concentrations. Yellow perch show consistent declines in the lipid-normalized geometric means. The difference between the wet-weight and lipid-normalized plots for yellow perch indicate the influence of lipid on the TPCB concentration. In the post-dredging period, lipid content has increased in yellow perch. When the wet-weight TPCB concentration is normalized to account for the increase in lipid, the change (decrease) in TPCB concentration becomes evident.

Another metric used to quantify how PCB concentrations in fish tissue change over time is the species-weighted average. The species-weighted average represents the average TPCB fish tissue concentrations for species expected to be commonly caught throughout the UHR for consumption. It is calculated using bass, bullhead and perch concentrations from all three river sections and accounts for how frequently these fish are expected to be caught and the length of each river section. The basis for ROD targets and goals is the species-weighted average. The species-weighted average has been calculated annually from 2004 through 2021. Similar to the results shown in Figure 3, the species-weighted average has decreased relative to the pre-dredging period (Appendix 3, Figure A3-19).

5.1.6 Positive Progress is Being Made Toward Achieving RAOs

This section discusses the progress being made toward achieving the RAOs described in Section 2.2.2. The 2002 ROD did not anticipate that RAOs would be achieved within six years (2016 to 2021) following completion of the dredging, however, the post-dredging data collected to date indicates that positive progress is being made towards meeting those goals.

5.1.6.1 The First Human Health Target Level of 0.4 mg/kg-ww Has Not Yet Been Achieved

The first RAO in the 2002 ROD is to reduce the cancer risks and non-cancer health hazards for people eating fish from the Hudson River by reducing the concentration of PCBs in fish. The remedial goal was established as 0.05 mg/kg-ww TPCB in fish tissue, which is protective of an adult who consumes one fish meal from the UHR per week. In addition to the goal of 0.05 mg/kg-ww, two targets were established, 0.4 mg/kg-ww TPCB in fish fillet (which is protective of the central tendency or average angler, who consumes one half-pound meal every two months) and 0.2 mg/kg-ww TPCB in fish fillet (which is protective at a fish consumption rate of one half-pound meal per month). The targets and goals established by the ROD are measured using a species-weighted average concentration. As discussed in Section 5.1.5.3, the species-weighted average represents the average PCB fish tissue concentrations for species expected to be commonly caught throughout the UHR for consumption. Model results presented in Table 11-2 of the 2002 ROD projected that for the UHR as a whole, a target level of 0.4 mg/kg-ww may be achieved about five years after completion of dredging, and the second target of 0.2 mg/kg may be achieved about 16 years after dredging. In 2020, five years after dredging, the species-weighted average TPCB concentration was 0.63 mg/kg-ww. Although the first target was not achieved in the time frame estimated by the modeling, concentrations appear to be declining. As discussed in Sections 5.1.5.3 above and 5.1.7 below, there is significant year-to-year variability in the fish tissue concentrations. Due to variability in the fish data, additional years of data are needed to determine when the ROD targets of 0.4 and 0.2 mg/kg will be achieved. Additionally, as noted in the response to comments for the Second FYR, any comparison of fish data to ROD model projections needs to consider that assumptions used in the ROD model projections were not expected to (and did not) exactly reflect actual implementation of the remedy (EPA, 2019c).

Although the target of 0.4 mg/kg has not yet been achieved in the post-dredging period, the percentage of sport fish samples with TPCB wet-weight concentrations below 0.4 mg/kg-ww has increased compared to the pre-dredging period across most river sections and species. Overall, across all UHR river sections, the number of samples below the 0.4 mg/kg-ww threshold increased from 21 percent in the pre-dredging period to 37 percent in the post-dredging period. The largest gain is in RS 1, where the number of samples below the 0.4 mg/kg-ww threshold increased from 15 percent to 44 percent, while the number of samples increased from 17 percent to 22 percent in RS 2, and from 31 percent to 42 percent in RS 3 (Appendix 3, Table A3-6).

5.1.6.2 The Ecological Targets for Protection of Ecological Resources Have Not Yet Been Achieved

The 2002 ROD specifies two targets for protection of ecological resources, one for largemouth bass and one for spottail shiner. For largemouth bass (whole-body) the ROD specified a target range from 0.3 to 0.03 mg/kg-ww TPCB (EPA, 2002) based on consumption of fish by the river otter, and for spottail shiner the ROD specified a target range from 0.7 to 0.07 mg/kg TPCB (whole-body) for consumption of fish by mink. As discussed in Question B below, changes to exposure parameters used in the 2002 ROD would narrow the range to 0.2 to 0.07 mg/kg-ww for largemouth bass and 0.34 to 0.11 mg/kg for spottail shiner (Appendix 5).

The ecological targets for largemouth bass are based on a whole-body largemouth bass of the size range typically consumed by river otter (4 to 7 inches; Erlinge, 1968). However, during the post-dredging period, largemouth bass samples have been analyzed for PCBs on a fillet basis only. As discussed in the Revised BERA, a conversion factor of 2.5 is applied to largemouth bass standard fillet PCB concentrations to convert fillet concentrations to estimate whole-body equivalent PCB concentrations (EPA, 1999). In the post-dredging period, 6 percent of the estimated whole-body largemouth bass PCB concentrations fell below the ROD 0.3 mg/kg-ww criterion using this conversion factor and no results are below the 0.03 mg/kg-ww criterion. However, the size range of largemouth bass collected for fillets typically ranged between 12 and 20 inches, which is outside the range typically consumed by river otter. Given the difference in size between fish collected for fillet analysis and the size targeted by river otter, there is uncertainty in using the 2.5 conversion factor when assessing current exposure and progress towards the RAO. EPA has identified the lack of PCB data on appropriately sized whole-body largemouth bass as a data gap. Now that the remedy is in the post-dredging period and overall fish concentrations have declined, whole-body largemouth bass which is representative of the size targeted by river otter will begin to be collected in 2024 or 2025. This data will provide information on the current risk exposure for river otter, allow an evaluation of time trends in PCB concentrations and confirm whether the multiplier is still appropriate.

The ROD RAO specifies a range of concentrations for spottail shiner that is protective of mink. Spottail shiner was used as an indicator species to represent forage fish less than 10 cm in length (EPA, 2000a). The sampling program between 2004 and 2020 did not focus exclusively on spottail shiner, but rather collected a variety of forage fish species. During the post-dredging period, approximately 20 percent of forage fish collected are below the 0.7 mg/kg-ww criterion and no results are below the 0.07 mg/kg-ww criterion. While a comparison of the forage fish data as a whole to the ecological risk criteria is appropriate for assessing ecological risk, combining different species presents challenges when evaluating PCB concentration trends though time (see Appendix 3). Therefore, beginning in 2021 EPA has modified the forage fish collection program to focus solely on spottail shiner. This will reduce uncertainty in time trends (e.g., avoids uncertainty introduced by combining different species) and a direct comparison to the ROD RAO can be made.

5.1.6.3 Increase in the Number of Water Column Measurements Meeting Most Stringent Water Column ARAR

Another RAO in the 2002 ROD was to reduce PCB levels in sediments in order to reduce PCB concentrations in the water column that are above specific ARARs. The most stringent ARAR identified by the ROD was the CCC FWQC for protection of aquatic life in freshwater (0.014 µg/L [14 ng/L] TPCBs). An evaluation of the post-dredging (2016 to 2021) water column data collected from the three water column stations located within the OU2 project area shows a substantial increase in the number of samples with concentrations below this criterion when compared to the pre-dredging period.

Using all water column samples (i.e., both routine and high-flow samples) collected during the pre-dredging period (2004 to 2008), the total percentage of samples less than 14 ng/L collected at Thompson Island Dam, Schuylerville and Waterford monitoring stations was 10 percent, 16 percent and 18 percent, respectively, while during the post-dredging period (2016 to 2021), the percentage of samples with contaminant levels below the criterion increased to 76 percent, 44 percent, and 57 percent, respectively. Recognizing that river flow influences water column PCB concentrations, and that the high-flow sampling program was only implemented at some locations (Schuylerville and Waterford) and at Schuylerville did not occur during both the pre- and post-dredging period, an assessment using routine data only was also performed. During the pre-dredging period (2004 to 2008), the total percentage of routine samples less than 14 ng/L at Thompson Island Dam, Schuylerville and Waterford was 10 percent, 16 percent, and 16 percent, respectively. For the post-dredging period (2016 to 2021), the total percentage of routine samples less than 14 ng/L at Thompson Island Dam, Schuylerville and Waterford was 76 percent, 40 percent, and 61 percent, respectively.

The substantial increase in the number of samples with detected TPCB concentrations below 14 ng/L from the pre-dredging to the post-dredging period, whether using all data or only routine data, indicates that positive progress is being made toward achieving the most protective water column PCB concentration ARAR.

5.1.6.4 PCB Mass Removed Exceeded ROD Expectations

An additional RAO in the 2002 ROD was to reduce the inventory (mass) of PCBs in sediments that are or may be bioavailable. It is estimated that 76 percent of the overall PCB mass from the UHR was removed by the dredging, which exceeds the 65 percent reduction assumed in the ROD. Total sediment volume and TPCB and Tri+ PCB mass removed were greater than planned in the remedial design, in part due to underestimates of the depth of contamination (primarily caused by wood debris that interfered with sediment sampling) during the original remedial design.

5.1.6.5 The Tri+ PCB Load to the Lower Hudson Is Lower than the Pre-dredging Load

The last RAO in the 2002 ROD focused on minimizing the long-term downstream transport of PCBs to the LHR. To accomplish this, EPA successfully implemented resuspension performance standards during the in-water remedial activities, as discussed in the Second FYR. To further evaluate the achievement of this RAO, the annual PCB loads at the Waterford station were estimated for the pre- and post-dredging years to confirm that loads to the LHR have been reduced.

PCB water column concentrations in the Hudson River are influenced by flow and season. Therefore, when calculating loads to the LHR, it is important to account for these variables. The USGS Load Estimator software package (LOADEST; Runkel et al., 2004) was used to estimate loads to the lower river and explicitly accounts for the influence of these variables on PCB load (Appendix 1, Section 3.3.1).

During the pre-dredging period, estimated annual Tri+ PCB loads ranged from 94 kg to 150 kg (Appendix 1, Table A1-8). During the post-dredging period, estimated annual Tri+ PCB loads ranged from 34 kg to 101 kg. As expected, annual loads, in part, reflect the magnitude of flows within a year – 2019 had both the highest PCB load and the highest median flow value (11,500 cfs), while 2016 and 2020 had the lowest PCB loads and the lowest median flow values (4,885 and

5,115 cfs, respectively) (Appendix 1, Figure A1-17). While year-to-year variability exists in both pre- and post-dredging period PCB loads, results indicate that PCB loads during the post-dredging period are lower than the pre-dredging period, consistent with observed changes in water column PCB concentration between the two periods.

Attributing changes in PCB loads to changes in PCB concentration can be difficult, as it is possible that water column PCB concentrations are declining under typical conditions, but year-to-year variability in flows (and possibly other co-variates that influence water column PCB concentrations) may obscure this decline, resulting in annual PCB loads that may appear stationary or appear to increase. To properly identify changes in PCB loads attributed to changes in PCB concentration, variability in annual loads that are a result of year-to-year variability in flow (and possibly other co-variates) needs to be removed so that changes in annual load estimates reflect changes in the water column PCB concentration. This can be accomplished using a normalization procedure based on Hirsch and De Cicco (2015). Results of this normalization procedure show a decrease in PCB loads between 2016 and 2021 (Appendix 1, Figure A1-19).

5.1.7 Additional Data Are Needed to Accurately Determine Long-term Trends

The 2002 ROD indicated that following dredging, the system would enter a period of MNR where PCB concentrations in all three media (water, sediment, and fish) would continue to decrease over time (EPA, 2002). As discussed in Section 5.1.5, both the water column and fish tissue PCB concentration datasets exhibit substantial year-to-year variability. The observed variability is not unexpected and is caused by a variety of environmental (for water and fish tissue concentrations) and physiological (for fish tissue concentrations) factors. In surface water, environmental factors such as flow, seasonality and temperature can explain some of the year-to-year and within-year variability observed in the data. In the case of fish tissue, physiological factors such as lipid content, age, length, gill surface area, blood, and environmental factors, such as temperature, pH, light, current, suspended particles and dissolved organic compounds, can control the variability in PCB bioaccumulation over time. The levels of contamination year-to-year in prey that the fish consume can also influence the variability. In some cases, it may be possible to account for these factors when assessing time trends (e.g., lipid normalization); however, it is not possible to account for all factors. Given the large year-to-year variability observed in the water and fish tissue dataset, the starting and ending concentrations in a particular span of time can have an impact on time trends, particularly when a limited amount of data (e.g., six years of post-dredging data) is available. The impact of starting and ending concentrations on short-term contaminant time trends has been observed in previous studies of fish (Gewurtz et al., 2011). Using data from the Great Lakes region, Gewurtz et al. (2011) analyzed datasets from different contaminant monitoring programs and demonstrated that more than 10 years of data is optimal for estimating time trends. Furthermore, estimated time trends were less sensitive to starting and ending concentrations when using this amount of data. In contrast, shorter term datasets could exhibit decreasing, increasing or no significant trends depending on the starting and ending concentrations.

In addition to the environmental and physiological factors described above that impact year-to-year variability in PCB concentrations in water column and fish, it is important to recognize that dredging imposed a significant disturbance on the river system, and the system requires a period of time to establish a new equilibrium. As discussed in the 2002 ROD, an equilibration period of one year or more was anticipated following dredging (EPA, 2002), and the RI/FS anticipated that a post-dredge period of re-equilibration may extend over more than one year (EPA, 2000a). During implementation, dredging occurred in all three river sections simultaneously during the last year of dredging (2015), which likely interrupted any prior re-equilibration that may have occurred.

Further, work boats and barges causing turbulence that may have disturbed river bottom sediment occurred throughout the UHR until the work was completed in 2015. As requested by New York State, some dredging was done in the uppermost portion of the river at Fort Edward in the last year of dredging in 2015.

During the first year or more of the post-dredging period, the concentrations of PCBs in water, sediment and fish were likely subject to lingering effects from the dredging activities. It is anticipated that as the system re-equilibrates, concentrations will more closely reflect ongoing recovery as a collective result of the remedy and MNR.

In this FYR, a moving window[13] analysis was conducted using both routine water column and lipid-normalized fish tissue PCB data to determine if the current amount of post-dredging data (six years, 2016 to 2021) spans a sufficiently long period of time such that accurate time trends can be estimated. Complete details of the analyses are presented in Appendices 1 and 3, respectively.

Moving Window Analysis Indicates Eight or More Years of Data are Needed to Determine a Meaningful Long-term Trend

Evaluating time trends in environmental data is useful because it allows for extrapolation of the data into the future to assess when certain goals may be achieved. However, extrapolation of the data into the future is very sensitive to the time trend estimated from the existing data. Incorrectly estimating the time trend, even by a small amount, can result in very large errors in the estimated time needed to achieve certain goals. Therefore, before a time trend can be estimated, it is important to determine whether the dataset spans a sufficiently long period of time so that the time trend accurately reflects the true, long-term time trend and is not affected by short-term natural variability in the dataset.

[13] The moving window analysis presented in this FYR is based on the moving window analysis presented in the Second Five-Year Review Comment Response (EPA, 2019c) that indicated eight or more years of data are needed to estimate an accurate time trend in the post-dredging fish tissue data.

The moving window analysis assessed whether six years of data is sufficient to accurately estimate time trends for water column and fish PCB concentrations. Because a moving window analysis requires a long-term dataset, the moving window analysis was conducted using pre-dredging data collected from 1998 to 2008[14]. The analysis assumed the true long-term rate of decline is reflected in the full 11 years of data. Different lengths of consecutive years of pre-dredging data were grouped together (representing the time "window") and a rate of decline estimated (the length of consecutive years of data ranged from three to 10 years). For a particular window of consecutive years, all combinations were evaluated. For example, for a window of six years, the possible window combinations are: 1998 to 2003, 1999 to 2004, 2000 to 2005, 2001 to 2006, 2002 to 2007 and 2003 to 2008. By varying the size of the window within the available data time span, the relationship between number of years of data and variability in the rate of decline can be evaluated.

The moving window analysis of the water column dataset indicated that using six years of data results in an estimated time trend that varied approximately ±50 percent from the 'true' time trend at both Thompson Island Dam and Schuylerville, the two stations with enough pre-dredging data to run the analysis (Appendix 1, Figure A1-15). For time trends calculated using eight or more years of data, all of the short-term time trends for Thompson Island and seven of the nine short-term time trends for Schuylerville fell within the 95 percent confidence interval of the true time trend, with at least nine years of data needed at Schuylerville for all short-term time trends to fall within the 95 percent confidence interval of the true trend. These results suggest that at least two more years of data (i.e., at least eight years of data, compared to the six years [2016 to 2021] of post-dredging data currently available) are needed to estimate a time trend that will likely be representative of the "true" long-term time trend in PCB concentration.

For the fish tissue moving window analysis, the continuous pre-dredging fish tissue data for brown bullhead, largemouth bass, pumpkinseed, and yellow perch available from 1998 to 2008 in RS 1 provide the best basis for this evaluation. For all fish species included in the analysis, results indicated that using a six-year time window resulted in an estimated time trend that varied approximately ±50 percent from the true time trend, similar to the water column results (Appendix 3, Figure A3-20). For time trends based on six or seven years of data, there are 11 possible window combinations. Out of the 11 possible window combinations, for brown bullhead only two short-term time trends were within the 95 percent confidence interval of the true time trend; two for largemouth bass, none for yellow perch, and three for pumpkinseed. When the length of the window increased to eight to 10 years (nine possible window combinations), five brown bullhead

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[14] The appropriateness of using pre-dredging data as a surrogate for post-dredging data was assessed by comparing the variability in the pre- and post-dredging datasets. Data variability for the two periods should be similar so those results based on the pre-dredging period are transferrable to post-dredging period. Results indicate variability is comparable across the two periods and the use of pre-dredging data in the moving window analysis is appropriate. See Appendices 1 and 3 for additional details.

time trends fell within the 95 percent confidence interval of the true time trend; six for largemouth bass, two for yellow perch, and two for pumpkinseed.

The results of the moving window analysis demonstrate that at least eight or more years of data are needed to reduce the variability in the time trend such that the estimated time trend will better represent the ‘true’ long-term time trend in PCB concentration.

5.1.8 Post-dredging PCB Dynamics in Fish, Sediment and Water

As described in Sections 5.1.5.1 to 5.1.5.3, the water, sediment and fish OM&M sampling programs are designed to both detect time trends in PCB concentrations and complement one another such that the recovery of the system can be understood holistically. Specifically, the fish, sediment and water sampling programs were designed to detect a 5 percent rate of decline over 10 years with 80 percent power and 95 percent confidence. Overall, the three sampling programs are designed to provide assessments at similar spatial scales (i.e., river sections), from which various comparisons can be made across the media, including whether the three media exhibit similar spatial patterns in PCB concentrations. This section presents an overall view of post-dredging PCB concentrations across the three media.

In aquatic systems, hydrophobic chemicals such as PCBs are mostly associated with sediments, and in the absence of significant external sources, the transport and fate of the legacy PCBs in the sediments of the UHR control the surface water concentrations and the bioaccumulation of PCBs in fish. Sediment concentrations influence PCB exposure through resuspension under high-flow conditions. Under lower flow conditions, transfer of dissolved phase PCBs from sediment to the overlying water becomes an important control on water column PCB concentrations. Bioturbation is another mechanism that can influence water column PCB concentrations. Fish and other aquatic organisms are exposed to PCBs through direct contact with water and sediment (bioconcentration), as well as through dietary sources (bioaccumulation). Because of the dynamic link between the three media, there is an expectation of a system-wide spatial correlation between PCB exposure and fish concentration. Therefore, long-term monitoring of all three media is important for understanding the recovery of the system.

In the UHR, post-dredging sediment concentrations are the highest in RS 2, followed by RS 1 and the lowest in RS 3 (Figure 3). The spatial pattern in post-dredging water column PCB concentrations is generally consistent with the spatial pattern observed in the surface sediment PCB concentrations. There is a water column Tri+ PCB parts per trillion concentration increase from Rogers Island to the Thompson Island Dam monitoring station (Figure 3). The water column PCB concentration further increases at the Schuylerville station (representing transport through RS 1 and RS 2) and then declines at the Waterford station (representing transport through RS 3). Changes in post-dredging fish tissue PCB concentrations generally follow the same spatial patterns seen in the sediment and water column datasets. Compared to the concentration detected at the

Feeder Dam station (the background station for the Site), concentrations increase in all fish species collected in RS 1. Further increases are observed within RS 2, before decreasing in RS 3. Overall, the similarity in the spatial pattern among the three media indicate they are closely linked at the river section scale, and therefore, continued monitoring of all three media is needed to understand the recovery of the system as a whole.

5.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Still Valid?

Remnant Deposits (OU1)

For OU1, there has been no change in the physical conditions of Remnant Deposits 2 through 5 that would affect the protectiveness of the current capping remedy. The cap system on the Remnant Deposits limits human exposure to the capped sediment and access to this area is restricted by perimeter fencing and by its location in the deeper gorge section of the UHR. The Remnant Deposits are inspected semiannually to identify and address any issues (i.e., maintenance of the vegetative cover, access roadways, diversion ditches, culverts, vent pipes, and Site security). Posted signage in the area provides an additional protective measure against exposure. The ongoing procedures to inspect and re-establish the fencing, where appropriate, should continue to function as a barrier to exposure.

A local municipality previously expressed interest in constructing a passive use type park on portions of the Remnant Deposits. Details of a future park have not yet been established and may consist of passive recreation activities such as walking and cycling. Development of the area, including additional measures designed to limit potential exposure to PCBs, would need to be planned in close consultation between EPA, NYS, and the parcel owners.

In 1984, when the Remnant Deposits remedy was selected, guidance on the development of risk assessment was only beginning at EPA and, as a result, a risk assessment was not conducted and a threshold of 5 mg/kg was used for determining areas to be capped.

Remediation of the Remnant Deposits consolidated these exposed sediments greater than 5 mg/kg and capped them. Sections of this former river bottom that remain uncapped are limited and are being evaluated under the floodplain RI/FS to determine if any further work is necessary in these areas.

In-River Sediments (OU2)

The RAOs for OU2 include reducing the cancer risks and non-cancer health hazards for people eating fish from the Hudson River by reducing the concentration of PCBs in fish. There has been no change in the physical condition of the Site since the Second FYR that would change the protectiveness of the remedy. The risk-based remediation goal for the protection of human health is 0.05 mg/kg PCBs in fish fillet based on the non-cancer hazard index for the RME adult fish consumption rate of one half-pound meal per week (this level is protective of cancer risks as well). This risk-based remediation goal remains protective of human health since there have been no significant changes to the toxicity and exposure assumptions used in the original risk assessment, as described further below. As addressed in more detail in Section 5.1.2, both NYSDEC and NYSDOH have fishing restrictions in place for the UHR to provide health protection until the cleanup goal for fish tissue is achieved.

5.2.1 Changes in Standards and To-Be-Considered Requirements

There are no ARARs or to-be-considered requirements for PCBs in fish and sediment.

5.2.2 Changes in Exposure Pathways

5.2.2.1 Human Health Exposure

Since the release of the 2002 ROD, EPA has updated guidance documents used in human health risk assessments based on the current state of the science. In 2011, Chapter 11 of the Exposure Factors Handbook was updated regarding fish consumption (EPA, 2011). Additionally, exposure assumptions were updated with the release of the 2014 Office of Solid Waste and Emergency Response (OSWER) Directive No. 9200.1-120 *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors* (EPA, 2014). Updates from this document include changes in exposure assumptions for body weight for the adult, skin surface area for the adult and child, drinking water ingestion rate for the young child and adult, and other parameters. These updates were documented and reviewed in the Second FYR and discussed in Appendix 11 of that document. These changes did not impact the conclusions of the Revised HHRA risk assessment or the protectiveness of the selected remedies. No exposure updates have been made since the Second FYR.

5.2.2.2 Ecological Exposure

The exposure assumptions associated with the ecological RAOs in the 2002 ROD (i.e., reduce the risks to ecological receptors by reducing the concentration of PCBs in fish) were evaluated for this FYR. A review of relevant literature was conducted, and no new information was identified that would change the validity of conclusions made in the Second FYR. As no substantial changes were identified as compared to values used in the Revised BERA, EPA concluded that the exposure assumptions supporting the RAO for ecological protection remained valid. While the review was limited to piscivorous mammalian receptors, it was assumed that this trophic level remained the most sensitive to PCBs in the UHR and that the remediation goals developed for them would also be protective of other ecological receptors.

Five exposure parameters were used in the Revised BERA to quantify wildlife dietary exposure: body weight, food ingestion rates, water ingestion rates, sediment ingestion rates, and home range. During the preparation of the Second FYR (EPA, 2019a), EPA conducted a comprehensive literature review to identify updated exposure factors and toxicity values different from those used in the Revised BERA. The inclusion of updated values for body weight, water ingestion rates, and sediment ingestion rates obtained from the literature review would not significantly affect the calculated risks for mink and river otter and would result in slightly more conservative estimates of exposure and risk (i.e., an increase in average daily dose and hazard quotient). Consequently, use of updated values for the exposure parameters identified above would reduce the upper-bound of the risk-based concentration ranges for the ecological exposure pathway identified in the 2002 ROD. A discussion of the updated values from the literature review is included in Appendix 5.

5.2.3 Changes in Toxicity and Other Contaminant Characteristics

5.2.3.1 Human Health Toxicity

For human health risk assessments, EPA relies on toxicity values from the Integrated Risk Information System (IRIS) for the cancer slope factor and the non-cancer toxicity values. The IRIS webpage indicates that the non-cancer toxicity information for PCBs will be updated. In 2019, EPA released the *Systematic Review Protocol For The Polychlorinated Biphenyls (PCBs) Non-cancer IRIS Assessment (Preliminary Assessment Materials) (Report)* for public review and comment (Federal Register Notice 2019). The IRIS Outlook Page indicates that the draft release of the document is planned for Fiscal Year 2024 with external review anticipated in Fiscal Year 2025. IRIS program updates for PCBs and other chemicals are available at:

https://iris.epa.gov/ChemicalLanding/&substance_nmbr=294#status

Associated changes in non-cancer toxicity values will be evaluated in the next FYR, as appropriate.

A subset of PCB congeners is dioxin-like in their structure and toxicity and are considered the most toxic of the PCB congeners. Dioxin-like congeners are structurally similar to dibenzo-*p*-dioxins, bind to the aryl hydrocarbon receptor and cause dioxin-specific biochemical and toxic responses (EPA, 2019a). In 2010, the IRIS program updated the dioxin Toxicity Equivalent Factors (TEFs) for dioxin-like PCBs and issued a non-cancer toxicity value for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) (EPA, 2010a). In the First FYR, the updated dioxin TEFs were evaluated based on the approach used in the Revised HHRA. In the Second FYR, a comparison was made between results from the Revised HHRA and those calculated with the new TCDD reference dose and the revised TEFs for the dioxin-like PCBs. The results showed that the RME from non-cancer hazards associated with the dioxin-like PCBs were comparable to those from TPCBs based on Aroclors 1254 and 1016, indicating the dioxin-like PCBs do not enhance the risks from TPCB exposure (EPA, 2019a).

At the time of this FYR, the IRIS agenda does not indicate any planned updates for TCDD. In addition, the EPA Risk Assessment Forum's (RAF) dioxin TEF was last updated in 2010 (EPA, 2010a) and the RAF is not planning to update the document at this time.

5.2.3.2 Ecological Toxicity

The LOAEL and NOAEL toxicity values used in the Revised BERA to estimate risks to piscivorous mammals (i.e., otter and mink) associated with consumption of fish tissue that has bioaccumulated PCBs are 0.04 and 0.004 mg/kg/day, respectively (EPA, 2000b). These values also formed the basis for the remedial goal range reported in the 2002 ROD for protection of the ecological exposure pathway. In the Second FYR (EPA, 2019a), EPA reviewed recent toxicity data for effects of PCBs on wildlife and updated the LOAEL and NOAEL toxicity values used in the Revised BERA to 0.033 and 0.011 mg/kg/day, respectively (Appendix 5). The refinements to the LOAEL and NOAEL toxicity values and, to a lesser degree, the otter and mink exposure parameters ultimately would result in narrower risk-based concentration ranges for PCBs in largemouth bass and spottail shiner for protection of the otter and mink, respectively. As reported in the Second FYR, the recalculated risk-based concentration range for largemouth bass consumed by the river otter is 0.2 to 0.07 mg/kg PCBs in fish compared to 0.3 to 0.03 mg/kg PCBs in fish in the Revised BERA. The recalculated risk-based concentration range for spottail shiner consumed by the mink is 0.34 to 0.11 mg/kg PCBs in fish compared with 0.7 to 0.07 mg/kg PCBs in fish in the Revised BERA. Refinement of the toxicity values results in risk-based ranges of PCBs in largemouth bass and spottail shiner that have lower uncertainty and bring into better focus the ranges of PCBs in fish expected to be protective of the ecological exposure pathway. The refinement of toxicity values and recalculation of the ecological remedial goal range for the river otter and risk-based concentration range for the mink does not affect the protectiveness determination of the selected remedy with respect to ecological receptors.

5.2.4 Changes in Risk Assessment Methods

In the Second FYR (EPA, 2019a), EPA reviewed directives from OSWER (now OLEM) to update the methodologies used in assessing risk. The review found that the OSWER directives used in the Revised HHRA were consistent with the update of OSWER 9200.1-120 (EPA, 2014). The changes in the OSWER Directive do not change the overall conclusions and the protectiveness of the remedy and no new changes have been identified since the Second FYR.

EPA followed the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final* (OSWER 9285.7-25; EPA, 1997) in conducting the Revised BERA. The methodologies in this guidance are current and were followed in the updates to the risk calculations discussed above.

5.2.5 Determination Regarding Remedial Action Objectives in 2002 ROD

As discussed in Appendix 5, EPA's evaluation of the Revised HHRA data and assumptions indicate the human health RAOs identified in the 2002 ROD are still valid and appropriate for the Site.

5.2.6 Risk Considerations

Risks to subsistence anglers, which would include subsistence anglers in environmental justice communities (specifically minority and low-income communities, with disproportionate adverse environmental impacts), were evaluated as part of the risk assessment performed for the 2002 ROD. EPA's evaluation of available literature regarding subsistence consumption led EPA to conclude that cancer risks and non-cancer health hazards to subsistence anglers were adequately evaluated in the Revised HHRA. Review of the limited literature available on subsistence or highly exposed angler populations supports the assumption that these subpopulations are likely to be adequately represented in the total distribution of fish ingestion rates developed for UHR anglers.

5.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

In July 2022, EPA reached an agreement with GE and Niagara Mohawk Power Corporation (NMPC), which is owned by National Grid, to dismantle the Powerhouse and Allen Mill structures located next to the former GE plant in Hudson Falls, New York. The agreement required NMPC and GE to submit detailed plans to EPA outlining how the structures will be safely removed, with measures in place to minimize the potential for a release of hazardous substances into the Hudson River. The plans included air, surface water, and groundwater monitoring, and this monitoring is intended to provide the data needed to assess potential impacts. The deconstruction work started in August 2022 and will continue through 2025. The deconstruction activities are being performed under direct oversight by EPA. EPA will closely monitor the deconstruction activities to identify any potential impacts to the OU2 Hudson River remedy.

VI. ISSUES/RECOMMENDATIONS

6.1 Issues and Recommendations Identified in the FYR

The table below describes issues that were identified during the FYR process that could potentially affect the protectiveness of the remedy. The inclusion of an item on the table does not necessarily indicate that the issue has an impact on the remedy, but it does indicate follow-up measures for each item. EPA will continue to coordinate with the appropriate federal and state support agencies and the public (including the project CAG) regarding these potential issues.

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the FYR:
None

<table>
<tr><th colspan="5">Issues and Recommendations Identified in the FYR:</th></tr>
<tr><td rowspan="3">OU(s): OU1

Issue 1 of 1</td><td colspan="4">Issue Category: Institutional Controls (ICs)</td></tr>
<tr><td colspan="4">Issue: The 1984 ROD does not contain requirements for institutional controls. An institutional control to ensure that future use of the Remnant Deposits does not compromise the integrity of the OU1 cap system or result in unsafe exposures should be selected and implemented.</td></tr>
<tr><td colspan="4">Recommendation: EPA will continue to coordinate with NYS to determine land ownership, which would be needed for institutional controls to be properly established. Currently, fences installed at the Remnant Deposits restrict access to the sites.

EPA will coordinate as appropriate with the municipalities about potential recreational use plans for the Remnant Deposits. Any use of Remnant Deposit properties would need to be limited to non-intrusive activities that would not compromise the integrity of the cap system.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>PRP</td><td>EPA/NYS</td><td>12/31/2024</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s): OU2

Issue 1 of 6</td><td colspan="4">Issue Category: Additional Information Needed</td></tr>
<tr><td colspan="4">Issue: There are not enough sets of annual data available since the completion of sediment dredging to establish rates of decline in fish with statistical confidence. A protectiveness determination of the OU2 remedy cannot be made until the rate of decline in fish tissue can be determined from post-dredging data.</td></tr>
<tr><td colspan="4">Recommendation: Once statistically relevant rates of decline in fish tissue post-dredging PCB data can be established, EPA will report the rates of recovery and determine if they are reasonably consistent with those anticipated by the ROD. Additional years of surface water and sediment data will contribute to EPA’s evaluation of fish recovery.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>PRP</td><td>EPA/NYS</td><td>9/30/2025</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s): OU2

Issue 2 of 6</td><td colspan="4">Issue Category: Special Studies – Potential Differences in Fish Recovery</td></tr>
<tr><td colspan="4">Issue: Based on existing data, certain fish species and sections of the river appear to be recovering differently. Although this circumstance is not unexpected, it does require further evaluation.</td></tr>
<tr><td colspan="4">Recommendation: Special studies will be conducted to provide insight into why different species and certain portions of the river appear to be recovering differently. Multiple special studies are anticipated to help understand this observation, including a fish aging study.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Unknown</td><td>PRP</td><td>EPA/NYS</td><td>12/31/2025</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s): OU2

Issue 3 of 6</td><td colspan="4">Issue Category: Special Studies – Localized Areas of Remaining PCBs - Potential Impact on Fish and Water Recovery</td></tr>
<tr><td colspan="4">Issue: Post-dredging sampling and subsequent surface sediment sampling indicated that the dredging phase of the remedy met design requirements. This work was certified as completed in 2019 by EPA. The dredging phase of the remedy resulted in the removal of 76 percent of the PCB-contaminated sediment mass in the river, which was greater than the ROD removal estimate of 65 percent.

Three surface sediment “areas of interest” were identified during surface sediment sampling in 2016/2017 and are being monitored. Based on the 2021 surface sediment data, these areas have decreased in PCB concentrations. The caps and these select sediment areas are being monitored and maintained as required by the Consent Decree. See Appendix 4 for additional details.

As approved by EPA, several considerations resulted in engineering offsets (for example near bridge piers and retaining walls), cultural resource offsets and safety offsets (primarily immediately above dams) that prevented sediment from being dredged in those areas.

Additionally, sampling has indicated that there are elevated PCB levels in soil within certain limited areas of the floodplain that are underwater during high flow portions of the year.

There is potential that areas with elevated PCBs, including the examples described above, could contribute to localized delays in recovery.</td></tr>
<tr><td colspan="4">Recommendation: These limited and localized areas of elevated PCBs concentrations in sediment/soil should be evaluated for their potential impact on water and/or fish recovery.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Unknown</td><td>PRP</td><td>EPA/NYS</td><td>12/31/2025</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s): OU2

Issue 4 of 6</td><td colspan="4">Issue Category: Supplemental Fish Collection to Inform Fish Advisories</td></tr>
<tr><td colspan="4">Issue: In order for NYSDOH to adjust fish consumption advisories, additional species of fish (not currently routinely collected) will need to be collected and tested for PCBs.

The Upper Hudson River long-term monitoring program has provisions for collection and analysis of supplemental and whole-body fish data. However, the scope of this work has not been defined yet.</td></tr>
<tr><td colspan="4">Recommendation: EPA will continue to coordinate with NYSDOH and NYSDEC regarding the scope and timing of this data collection, but it is expected to occur in the next year. These supplemental data collection events will be needed at various times over the anticipated decades-long recovery of the Upper Hudson River to support the fish advisories. GE will conduct these data collection events.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Unknown</td><td>PRP/EPA/NYSDOH</td><td>EPA/NYS</td><td>12/31/2025</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s): OU2

Issue 5 of 6</td><td colspan="4">Issue Category: Institutional Controls – Continued Funding to Support Fish Advisory ICs</td></tr>
<tr><td colspan="4">Issue: Since 2005, the State’s implementation of fish consumption advisories has been supported by Health Research, Inc., of Rensselaer, New York. In 2008, NYSDOH established the Hudson River Fish Advisory Outreach Project. The goal of this initial 20-year initiative is for all people who consume Hudson River fish and crab to be aware of and follow the Hudson River fish advisories.

This work supports the NYSDOH Hudson River advisory and NYSDEC restriction ICs in various ways including encouraging anglers and other fish consumers to follow health advisories, promoting awareness of advisories by posting signs, maintaining advisory awareness through education and promotional activities, and identifying reasons that anglers or other fish consumers may not follow the fish advisories. See Appendix 8 for additional details.

As a condition of the 2005 Consent Decree, GE funded Health Research, Inc., of Rensselaer, New York, to support the State’s implementation of fish consumption advisories. The funding GE provided is expected to run out by the end of 2027.</td></tr>
<tr><td colspan="4">Recommendation: EPA supports these education and outreach efforts, including the need for continued funding of the outreach program beyond its current funding limit of 2027. The additional funding will need to be in place in advance of 2027 so that a smooth transition can occur and to avoid disruptions to the program. EPA will continue to coordinate with NYSDOH and engage in discussions with GE regarding continued funding.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>PRP/EPA</td><td>EPA/NYS</td><td>12/31/2026</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s): OU2

Issue 6 of 6</td><td colspan="4">Issue Category: Ecological Risk – Collection of Ecological Risk Target Species</td></tr>
<tr><td colspan="4">Issue: The 2002 ROD specifies two targets for protection of ecological resources: 1) largemouth bass based on a whole-body largemouth bass of the size range typically consumed by river otter (4 to 7 inches) and 2) spottail shiner as representative of forage fish of the size range typically consumed by mink (less than 10 cm in length). During the post-dredging period, largemouth bass samples of a size larger than typically consumed by river otter have been analyzed on a fillet basis. Additionally, during the post-dredging period, forage fish collection has focused on collection of a variety of forage fish species, including spottail shiner.

EPA identified the lack of PCB data on appropriately sized whole-body largemouth bass as a data gap. For forage fish, while a comparison of the existing forage fish data to the ecological risk criteria is appropriate, combining different species presents challenges when evaluating PCB concentration trends through time.</td></tr>
<tr><td colspan="4">Recommendation: Whole-body largemouth bass which is representative of the size targeted by river otter will begin to be collected in 2024 or 2025. This data will provide information on the current risk exposure for river otter and allow an evaluation of time trends in PCB concentrations.

For forage fish, beginning in 2021, EPA has modified the forage fish collection program to focus solely on spottail shiner. This will reduce uncertainty in time trends (e.g., avoids uncertainty introduced by combining different species) and a direct comparison to the ROD RAO can be made. The frequency of spottail shiner collection will be implemented such that time trends can be further established.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Unknown</td><td>PRP</td><td>EPA/NYS</td><td>12/31/2026</td></tr>
</table>

6.2 Other Findings

The following are findings related to OU2 that are not expected to impact protectiveness but may inform future work:

6.2.1 IRIS Database

The Second FYR established that EPA will continue to review new or updated information in IRIS in future assessments of risk at the Site and FYRs. It should be noted that EPA uses IRIS, a Tier 1 Toxicity source, for data regarding the toxicity of PCBs. The IRIS webpage identifies PCBs for update of non-cancer toxicity information and EPA released its review protocol for public review and comment. The IRIS Program Outlook indicates that the draft release of the document is planned for FY'24 with external review anticipated in FY'25. Associated changes in non-cancer toxicity values will be evaluated in the next FYR. The IRIS agenda that lists chemicals being assessed under the IRIS program does not identify plans to update cancer toxicity values for PCBs.

6.2.2 Capping Institutional Controls

ICs are needed in order to protect the subaqueous caps installed by GE during dredging and to protect areas in which GE conducted habitat reconstruction and restoration. Such ICs may include restrictions on anchoring and other activities that may damage the caps or planted areas. EPA will continue to coordinate with the state (including the NYSCC), the U.S. Army Corps of Engineers and GE regarding establishing ICs to limit the potential for disturbances of these areas.

6.2.3 Additional Monitoring to Support the Operation, Maintenance & Monitoring Program

OM&M of water, sediment, fish, caps, and habitat is an important component of the remedy. It is necessary that OM&M plans reflect the current understanding of the system being monitored and that monitoring plans have the flexibility to be adjusted as necessary during the ongoing MNR phase of the remedy. EPA is overseeing GE's development and implementation of the OM&M program in consultation with NYS. The program may need to be adjusted periodically to allow for further evaluation of the river system and to account for changes in data variability. These adjustments could require changes to ongoing sampling and investigation scopes of work.

6.2.4 Rogers Island High-Flow Water Sampling Study

The Rogers Island water column monitoring station is located upstream of the areas dredged during Phase 1 and Phase 2 of the remedial action. Understanding PCB concentrations entering the upstream portion of the UHR is important for assessing the recovery of the river. As discussed in Section 5.1.3, high-flow samples have not been collected at Rogers Island and, therefore, the concentration of PCBs entering the upstream portion of the UHR during high-flow events is not well known. The PCB load estimated at Waterford (Appendix 1, Attachment A) shows that a few high-flow events may carry the majority of the annual load. Given the importance of high-flow events in transporting PCBs within the UHR, high-flow samples are needed at Rogers Island.

6.2.5 Mohawk River Water Sampling Study

The Mohawk River is a tributary that flows into the UHR downstream of the project Waterford monitoring station. The Mohawk River was sampled in 2023 for the first time since 2011. It is important to evaluate PCB concentrations from the Mohawk River as the Tri+ PCB concentrations at Waterford (approximately 6 ng/L, using 2016 to 2021 data) are approaching the Mohawk (approximately 2.5 ng/L, using 2004 to 2011 data). The results of this ongoing sampling study are important to continue to assess the contribution of PCBs from the Mohawk to the River and how that affects the natural recovery of the River.

6.2.6 Passive Sampler Water Column Study

As discussed in Section 5.1.8, the post-dredging data show that there is a water column Tri+ PCB concentration increase from Rogers Island to Thompson Island Dam and from Thompson Island Dam to Schuylerville during the summer months, possibly indicating that sediment from RS 1 and RS 2 continue to influence fate and transport of PCBs in the UHR. The spatial pattern in water column PCB concentration appears to be generally consistent with that in the surface sediment and fish tissue.

To evaluate this increase in water column PCB concentrations in the Thompson Island Pool and at Schuylerville during summer months, it is important to identify areas or sources that may contribute to the observed increase of PCB concentrations. To do this, routine summer water column PCB concentrations can be monitored via in-situ passive samplers. Passive samplers can be used to generate a time-averaged representation of PCB concentrations and are generally more representative of concentrations to which receptors are exposed than grab samples. The passive sampler study was initiated in 2023. EPA will review the data from this study once received and determine the next steps as appropriate.

6.2.7 Dissolved Phase and Particulate Organic Carbon Water Column Study

UHR surface waters contain both dissolved and particulate organic carbon. The organic carbon component of particulates in the water column acts as an attractor for hydrophobic compounds such as PCBs. This attraction plays an important role in the bioaccumulation of PCBs in biota. For this reason, additional particulate organic carbon measurements are needed to resolve uncertainties regarding dissolved and particulate phase interactions. The goal of the study is to improve our understanding of how reductions in post-dredging sediment and surface-water PCB concentrations relate to changes in PCB accumulation in fish.

6.2.8 Lipid Normalization and Observed Recovery Trends

Lipid normalization of fish data influences observed trends. Therefore, it is important to understand the causes of the observed potential atypical variability in lipid content and declines over time in the UHR. Continued evaluation of this matter including non-lipid organic matter considerations is needed.

6.2.9 Other Activities

There are several other studies and data collection efforts that are either ongoing or upcoming. This includes the evaluation of PCBs in recently deposited Be-7 bearing sediments, and sampling of cap isolation layer material.

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
Operable Unit: OU1	*Protectiveness Determination:* Short-term Protective

Protectiveness Statement:
The remedy at OU1 currently protects human health and the environment in the short term, as the in-place containment and cap system prevent human exposure. Perimeter fencing and signage continue to be maintained. In order for the remedy to be protective in the long-term, an institutional control needs to be implemented to ensure that the future use of the Remnant Deposits areas does not compromise the integrity of the cap system or result in exposures. EPA, in coordination with NYSDEC, is in the process of determining ownership of the Remnant Site properties so that the institutional controls can be established.

Protectiveness Statement(s)		
Operable Unit: OU2	*Protectiveness Determination:* Protectiveness Deferred	*Milestone Date:* 2025

Protectiveness Statement:

A protectiveness determination for the OU2 remedy cannot be made at this time until further information is obtained. In the last FYR, EPA indicated that as many as eight or more years of post-dredging data are needed to establish rates of decline for fish with an appropriate level of statistical confidence. Since sediment dredging activities were completed in 2015, EPA has gathered and evaluated fish data up to 2022. EPA does not yet have sufficient sets of annual fish data to make a protectiveness determination and, therefore, is deferring such determination.

Based on the analysis conducted during this FYR and consistent with the last FYR, once statistically relevant rates of decline in post-dredging fish tissue PCB levels can be established, EPA will estimate the rates of fish recovery and determine if they are reasonably consistent with those anticipated by the ROD and make a protectiveness determination. EPA will issue a protectiveness determination through an addendum to this FYR report. It is anticipated that the results of the annual 2024 fish data could provide the information that results in determining statistically relevant rates, allowing EPA to make a protectiveness determination, and issuing an addendum in 2025. If not, EPA will report out its analysis and continue to actively monitor the river and evaluate data until sufficient data is available to determine statistically confident rates of decline in fish. At that point, but no later than 2027, EPA will issue the addendum with a protectiveness determination.

The sediment, surface water and fish data, coupled with the special studies to further evaluate fish recovery and potential impacts associated with localized areas of elevated PCBs in sediments, will help inform EPA's understanding of fish recovery and support any additional recommendations regarding remedy performance.

In the interim, the NYSDOH has in place a fishing restriction in the Upper Hudson River, the area subject to this FYR, prohibiting the possession of fish. This Upper Hudson River fishing restriction and advisory (i.e., take no fish and eat no fish) are effective in controlling exposure when followed. Extensive outreach to inform the public about these advisories and restrictions is in place as part of the

OU2 institutional controls. EPA will continue to support fishing advisories and restrictions through the collection and testing of supplemental fish and appropriate funding for the outreach program.

In addition, in the Mid and Lower Hudson River, which is currently under further investigation by EPA and not the subject of this FYR, fish consumption is also limited by fish advisories established by NYSDOH. These advisories allow for certain fish and crab consumption for the general public and advises against fish consumption for sensitive members of the population.

VIII. NEXT REVIEW

The next FYR for the Hudson River PCBs Superfund Site is required five years from the completion date of this review.

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