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HUDSON RIVER PCBs REASSESSMENT RI/FS

PHASE 3 FEASIBILITY STUDY

SCOPE OF WORK

SEPTEMBER 1998

UNITED STATES • ENVIRONMENTAL PROTECTION AGENCY

Prepared for:

U.S. Environmental Protection Agency
Region II
and
U.S. Army Corps of Engineers
Kansas City District

Prepared by:

TAMS Consultants, Inc.
New York, NY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

SEP 2 3 1998

To All Interested Parties:

The U.S. Environmental Protection Agency (EPA) is pleased to release the Phase 3 Feasibility Study Scope of Work for the Hudson River PCBs Superfund site Reassessment. This document describes the approach to be taken by EPA to evaluate remedial alternatives for the PCB-contaminated sediments in Upper Hudson River. The Feasibility Study will be conducted in accordance with applicable regulations and EPA guidance.

The Feasibility Study (the Phase 3 Report) is scheduled to be released to the public in December 2000. EPA will concurrently issue a Proposed Plan for the site, which will identify and describe the Agency's preferred alternative. After a public comment period, EPA will then select a remedy for the site, which will be documented in the Record of Decision.

EPA will accept comments on the Feasibility Study Scope of Work until **Monday, November 2, 1998.** Comments should be marked with the name of the report and should include the report section and page number for each comment. Comments should be sent to:

Douglas Tomchuk
USEPA - Region 2
290 Broadway - 20th Floor
New York, NY 10007-1866

Attn: FS SOW Comments

Similar to the release of previous Reassessment reports, EPA will make presentations on the Feasibility Study Scope of Work, as well as the Ecological Risk Assessment Scope of Work, at a Joint Liaison Group meeting on the day of release. EPA will follow-up with an availability session to answer the public's questions regarding these documents. The availability session will be held on Tuesday, October 20, 1998 at the Marriott Hotel, 189 Wolf Road, Albany, New York from 2:30 to 4:30 p.m. and from 6:30 to 8:30 p.m.

If you need additional information regarding this Scope of Work, or with respect to the Reassessment in general, please contact Ann Rychlenski, the Community Relations Coordinator for this site, at (212) 637-3672.

Sincerely yours,

William McCabe

William McCabe, Deputy Director
Emergency and Remedial Response Division

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1. INTRODUCTION

This document describes the work to be performed in Phase 3 of the Hudson River PCBs Reassessment Remedial Investigation and Feasibility Study (RI/FS). For the purposes of the Hudson River Reassessment, the RI/FS process has been separated into three phases as follows:

1. **Interim Characterization and Evaluation**, which included a compilation of historical data and information related to the Superfund site, a preliminary evaluation of human health and ecological risks, and a determination of data gaps;

2. **Further Site Characterization and Analysis**, including extensive sediment (chemistry and geophysical), surface water, and biota sampling as necessitated by the Phase 1 findings, as well as development and calibration of PCB fate and transport models, and preparation of baseline human health and ecological risk assessments; and

3. **Feasibility Study**, including an evaluation of "No Action" as well as an appropriate range of remedial alternatives which will reduce risk to humans and biota from exposure to PCB contamination, utilizing data compiled during Phases 1 and 2 and models and risk assessments developed in Phase 2, and other data and information as necessary.

The Hudson River PCBs Superfund site extends from Hudson Falls, New York (River Mile [RM] 197) to the Battery in New York City (RM 0). USEPA's previous Feasibility Study (USEPA, 1984a), the interim "No-Action" decision for contaminated river sediments in the 1984 Record of Decision (ROD; USEPA, 1984b), and rationale for this Reassessment are described in the Phase 1 Report for this Reassessment (TAMS/Gradient, 1991). The scope of potential remedial activities for this Reassessment is limited to the PCB-contaminated sediments in the Upper Hudson River between

Hudson Falls and Federal Dam at Troy (RM 153.9). The Phase 2 investigation (TAMS/Cadmus/Gradient. 1997) confirmed that generally higher levels of PCB contamination are found in the Upper Hudson (above RM 153.9) and thus this area should be the primary focus of the Feasibility Study. However. impacts to both the Upper Hudson River and Lower Hudson River will be addressed in the risk assessments.

To date. the USEPA has issued five major reports summarizing the analyses performed for the Hudson River PCBs Reassessment. In August 1991, USEPA issued a Phase 1 Report. entitled Interim Characterization and Evaluation (TAMS/Gradient, 1991), which described the results of Phase 1 studies. The Phase 1 Report contains a compendium of background material. discussion of findings. and preliminary assessment of risks. The Phase 2 work began in December 1991 (upon approval of the earlier Phase 2A Sampling Plan) and is still ongoing. Four reports have been released from this phase of the investigation. specifically:

- Phase 2 Report. Volume 2A: Database Report - October 1995;
- Phase 2 Report. Volume 2B: Preliminary Model Calibration Report - October 1996;
- Phase 2 Report. Volume 2C: Data Evaluation and Interpretation Report (DEIR) - February 1997; and
- Phase 2 Report. Volume 2C-A: Low Resolution Sediment Coring Report - July 1998.

The Responsiveness Summary for these four volumes of the Phase 2 Report (Volumes 2A to 2C-A) will be released later this year.

This scope of work outlines the technical approach and major tasks for the Feasibility Study to be issued in December 2000.

The complex and controversial nature of PCB contamination in the Hudson will be an important consideration in the preparation of the FS. From both a technical and community perspective. there are many unique concerns and challenges associated with the selection of a remedial action for the river. Because of the complex nature of sediment PCB contamination and its relationship to water and biota contamination, computer models will be employed to assist in the selection of remedial objectives as well as to assess the likely success of any remedial action in attaining these goals.

1.1 Site History

The Hudson River PCBs Superfund site encompasses the Hudson River from Hudson Falls to the Battery in New York Harbor, a stretch of nearly 200 river miles (322 km). During an approximately 30-year period ending in 1977, two General Electric (GE) facilities, one in Fort Edward, NY and the other in Hudson Falls, NY, used PCBs in the manufacture of electrical capacitors. Estimates of the total quantity of PCBs discharged from the two plants to the river from the 1940s to 1977 range from 209,000 to 1,330,000 pounds (95,000 to 603,000 kg) (TAMS/Gradient, 1991). In 1977, manufacture and sale of PCBs within the US was stopped under provisions of the Toxic Substances Control Act (TSCA).

Many of the PCBs discharged to the river adhered to sediments and accumulated downstream with the sediments as they settled in the impounded pool behind the former Fort Edward Dam (RM 195), as well as in other impoundments farther downstream. Because of its deteriorating condition, the dam was removed in 1973. During subsequent spring floods, PCB-contaminated sediments were scoured and transported downstream. A substantial portion of these sediments were stored in relatively quiescent areas of the river. These areas, which were surveyed by New York State Department of Environmental Conservation (NYSDEC) in 1976 to 1978 and 1984, have been described as PCB *hot spots*. Exposed sediments from the former pool behind the dam, called the "remnant deposits," have been capped by GE under a consent decree with USEPA.

Although commercial uses of PCBs ceased in 1977, loading of PCBs derived from the GE plants to the Hudson River continued, due primarily to erosion of contaminated remnant deposits, discharges of PCBs via bedrock fractures from the GE Hudson Falls plant, and erosion from contaminated deposits above the water line near the GE Fort Edward plant outfall. Capping of the remnant deposits (in the area of RM 195 to RM 196) was completed in 1991. In September 1991, high PCB concentrations were again detected in Hudson River water. GE attributed the higher levels to the collapse of a wooden gate structure within the abandoned Allen Mill located adjacent to the GE Hudson Falls capacitor plant (RM ~197) (O'Brien and Gere, 1993). As reported by GE, the gate had kept water from flowing through a tunnel cut into bedrock below the mill, which contained oil-phase PCBs that migrated there via subsurface bedrock fractures. During 1993 to 1995, extensive PCB contamination was detected in water conduits within the mill and approximately 45 tons of PCB-bearing oils and sediments were eventually removed (O'Brien and Gere, 1995). In 1994, GE documented the presence of PCB dense non-aqueous phase liquid (DNAPL) seeps in a dewatered portion of the river bottom at Bakers Falls adjacent to the Hudson Falls plant site. GE instituted a number of mitigation efforts that have resulted in a decline, but not total cessation, of these seeps (O'Brien and Gere, 1995). A more in-depth discussion of external PCB sources, including the GE facilities, the remnant deposits, and other sources in both the Upper and Lower Hudson River, is contained in the Phase 2 Data Evaluation and Interpretation Report (TAMS/Cadmus/Gradient, 1997).

In 1984, USEPA issued a Record of Decision (ROD) for the site (USEPA, 1984b). The ROD selected: 1) an interim "No-Action" decision concerning river sediments; 2) in-place capping, containment, and monitoring of remnant deposit sediments; and 3) a treatability study (at the Waterford Water Works) to evaluate the effectiveness of removing PCBs from the Hudson River for domestic water supply.

In December 1989, USEPA Region II began a reassessment of the "No-Action" decision for the Hudson River sediments based on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) five-year reevaluation requirement for remedies that leave contamination on site: the reopener in the 1984 ROD; and the request from NYSDEC to conduct the Reassessment. The ongoing reassessment consists of three phases: Phase 1 - Interim Characterization and Evaluation: Phase 2 - Further Site Characterization and Analysis; and Phase

3 - Feasibility Study. This document represents the scope of work for the Phase 3 Feasibility Study that will be developed for the Reassessment.

The 1984 ROD does not address PCB DNAPL seeps near the GE Hudson Falls plant, which were unknown at the time. Also, the outfall area at the GE Fort Edward plant site is likely a source of PCBs to the river (TAMS/Cadmus/Gradient, 1997). Remedial activities at the GE Hudson Falls and Fort Edward sites are being performed under Orders on Consent between NYSDEC and GE. The changing loading from the GE sites upstream of the Thompson Island (TI) Pool will be considered in evaluation of remediation for the Hudson River.

1.2 Objective and Scope

The overall objective of the Phase 3 Feasibility Study is to develop and evaluate an appropriate range of remedial alternatives which will reduce risk to humans and biota from exposure to PCB contamination. This effort is the continuation of preliminary FS efforts (*e.g.*, TAMS/Gradient, 1991 and TAMS, 1997) which were initiated in Phase 1. Based on the results of the Phase 3 work, USEPA will select a remedy (or "No Action") which meets the requirements of CERCLA while taking into account the recommendations and concerns of New York State and the local communities affected.

Preliminary remedial action objectives will be refined and developed. For protection of human health (*i.e.*, consumption of contaminated fish or ingestion of water), it is anticipated that the remedial action objectives will be defined primarily for the media of exposure (*e.g.*, fish and water) and not in terms of sediment levels unless direct sediment exposure is involved. Although, in the Hudson River, the sediments are not typically the medium of PCB exposure for assessing human health risks, nonetheless they comprise one of the main sources of PCBs to the exposure media and thus will be the focus of the FS. For protection of biota (*i.e.*, benthic invertebrates, fish, birds, and mammals), direct exposure to sediment will be considered in the ecological risk assessment. However, the link between sediment PCB levels and the exposure media is complex. As a result, as part of the Phase 2 investigation, computer-based, geochemical and ecological model components are being developed to simulate the sediment-water-biota interactions. USEPA will also utilize a model of the Lower Hudson River developed by Drs. Robert Thomann and Kevin Farley for the Hudson River Foundation. As part of the FS, the USEPA Reassessment and Thomann/Farley models will be used to examine the impact of possible remedial actions in the Upper Hudson River on PCB levels in fish and water in both the Upper Hudson River and Mid-Hudson River (in this case, the Mid-Hudson is defined as the freshwater portion of the Lower Hudson River from Federal Dam at Troy to Poughkeepsie, NY). In this manner, the model responses will be used to suggest both the degree and extent of cleanup (*i.e.*, concentration threshold and spatial coverage) as well as the likely timeframe for measurable improvements attributable to the remedial actions. This approach is unique to a relatively few complex Superfund sites, since action levels are typically established in a direct fashion from human health risk assessment calculations, ecological risk assessment calculations or applicable or relevant and appropriate requirements (ARARs). Ultimately, all four approaches (modeling, human health and ecological risk assessments, and ARARs) will be considered in establishing the remedial action objectives for the sediments.

Based on the results of the then-established remedial action objectives and the results of the baseline human health and ecological risk assessments, the initial screening of remedial alternatives will be performed according to the procedures recommended in "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (USEPA, 1989), as well as the National Contingency Plan (NCP). The subtasks to be completed during the initial screening process include:

- Development of remedial response objectives and general response actions;
- Identification and screening of remedial technologies and specific process options for each technology; and
- Development and screening of remedial alternatives, which can comprise one or more remedial technologies.

Upon completion of the initial screening. the remaining alternatives will be subjected to detailed analysis. The results of the entire FS process will be described in the Reassessment FS Report.

It has been USEPA's continuing goal since this Reassessment commenced to solicit information and provide feedback to the public through a Community Interaction Program (CIP). CIP participants and committees have provided written and verbal comments throughout the project. These comments are useful and greatly appreciated. Comments on this document will be reviewed and considered in the development of the Phase 3 FS.

1.3 Schedule

The FS report is scheduled to be released in December 2000.

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2. DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

As discussed above, the remedial action objectives will be developed based on the results of the Phase 2 investigation. These objectives will be constructed in light of data collected for the Reassessment as well as data from other sources (*e.g.*, GE, NYSDEC, National Oceanic and Atmospheric Administration [NOAA], and US Fish and Wildlife Service [USFWS]). Prior to the development of these objectives, significant site concerns and contaminant pathways identified in the previous phases will be examined. Considering these concerns and pathways, the remedial action objectives that would eliminate or minimize substantial risks to public health and the environment will be developed further. Included in this step is the development of potential remedial action objectives via the use of the geochemical and ecological model results to suggest both the degree and extent of sediment remediation necessary to reduce exposures to acceptable levels. ARARs will be refined by considering site-specific conditions. Based on the remedial action objectives, general response actions will be delineated to address each of the site concern areas. These response actions will form the foundation for the screening of remedial technologies. General response actions considered will include the "No-Action" alternative as a baseline against which the other alternatives can be compared.

2.1 Applicable or Relevant and Appropriate Requirements

Section C.3 of the Phase 1 Report (TAMS/Gradient, 1991) initially addressed applicable or relevant and appropriate requirements (ARARs) in some detail. Tables 1, 2 and 3 herein represent updated but not final lists of potential chemical-specific, location-specific and action-specific ARARs, respectively. As part of the Phase 3 effort, the ARARs will be reviewed and modified as appropriate in light of Phase 2 analyses and other appropriate data. The revised ARARs will then be used during Phase 3 screening and detailed analysis tasks.

As originally indicated in USEPA's Responsiveness Summary for the Phase 1 Report (TAMS/Gradient, 1992), NYSDEC will provide USEPA with a complete list of State ARARs and To Be Considered Requirements (TBCs) for USEPA's use in the Phase 3 FS. An initial list of ARARs was provided by NYSDEC in 1994. This list will be updated by NYSDEC in Phase 3. Tables 1, 2 and 3 include the ARARs provided by NYSDEC in 1994 as well as other ARARs. Although extensive, the tables contain only potential ARARs. A final evaluation and selection of the ARARs will be done in Phase 3.

2.2 Remedial Action Objectives

Remedial action objectives serve as guidelines in the development of alternatives for site remediation. Remedial action objectives should specify the contaminants and media of concern, exposure routes and potential receptors, and an acceptable concentration limit or range for each contaminant for the various media, exposure routes and receptors. In constructing these objectives for the Hudson, it will be necessary to establish both acceptable concentrations as well as areas requiring remediation. Accessibility of contamination to humans, the water column and biota will all figure in the selection of areas for remediation.

The results of the preliminary risk assessments completed in Phase 1 indicate that the contaminants of concern are PCBs and that the primary exposure route is consumption of aquatic life. The receptors are the consumers of aquatic life: human receptors and ecological receptors (fish-eating birds and mammals). As extensively discussed in the Data Evaluation and Interpretation Report (TAMS/Cadmus/Gradient, 1997), the sediments are a major, if not the major, source of PCBs to the water column in the Upper Hudson. Since the exposure of aquatic life to PCBs must take place either through sediment-based or water-based exposure routes, the primary medium of concern is Upper Hudson River sediments. Establishing remedial action objectives on the basis of these exposure routes will require analysis and modeling. Additionally, direct human and ecological exposure to PCB-contaminated sediments and water may also pose unacceptable risks and provide an additional basis to establish remedial action objectives. Ecological receptors will include piscivorous birds and mammals as identified above as well as fish, benthic invertebrates, and insectivorous birds. In addition to risk-based remedial action goals, PCB concentrations in Upper Hudson River water and sediment may exceed limits specified in State and Federal ARARs or other criteria, advisories or guidance to be considered. The refinement of ARARs described in Section 2.1 above will provide input to the development of remedial action objectives.

Target contaminant concentration limits or ranges may be developed for various media and receptors as part of the process of developing remedial action objectives. Concentration limits may be based on ARARs or the results of the human or ecological risk assessments. The concentration limits would be set to reduce incremental human cancer risk to between 10^{-4} and 10^{-6} or to reduce the non-carcinogenic Hazard Index (HI) to below 1.0. Ecological contaminant concentration limits would be set at levels demonstrated to be protective of ecological receptors. Target concentration limits will also be developed using the geochemical and ecological model components to examine the relationship between various sediment concentrations and attainment of acceptable PCB levels in fish and other biota (*e.g.*, FDA limits).

In addition to setting target contaminant concentration ranges or limits, it will also be necessary to specify areas of sediment to be addressed. PCB concentration in sediment alone is unlikely to be a sufficient criterion, since PCB transfer to the water column and biota would be expected to vary with other environmental factors, such as sediment type, proximity to biologically-important areas and depth of contamination. Thus different areas might be assigned different target levels or be remediated in different ways. Selection of areas for remediation will be done based on the criteria developed during Phase 2 and finalized in Phase 3, including ARARs and the results of the human or ecological risk assessments. Areas for remediation will also be developed in conjunction with the modeling efforts. The geochemical and ecological model components will be used to determine the spatial extent of cleanup and the recovery of fish and biota body burdens.

Development of Remedial Action Objectives from the Hudson River Models

Potential remedial action objectives will be developed from the Reassessment models of PCB geochemical fate and transport and ecological impact as well as from the risk assessments and ARARs. As part of the Phase 2 investigation, these models will be calibrated and subsequently run to estimate future river conditions assuming no remedial activities are implemented to control sediment-related PCBs. This model run will define the "No-Action" scenario which will be compared with subsequent model runs simulating various remedial options. In addition, the models will be used to predict PCB fate and transport for a 100-year flood event in the Upper Hudson. As part of the Phase 3 effort, these models will also be run assuming various remedial actions have taken place, resulting in changes in the sediment PCB inventory (*e.g.*, dredging) or exposure pathway (*e.g.*, capping). One scenario that might be considered would involve the removal or isolation (*e.g.*, capping) of all sediments with PCB concentrations greater than 50 mg/kg (ppm). Model outputs from each run would be examined to see if the scenario would impact body burdens of PCBs in fish and other biota. If such changes did occur, the timing and scale of the change relative to the "No-Action" scenario would be evaluated. In this manner, the scale of change in sediment conditions required to produce a substantive change in fish and biota body burdens could be estimated.

Utilizing this approach, both the scale and timing of the recovery of fish body burdens could be examined relative to the degree of remediation implemented. It is anticipated that at least 20 model runs will be required. Likely remedial scenarios to be tested in this manner include:

- Removal or isolation of all sediment in the Upper Hudson (Rogers Island to Federal Dam) with average PCB concentrations greater than 50 mg/kg;
- Removal or isolation of all sediment in the Upper Hudson with average PCB concentrations greater than 1 mg/kg;
- Removal or isolation of all sediment in the Upper Hudson with average PCB concentrations greater than the risk assessment-derived acceptable concentration;

- Removal or isolation of all contaminated sediment in the NYSDEC *hot spots*;
- Removal or isolation of all sediment with average inventories greater than 10 g/m^2 (mass of PCBs per unit area of sediments);
- Removal or isolation of all fine-grained sediment based on the side-scan sonar results (which extend to Lock 5) and removal of *hot spot* areas below Lock 5;
- Bank-to-bank dredging of the Thompson Island Pool (TIP) sediments;
- Bank-to-bank dredging of the TIP sediments and removal of NYSDEC *hot spots* below the TI Dam;
- Removal of contaminated sediments with average PCB concentrations greater than 10 mg/kg within 50 ft of shore and removal or isolation of sediments greater than 50 mg/kg for deeper locations; and
- Removal of all contaminated sediment associated with the proposed NYSDEC dredge locations as documented in Malcolm Pirnie, 1992.

In each instance the magnitude of fish and biota body burden recovery would be examined. Similarly, the time needed to achieve the recovery or the time to achieve some preset threshold (*e.g.*, the FDA limit or an ecological threshold) would be examined relative to the "No-Action" scenario. Because the various remedial scenarios will have different impacts at various locations, the model may also be used to provide information on the extent and rate of recovery at upstream and downstream stations (*e.g.*, TI Pool *vs.* Stillwater). In this manner, a range of possible remedial action objectives and their likely impact on the recovery of fish and biota body burdens in the Upper Hudson and Mid-Hudson will be developed. Results from these model runs will also be used to assess the degree and timing of the recovery of water column PCB concentrations to ARAR-specified or risk assessment-derived levels.

It should be noted here that although the Mid-Hudson will be examined using models to assess PCB risks under the "No-Action" scenario and select remedial action scenarios, Lower Hudson model components will not be used in the determination of remedial action objectives for the Upper Hudson. This exclusion is based on the premise that Lower Hudson biota will be less affected by remedial efforts in the Upper Hudson relative to resident Upper Hudson biota. Proximity to the more concentrated sediments and any potential remedial actions in the Upper Hudson suggest that Upper Hudson biota should be most responsive to any remedial action. Therefore, the Upper Hudson models should be used as a basis for selecting remedial action objectives. However, the Lower Hudson models will be used to assess the impacts of select Upper Hudson remedial scenarios on Mid-Hudson water column and biota concentrations. PCB loadings from the Upper Hudson will be specified as input to the Lower Hudson model.

It is anticipated that the modeling analysis to develop remedial action objectives will be done in an iterative manner wherein model results from previously defined scenarios will aid in selecting conditions for subsequent model runs. Figure 1 represents the general modeling approach to be used for both the Phase 2 and Phase 3 efforts. Highlighted in the figure is the model iteration loop expected to be used in the development of model-based remedial action objectives. It is expected that only one of the ecological models will be used in the iterative process. However, once the analysis is near completion using one of the ecological models, the results will be confirmed to the extent possible with the remaining two models. The diagram shows the probabilistic model in the iteration loop but the actual ecological model selected for this purpose will be determined at the completion of the baseline modeling effort.

This approach has the potential to provide a great deal of insight regarding possible remedial actions and their likely outcomes. However, the outcome of the modeling effort can be no better than the data set on which it is based. Therefore, TAMS and its subcontractors are currently developing and calibrating the various model components utilizing available data from a wide range of sources, including the Phase 2 sampling efforts, NOAA, NYSDEC, USGS and GE. Even so, due to the scale and complexity of PCB contamination in the Hudson, there remain a number of less well-understood issues or parameters which may add a degree of uncertainty to model output. As a result, the model output cannot be used as the sole basis for the selection of remedial action objectives. Rather, it must be considered in the context of other remedial goals and USEPA guidance in the selection of remedial action objectives.

Lastly, it is important to note here that the inclusion of any specific remedial approach within the range of possibilities presented (*e.g.*, bank-to-bank dredging of the Thompson Island Pool) at this point in the FS does not indicate a predilection to that particular approach. Rather, a wide range of scenarios need to be considered in order to correctly assess the effectiveness of various remedial approaches relative to the others. The main point of the modeling is to provide a basis on which to evaluate various remedial action scenarios in view of attaining acceptable PCB body burdens in fish within an acceptable timeframe. In performing this analysis, TAMS will incorporate guidance to be provided by USEPA as to the desired level and timing of the recovery of fish body burdens.

Final Selection of the Remedial Action Objectives

While the final list of remedial action objectives will be developed by the USEPA, it is expected that these objectives will ultimately be designed to reduce risk to human and ecological receptors, to achieve water quality criteria, and satisfy other ARARs. In this regard, the objectives will be designed to attain one or more of the following goals:

- reduce PCB concentrations in Hudson River fish below the FDA-acceptable level of 2 ppm which is based on human health considerations or to other acceptable levels based on site-specific risk assessments or ARARs by reducing or mitigating PCB sediment concentrations. This will require a determination of (a) the desired level in fish; (b) the timeframe in which the fish are to reach the desired level; and (c) the location at which this objective is to be achieved (*e.g.*, Troy vs. Thompson Island Pool);

- reduce human health risk associated with exposure to near-shore contamination to an acceptable level (to be determined by USEPA, expected to be in the range of 10^{-4} to 10^{-6} incremental carcinogenic risk) by reducing or mitigating PCB sediment concentrations. The specific concentration goal will be based on the Phase 2 human health risk assessment to be released in August 1999;

- reduce ecological risk associated with the exposure of ecological receptors to PCB-contaminated water and sediment, based on input from the ecological risk assessment to be released in August 1999;

- reduce PCB water column concentrations to the NYS promulgated surface water standards (based on the recent NYSDEC update, TOGS 1.1.1, June 1998 and 6 NYCRR 703.5) of 1×10^{-6} ug/L (0.001 nanogram [ng]/L) for protection of human consumption of fish or 1.2×10^{-4} ug/L (0.12 ng/L) for protection of wildlife by reducing or mitigating PCB sediment concentrations; and

- reduce the inventory of sediment PCBs available for interaction with the river, perhaps by removal or isolation of previously-defined *hot spots* refined by more recent studies (*e.g.*, removal or isolation of areas where the highest concentrations of PCBs are at or near the surface and are thus not being buried by "clean material").

To facilitate the start of Phase 3 FS work, pending the completion of Phase 2, it will be assumed that the target maximum PCB concentration in sediment remaining in contact with river water or potential receptors to be achieved by remediation is in the range of 1 to 50 mg/kg.

2.3 General Response Actions

A summary of the general response actions for remediation of the Upper Hudson River sediments include the following:

1. "No Action";
2. Monitored natural attenuation;
3. Containment;
4. *In situ* treatment;

5. Complete or partial removal with on-site dewatering and subsequent on-site or off-site disposal: and
6. Complete or partial removal with on-site or off-site treatment and disposal.

The distinction between "No Action" and "monitored natural attenuation" (or natural recovery) is important. "No Action" means that no active remedial measures will be taken at the site, because the site poses no current or potential threat to human health or the environment. No institutional controls (*e.g.*, fishing bans) are implemented as part of a "No-Action" alternative. Monitoring is the only activity that may be considered as part of the "No-Action" alternative.

Similarly, in a "monitored natural attenuation" alternative, no active remedial measure would be implemented. In contrast to "No Action", however, the "monitored natural attenuation" alternative is expected to achieve site-specific remedial objectives within a timeframe that is reasonable compared to that offered by other more active methods. Natural attenuation could occur by *in situ* processes such as biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of PCBs. Monitoring of the river would be an important aspect of a natural attenuation alternative. It is also possible that institutional controls would be required until remedial objectives are met.

When relying on natural attenuation processes for site remediation, USEPA prefers those processes that degrade contaminants. It is most appropriate at sites that have a low potential for contaminant dispersion. Monitored natural attenuation may be used in conjunction with, or as a follow-up to, active remediation measures.

For general response actions 5 and 6 identified above, "on-site" refers to a corridor including the Upper River and extending two miles from either bank. In addition to these individual response actions, combinations of these actions will also be considered due to the varied nature of sediment PCB contamination and its large spatial extent. For example, containment might be combined with *in situ* treatment in order to achieve a remedial action objective for a *hot spot* area. Similarly, *in situ* treatment might be combined with complete removal in a setting where PCB contamination extended from near-shore (complete removal) to deeper sediments (*in situ* treatment). Removal rather than containment (capping) or *in situ* treatment will be considered the preferred action for contaminated sediments within the limits of the navigation channel, if necessary.

It is believed that the full range of general response actions for the site has been identified, and that it will not be necessary to conduct further work on developing general response actions in Phase 3.

3. IDENTIFICATION AND SCREENING OF APPLICABLE TECHNOLOGIES AND PROCESS OPTIONS

Based on the remedial action objectives and each identified general response action, potential treatment technologies and their associated containment or treatment and disposal requirements will be identified. A prescreening of these potential treatment technologies for suitability as part of remedial alternatives will be conducted. Where several process options exist for a particular technology, the process option for which most data exist and whose capabilities/constraints most closely match site conditions will be selected for further detailed evaluation. The final selection of a process option will occur during development of a Record of Decision.

Technologies that could prove extremely difficult to implement, might not achieve the remedial objective in a reasonable time, or might not be applicable or feasible based on the site-specific conditions will be eliminated from further consideration. A two-step screening process will be used to select technologies and process options for further consideration.

As is discussed below, an initial two-step screening of applicable technologies and process options has already been undertaken. A list of technologies considered is provided in Table 4. This screening, completed in 1994, will be updated in Phase 3 to reflect currently available technologies as well as the better defined constraints on available sites for landfilling and treatment facilities.

It is expected that this portion of the Phase 3 effort can proceed concurrently with the development of remedial action objectives. However, finalization of this step will require a final selection of remedial action objectives.

3.1 Technology and Process Option Identification and Screening

During Phase 1. several established and innovative technologies within several response action categories were identified. These and other technologies identified since that time will be examined for their implementability. Those technologies that are infeasible to implement will be eliminated from further evaluation.

The criterion for elimination of a particular technology or process option during Phase 3 will be technical feasibility. Technologies or process options will be determined to be technically infeasible based on study area-specific factors. Conditions. such as a sediment matrix being incompatible with a technology or process. restricted access of the process equipment to the possible remediation areas. and other such factors will be grounds to eliminate technically infeasible processes. Results of treatability studies presented in the literature or provided by technology vendors may be considered in the screening process. as appropriate. Technologies or processes that are removed from further consideration will be documented in the Phase 3 Report.

While this step provides some level of technology screening. in many cases the wide range of river conditions serves to simply segregate various technologies based on the anticipated location or use. For example. standard dredging techniques which can be employed in deeper portions of the river may be unsuitable for near-shore sediment removal. Alternatively. installation of sheet piling and sediment removal by standard soil excavation equipment may be suitable for the near-shore and shallow sediment environments. The latter technique may have subsequent limitations due to the shallow depth to bedrock in some locations. preventing a cost-effective installation of sheet piling. Thus it is unlikely that any single set of technologies will be suitable for all remediation areas. As part of this process. a suite of technology sets which can be employed dependent on the conditions of the remediation area will be developed.

An initial screening of technologies with respect to technical feasibility has been conducted as part of the initial FS work. This screening will be updated and finalized as part of the Phase 3 effort. In the initial review, several technologies were screened out based on the scale of the potential cleanup effort. For example, solvent extraction of PCBs in sediments was eliminated as an *in situ* treatment option based on the large scale of the remediation required and the difficulties involved in controlling solvent migration in difficult-to-constrain sediments. Similarly, centrifuge techniques were eliminated as a potential sediment pretreatment/dewatering process based on the anticipated large volumes of sediment to be treated. Several techniques for *ex situ* treatment, including specific solvent extraction processes, were eliminated for reasons such as materials handling difficulties.

3.2 Evaluation of Technologies and Process Options

Those technologies and process options carried forward for the second screening step will be evaluated based on three criteria:

- effectiveness;
- implementability; and
- relative cost.

This screening step will evaluate each process option within the same technology type to determine which is most effective. The process option determined to be most effective will be carried forward in the screening evaluation for further development. Typically, process effectiveness depends on such factors as:

1. The ability to handle the range of sediment volumes that could require remediation. Prior estimates of sediment remediation volumes for the *hot spots* alone were over one million cubic yards (Malcolm Pirnie, 1992). The actual volume to be remediated will of course be dependent on the selected remedial action objectives and will be determined in Phase 3 after the final selection of objectives is made by USEPA.

2. The ability to meet a range of remediation goals. It is expected that sediment cleanup levels will be established on the basis of current sediment inventories, proximity to shore and human receptors, and potential for re-release. Thus several different concentration objectives are possible.

3. Potential impacts to human health or the environment during construction and implementation. In this regard, the ability to control the release of dredged sediment to the river via spill and leakage must be considered. Also, volatilization of PCBs from treatment streams during dewatering or other *ex situ* processes may need to be considered.

4. Whether the process or technology is proven and reliable for site-specific contaminants and conditions. For example, any *ex situ* process must not be adversely affected by the presence of heavy metal contamination also found in some Hudson River sediments.

Because of the range of conditions anticipated in the Hudson River, several technologies for each response action may be carried forward when it is apparent that no single technology can handle the anticipated range of conditions. For example, see the discussion in Section 3.1 concerning the use of dredging *vs.* dry excavation techniques in river areas of varying depths.

Implementability is evaluated based on both technical and administrative factors. Technical implementability screening would include site-specific and process-specific considerations, such as volume of material to be processed, compatibility or effectiveness with other than target contaminants or conditions, site access limitations or weather-related concerns, among others. Administrative considerations include any federal or state permit requirements and municipal constraints, availability of treatment equipment and facilities to the project within the required timeframe, and the availability of technology vendors or suppliers.

Falling into the administrative category is the amount of space available for siting a pretreatment facility. Due to the extensive use of the neighboring areas for agriculture, housing and recreation, the number of sites with the large open areas necessary for this purpose are limited (*cf.*. Landfill/Treatment Facility Siting Survey [TAMS, 1997]). It is anticipated that portions of the combined remnant deposit areas present a potential location for such a facility. This limitation presents a substantive constraint on those technologies which require large areas of land in order to operate. Based on the initial second level screening conducted by TAMS in 1994, technologies such as land farming and composting, which require very large areas of land in relation to the volume of material treated, were screened out.

Similarly, recent municipal and county resolutions opposing landfilling of PCB dredge spoils in agricultural areas would make the administrative process of selecting a local landfill site difficult. Thus, off-site landfilling will also be considered in the FS technology screening. As part of Phase 3, the secondary technology screening performed in 1994 will be updated and finalized to reflect currently available technologies as well as the potential limitations to landfill site selection.

Relative capital and operation and maintenance (O&M) costs, rather than detailed estimates, are used for this evaluation. An evaluation is made of high, moderate, and low cost process options at this stage.

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4. DEVELOPMENT, SCREENING AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The FS process will continue in Phase 3 with the development of remedial alternatives from the technologies and process options that survive the technology screening. The development of alternatives requires combining appropriate remedial technologies from the screening described above in a manner that will satisfy the remedial action objectives (see Section 2.2). It is anticipated that several processes will be needed within each remedial alternative in order to cover the range of conditions anticipated in the Upper Hudson River. Remedial alternatives will be developed in each of the following categories:

- Alternatives for treatment that would eliminate, or minimize to the extent feasible, the need for long-term management (including monitoring) of Upper Hudson River sediments;
- Alternatives which use treatment as the primary component to address the principal threats related to Hudson River sediments with a requirement for long-term monitoring;
- Alternatives which use removal without treatment as the primary component to address the principal threats related to Hudson River sediments;
- Alternatives that rely on containment with little or no treatment, but are protective of human health and the environment by preventing potential exposure to contaminants or by reducing their mobility;
- A "monitored natural attenuation" alternative; and
- A "No-Action" alternative.

The potential remedial alternatives developed in the categories above will be screened. The objective of this effort is to reduce the number of technologies and alternatives for further analysis while preserving a range of options. This screening will be accomplished by evaluating alternatives on the basis of effectiveness, implementability and cost as specified in the USEPA guidance document (USEPA, 1989). These screening criteria are described below in Sections 4.2 through 4.4. Information developed for the Landfill/Treatment Facility Siting Survey (TAMS, 1997) will be used in the development and screening process.

It is possible, pending the results of the ongoing risk assessments, that remedial alternatives may be developed separately for different areas of the river. For example, alternatives may be developed to reduce the risk associated with near-shore sediments which pose a dermal contact risk for waders. Alternatives for remediation of these sediments may not be the same as alternatives designed to achieve the other remedial action goals for the project. Remedial alternatives which utilize several technologies may be constructed depending upon the conditions encountered.

4.1 "No-Action" Alternative

A "No-Action" alternative will be formulated and assessed to determine its human health and ecological risk levels. This alternative is identical to the scenario developed for the baseline modeling report. The "No-Action" alternative will be carried through the entire FS process (alternatives screening and detailed analysis) to provide a basis for comparison with other more aggressive remedial alternatives.

The "No-Action" alternative will include no containment, removal or treatment of river sediment, and could include the following components:

- long-term PCB monitoring in sediment, water or biota; and
- continuation of current institutional controls, such as fishing bans.

Monitoring and institutional controls can be included in the "No-Action" alternative because they are currently in place and are not "remedial" in nature. The "No-Action" alternative means that no *additional* remedial actions will be taken.

4.2 Effectiveness Evaluation

Using the quantitative methodologies developed in Phase 2, human health and ecological risks associated with each remedial alternative, including the "No-Action" alternative, will be evaluated. Both short-term risks, associated with the implementation of a remedy and the time period required for stabilization thereafter, and risks over the long term, after transient remediation conditions are stabilized, will be evaluated. For evaluation of long-term risks, scenarios that meet model-based remedial action objectives can utilize the model output to assess the long-term changes in risk to humans and the environment. Short-term risks associated with the period of remediation are much more difficult to quantify due to the lack of information on the nature of PCB releases during this time. Although both resuspension and air-borne releases may take place during removal and treatment, the ultimate fate of these specific materials will not be well-known. As a result, any risks posed by these materials will be handled qualitatively only.

In light of this potential concern, qualitative considerations of the potential for PCB release during the remedial process will be included in this evaluation. Thus, a process which minimizes the storage of PCB-bearing sediments during the removal and treatment process would be preferred over a process which must have a large volume of material on hand to operate effectively. Similarly, a removal process which is highly effective at preventing resuspension would be preferable over a process wherein a portion of the sediments removed was regularly lost.

It is anticipated that the same exposure pathways identified in Phase 1, such as ingestion of contaminated fish, will be of concern for the remedial alternative evaluation. The final resolution of pathways will be resolved in the completion of the human health and ecological risk assessments. Effectiveness will be judged in the context of reducing risk via these pathways, both quantitatively and qualitatively.

4.3 Implementability Evaluation

The implementability evaluation will be used to measure both the technical and administrative feasibility of constructing, operating and maintaining a remedial action alternative. In addition, the availability of the technologies involved in a remedial alternative will be considered.

Innovative technologies will be considered throughout the screening process if there is a reasonable belief that they offer potential for comparable treatment performance or implementability, fewer or lesser adverse impacts than other available approaches, or lower costs for similar levels of performance than demonstrated technologies.

Administrative implementability will include a consideration of the land requirements for the various remedial alternatives, among other issues. Specifically, for example, the amenability of the alternative to the anticipated use of the remnant deposit areas will be considered here. Whether locations other than the remnant deposits are available for a treatment or dewatering facility will also be considered. Similarly, the requirement to create a permanent facility such as a landfill will also be considered. No alternative will be excluded based solely on its need for a landfill; however, in light of local concern and opposition to such facilities, greater land requirements inherently imply greater implementation difficulties.

4.4 Cost Evaluation

Cost evaluation will include estimates of capital costs, annual operation and maintenance (O&M) costs, and present worth analysis. These conceptual cost estimates are order-of-magnitude estimates, and will be prepared based on preliminary conceptual engineering for major construction components, and unit costs of capital investment and general annual O&M costs available from USEPA and US Army Corps of Engineers documents, from the technical literature and from TAMS' in-house files. TAMS also will utilize relevant information found in USEPA and other government and private on-line databases for current cost information.

4.5 Detailed Analysis of Remedial Alternatives

The remedial alternatives that pass the screening will be subject to a detailed analysis, including presentation of a conceptual design and layout. The detailed analysis will consist of technical, environmental and cost evaluation, as well as an analysis of other factors, as appropriate. The detailed analysis will follow the process specified in the NCP and the "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (USEPA, 1989).

Given the anticipated rigorous and unique path to this point in the FS process, it is unclear how many remedial alternatives will require detailed analysis. It is currently estimated that five such alternatives will be evaluated, but this number is highly dependent on the remedial action objectives selected. It is expected that each of the remedial alternatives will have at least two and probably more technologies which enable the alternative to address the various river conditions.

The NCP identifies a set of nine evaluation criteria that are to be applied in the evaluation of each remedial alternative. These nine criteria are grouped into three categories to develop the rationale for a remedy selection, including "threshold" factors, "primary balancing" factors, and "modifying" considerations. These are:

"Threshold" Factors:

- Overall protection of human health and the environment; and
- Compliance with ARARs.

"Primary Balancing" Factors:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

"Modifying" Considerations:

- State acceptance; and
- Community acceptance.

In this context, long-term effectiveness and permanence refers to the ability to maintain protection of human health and the environment after response objectives have been met as well as the adequacy and reliability of controls (if any) that are used to manage treatment residuals and untreated wastes (USEPA, 1989). In particular, long-term effectiveness will consider the degree to which the contamination is effectively isolated from the river over a long period of time. For example, removal of PCB-bearing sediment followed by treatment would provide a greater degree of long-term effectiveness for river sediments relative to an in-place capping scenario since the stability of the cap over the long term, particularly in light of major floods, would be less assured. Short-term effectiveness refers to the ability to maintain protection of human health and the environment during the construction and implementation phase until remedial response objectives are met (*e.g.*, a cleanup target has been met) (USEPA, 1989). This evaluation criterion includes a consideration of the time required to achieve protection. For example, implementation of removal of PCB-bearing sediment to off-site landfills relative to in-place capping would likely result in a greater human health risk due to potential exposure during material handling.

5. FEASIBILITY STUDY REASSESSMENT REPORT

The FS Reassessment Report will be prepared to summarize the Phase 3 activities and to present the results and associated conclusions. The FS report will be prepared and presented in the format specified in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (USEPA, 1989). This report will represent the culmination of the entire Reassessment and provide the basis for the final steps in the RI/FS process: the proposed plan and record of decision.

In the report, the feasibility of technologies and process options for site remediation will be identified for each general response action, and the results of the remedial technology screening will be described. Remedial alternatives developed by combining the technologies identified in the previous screening process, and the results of the initial screening of remedial alternatives with respect to effectiveness, implementability and cost will be described.

A detailed description of the cost and non-cost features of each remedial action alternative passing the screening will be presented. A detailed analysis of each remedial alternative with respect to each of the evaluation criteria will be presented, along with a conceptual design and layout, as appropriate. A comparison of these alternatives will also be presented.

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REFERENCES

Limno-Tech/Menzie-Cura & Associates/Cadmus. 1996. "Phase 2 Further Site Characterization and Analysis - Model Calibration Report (Volume 2B)." Review Copy. Prepared for USEPA Region II, NY, NY.

Malcolm Pirnie, Inc. 1992. Hudson River PCB Project, Proposed Dredging Locations. Prepared for NYSDEC, Albany, NY.

NYSDEC. 1998. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1. Reissue date: June 1998.

O'Brien & Gere Engineers, Inc. 1988. "Hazardous Waste Site Remediation, the Engineer's Perspective." Van Nostrand Reinhold Company, NY, NY.

O'Brien & Gere Engineers, Inc. 1993. "Bakers Falls Operable Unit 3, Interim Remedial Measure." Prepared for General Electric Company.

O'Brien & Gere Engineers, Inc. 1995. "Fort Edward Dam PCB Remnant Containment 1994 Post-Construction Monitoring Program." Prepared for General Electric Company.

TAMS. 1992. "Final Phase 2 Work Plan and Sampling Plan, Hudson River PCBs Reassessment RI/FS." Prepared for USEPA Region II, NY, NY.

TAMS. 1997. "Landfill/Treatment Facility Siting Survey, Hudson River PCBs Reassessment RI/FS." Prepared for USEPA Region II and the US Army Corps of Engineers, Kansas City District.

TAMS/Cadmus/Gradient. 1997. "Phase 2 Report - Further Site Characterization and Analysis: Volume 2C - Data Evaluation and Interpretation Report." Review Copy. Prepared for USEPA Region II, NY, NY.

TAMS/Gradient. 1990. "Scope of Work, Hudson River PCBs Reassessment RI/FS." Prepared for USEPA Region II, NY, NY.

TAMS/Gradient. 1991. "Phase 1 Report - Review Copy, Interim Characterization and Evaluation, Hudson River PCBs Reassessment RI/FS." Prepared for USEPA Region II, NY, NY.

TAMS/Gradient. 1992. "Responsiveness Summary for the Phase 1 Report, Hudson River PCBs Reassessment RI/FS." Prepared for USEPA Region II, NY, NY.

TAMS/Gradient. 1995. "Phase 2 Further Site Characterization and Analysis - Database Report (Volume 2A)." Prepared for USEPA Region II. NY. NY.

USEPA. 1984a. "Feasibility Study. Hudson River PCB Site. New York." USEPA Region II. NY. NY.

USEPA. 1984b. "Record of Decision. Hudson River PCB Site." USEPA. Region II. NY. NY.

USEPA. 1989. "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA." EPA 540/G-89/004. Office of Emergency and Remedial Response. Washington. DC.

USEPA. 1989. "Risk Assessment Guidance for Superfund, Volume 1. Human Health Evaluation Manual. Part A" EPA/540/1-89/002. Office of Emergency and Remedial Response. Washington. DC.

USEPA. 1990. "Guidance on Remedial Actions for Superfund Sites with PCB Contamination." EPA/540/G-90/007, Office of Emergency and Remedial Response. Washington. DC.

USEPA. 1991. "Handbook: Remediation of Contaminated Sediments." EPA/625/6-91/028. Office of Research and Development. Washington. DC.

TABLES

TABLE 1
POTENTIAL CHEMICAL-SPECIFIC ARARS AND CRITERIA, ADVISORIES AND GUIDANCE

MEDIUM/ AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
BIOTA				
Federal Regulatory Requirements	Federal Food, Drug and Cosmetic Act	Relevant and Appropriate	This sets forth FDA limit of 2 ppm for PCB concentrations in commercial fish and shellfish	To be determined.
SURFACE WATER				
New York State Standards	6 NYCRR 703, NYSDEC TOGS 1.1.1 (June 1998)	Applicable	Establishes water quality standards for various classes of surface water. Standards for PCBs are 0.001 ng/L for protection of human health (fish consumption) and 0.12 ng/L for protection of wildlife.	Potential ARAR for establishing PCB cleanup criteria for Hudson River water.
Federal Criteria, Advisories, and Guidance	Federal Water Pollution Control Act and Ambient Water Quality Criteria (AWQC)	To Be Considered	Federal AWQC are ecological and health-based criteria developed for various pollutants, including total PCBs and individual Aroclors. Freshwater chronic (ecological) criterion for total PCBs is 0.014 ug/L.	To be determined.
Safe Drinking Water Act and Regulations	42 USC 300f et seq; 40 CFR 141	Relevant and Appropriate.	Maximum Contaminant Level (MCL) for PCBs in finished drinking water supplied to consumers of public water supply systems is 0.5 ug/L; goal (MCLG) is zero.	Relevant and appropriate since Hudson River water is used as a drinking water supply source for several communities.
Toxic Pollutant Effluent Standards	Clean Water Act; Pollutants listed in 40 CFR 401; PCB criterion in 40 CFR 129.	Applicable.	The ambient water quality criterion for navigable waters is established at 0.001 ug/L total PCBs (40 CFR 191.105(a)(4)). PCB manufacturers prohibited from discharging PCBs.	Applicable; Hudson River is a navigable water. Applicability of manufacturing discharge prohibition to be determined.
NY SPDES limits	6 NYCRR Parts 700-757; NYSDEC TOGS 1.3.4	Applicable	Discharges of PCBs should be non detected, based on practical quantitation limit of 0.3 ug/L PCBs	Applicable to activities (e.g., remediation) involving discharges of water to the Hudson River.

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Source: Based on Table C.3-1 of the Phase 1 Report; updated 5/05/95 and 9/3/98

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POTENTIAL CHEMICAL-SPECIFIC ARARS AND CRITERIA, ADVISORIES AND GUIDANCE

MEDIUM/ AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
AIR				
Federal Regulatory Requirements	CAA - National Ambient Air Quality Standards (NAAQS) 40 CFR 50	Relevant and Appropriate	These standards were primarily developed for particulates and conventional air pollutants. No specific standard for PCBs.	Standards for particulate matter will be used when assessing excavation and emission controls for sediment treatments.
New York State	Clean Air Act (6 NYCRR 256 and 257)	Applicable	Establishes an air quality classification system and air quality standards. No specific standard for PCBs.	Standards for emissions from remedial activities.
Federal Criteria, Advisories, and Guidance	American Council of Governmental and Industrial Hygienists Threshold Limit Values (TLV)	To Be Considered	These standards were issued as consensus standards for controlling air quality in workplace environments.	TLVs could be used for assessing site inhalation risks for soil removal operations.
New York State Guidance	Air Guide-1 (NYSDEC Division of Air Resources; Draft, 1991)	To Be Considered	Establishes Short-term Guideline Concentrations and Annual Guideline Concentrations (SGCs and AGCs) for PCBs (0.1 ug/m^3 and 0.00045 ug/m^3)	Applicable to emissions of PCBs from the Hudson River (e.g., volatilization); potentially applicable to various remedial actions.
SEDIMENT				
New York State	Technical Guidance for Screening Contaminated Sediment, November 1993; April 1996 update	To Be Considered	Guidance document used by the Division of Marine Resources, Division of Fish and Wildlife, for evaluating contaminant levels in sediment. Calculated value based on fraction organic carbon and octanol-water partition coefficient of the contaminant.	Criteria for determining water and sediment levels for protection of human health (bioaccumulation), benthic aquatic life (acute and chronic toxicity), and wildlife (bioaccumulation). Values for PCBs vary by several orders of magnitude for the four levels of protection.
National Oceanic and Atmospheric Administration	Potential for Biological Effects of Sediment-Sorbed Contaminants - Tech Memorandum NOS OMA 52, March 1990	To Be Considered	Guidance document with estimated concentrations at which biological effects of contaminants including PCBs may be observed.	Technical guidance for use in establishing sediment cleanup levels.

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Source: Based on Table C 3-1 of the Phase I Report, updated 5/05/95 and 9/3/98

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POTENTIAL CHEMICAL-SPECIFIC ARARS AND CRITERIA, ADVISORIES AND GUIDANCE

MEDIUM/ AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
TSCA Spill Cleanup Policy	49 CFR 761.120 - 761.135	To Be Considered	Not an ARAR but specifies allowable levels of residual PCB contamination from spill cleanup. Also used by NYSDEC as a soil criterion.	Requirement for cleanup to 10 ppm PCBs in unrestricted access areas may be relevant as guidance to some areas of site.

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Source: Based on Table C.3-1 of the Phase 1 Report; updated 5/05/95 and 9/3/98

TABLE 2
POTENTIAL LOCATION-SPECIFIC ARARS AND CRITERIA, ADVISORIES AND GUIDANCE

MEDIUM/ AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
Federal Regulatory Requirements for Wetlands/ Floodplains	Clean Water Act (CWA) Section 404 and Rivers and Harbors Act of 1899 (40 CFR Part 230 and 33 CFR Part 320-329)	Applicable	Under this requirement, no activity that adversely effects a wetland shall be permitted if a practicable alternative that has less effect is available. If there is no other practical alternative, impacts must be mitigated. A permit is required for construction of any structure in a navigable water. Section 307, effluent standards of 1-ppb concentration of PCB, is incorporated into this section by reference.	During the identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated. Effluent levels will be used as guidance levels to which alternatives will be evaluated.
	RCRA Location Standards (40 CFR 264.18)	Relevant and Appropriate	This regulation outlines the requirements for constructing a RCRA facility on a 100-year floodplain.	A facility located on a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood, unless waste may be removed safely before floodwater can reach the facility or no adverse effects on public health and the environment would result if washout occurred.
	TSCA facility requirements (40 CFR 761.65 - 761.75)	Applicable	Establishes siting guidance and criteria for storage (761.65), chemical waste landfills (761.70), and incinerators (761.75).	Land disposal facilities should not be in 100-year floodplain; not hydraulically connected to surface water bodies.
Federal Nonregulatory Requirements for Wetlands/ Floodplains	Executive Order 11990 (Protection of Wetlands); 40 CFR Part 6, Appendix A, mandated by EPA's 1985 Statement of Policy on Wetlands and Floodplains Assessments for CERCLA Sites.	To Be Considered	Under this regulation, federal agencies are required to minimize the destruction loss or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands.	Remedial alternatives that involve construction must include all practicable means of minimizing harm to wetlands. Wetlands protection considerations must be incorporated into the planning and decision-making about remedial alternatives.
	Executive Order 11988 (Floodplain Management)	To Be Considered	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	Evaluate potential effects of actions to ensure that planning and decision-making consider the effect of the 100-year and 500-year floodplains and floodplain management, including floodplain preservation and/or restoration.

Source: Based on Table C.3-2 of the Phase I Report; updated 5/05/95 and 9/3/98

TABLE 2
POTENTIAL LOCATION-SPECIFIC ARARS AND CRITERIA, ADVISORIES AND GUIDANCE

MEDIUM/ AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
New York State Freshwater Wetlands Law	ECL Article 24 & 71 in Title 23; 6 NYCRR Part 665	Applicable	Regulates activities conducted in a wetlands area to minimize the destruction, loss or degradation of the wetlands.	Remedial alternatives that involve construction must include means to protect wetlands.
New York State Freshwater Wetlands Permit Requirements Regulations	6 NYCRR Part 663	Applicable	Regulates the procedural requirements to be followed in undertaking different activities in wetlands and in areas adjacent to wetlands.	Remedial alternatives that involve construction must include means to protect wetlands. No permit required for CERCLA but actions must meet substantive requirements.
NY State Floodplain Regulations	6 NYCRR 372-2	Applicable	Establishes construction requirements for hazardous waste facilities in 100-year floodplain	Potentially applicable for remedial activities if conducted within floodplain
Endangered Species Act of 1973, as amended; Fish and Wildlife Coordination Act	16 USC 1531; 16 USC 661	Applicable	Federally supported actions are required to not jeopardize the continued existence of endangered/threatened species or adversely modify or destroy the critical habitats of such species. Consultation with NOAA/NMFS and USFWS required (Section 7 consultation).	Potential ARAR as threatened or endangered species (shortnose sturgeon) may inhabit the site downstream of the potential remediation area (Esopus Meadows area in the Lower Hudson estuary).
Farmland Protection Policy Act of 1981 (FPPA)	7 USC 4201 *et seq*	Applicable	Regulates the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses.	Potential ARAR for remedial alternatives.
Endangered and Threatened Species of Fish and Wildlife Requirements	6 NYCRR 182	Applicable	Restricts activities in areas inhabited by endangered species.	Potential ARAR as many fish and wildlife species inhabit the site.
National Historic Preservation Act	PL 89-655; 33 CFR Part 800	Potentially Applicable	Proposed remedial actions must take into account effect on properties in or eligible for inclusion in the National Registry of Historic Places.	Presence of National Landmarks and NRHP sites to be determined.
Wild and Scenic Rivers Act	16 USC 1271-1272; 40 CFR 6.302	Potentially applicable	Selected rivers of the Nation and their immediate environments shall be protected for the benefit and enjoyment of present and future generations.	Wild or scenic status to be determined. Designation made by States using federal criteria. Not applicable if Hudson River project area is not designated as wild and scenic river.

Source: Based on Table C 3-2 of the Phase I Report, updated 5/05/95 and 9/3/98

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TABLE 2
POTENTIAL LOCATION-SPECIFIC ARARS AND CRITERIA, ADVISORIES AND GUIDANCE

MEDIUM/ AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
NY Wild, Scenic, and Recreational Rivers Act and Regulations	ECL Article 15, Title 27; 6 NYCRR Part 666	Potentially applicable	Similar to Federal act but adds additional category of "recreational"	Presence of wild, scenic, and recreational rivers to be determined.
NY Industrial Hazardous Waste Facility Siting Board	6 NYCRR Part 361	Potentially applicable	Hazardous waste management facilities must obtain a certificate from the board before a new facility can be sited.	To be determined.

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Source: Based on Table C.3-2 of the Phase I Report, updated 5/05/95 and 9/3/98

TABLE 3
POTENTIAL ACTION-SPECIFIC ARARS

ARAR	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS IF A REMEDY IS SELECTED FOR WHICH THESE REQUIREMENTS ARE ARAR
Toxic Substances Control Act (TSCA) - Chemical Waste Landfill Requirements (40 CFR 761.75)	Establishes approval and technical requirements for land disposal (landfilling) of PCBs	Landfills must be approved by Regional administrator, soil/liners permeability $< 10^{-7}$ cm/sec, must have groundwater monitoring, leachate collection and monitoring, etc.
TSCA - Incineration Requirements (40 CFR 761.70)	Establishes requirements for thermal destruction of PCBs in incinerators (boilers not permitted for non-liquid PCBs or dredged material)	Incinerators must be approved (trial burn at discretion of regional administrator). For non-liquid PCBs, combustion efficiency must be $\geq$99.9%, DRE $\geq$99.9999%, feed, stack gas, and operation monitoring required; shutdown required if monitoring fails.
TSCA - Storage requirements (40 CFR 761.65)	Establishes technical requirements for temporary storage of PCB wastes prior to treatment or disposal	Must have roof, curbing, impervious floor; check monthly; not allowed in 100-year floodplain. Proposed revision would also allow storage in RCRA facility.
RCRA - General Facility Standards (40 CFR 264.10 - 264.18)	General facility requirements outline general waste analysis, security measures, inspections and training requirements.	Any facilities will be constructed, fenced, posted and operated in accordance with this requirement. All workers will be properly trained. Process wastes will be evaluated for the characteristics of hazardous wastes to assess further landfilling requirements.
RCRA - Preparedness and Prevention (40 CFR 264.30 - 264.31)	This regulation outlines requirements for safety equipment and spill control.	Safety and communication equipment will be installed at the site; local authorities will be familiarized with site operations.
RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50 - 264.56)	This regulation outlines the requirements for emergency procedures to be used following explosions, fires, etc.	Plans will be developed and implemented during site work including installation of monitoring wells, and implementation of site remedies.
RCRA - Releases from Solid Waste Management Units (40 CFR 264.90 - 264.109)	This regulation details requirements for a groundwater monitoring program to be installed at the site.	A groundwater monitoring program is a component of all alternatives. RCRA regulations will be utilized as guidance during development of this program.
RCRA - Closure and Post-closure (40 CFR 264.110 - 264.120)	This regulation details specific requirements for closure and post-closure of hazardous waste facilities.	Those parts of the regulation concerned with long-term monitoring and maintenance of the site will be incorporated into the design

Source: Based on Table C 3-3 of the Phase I Report, updated 5/05/95 and 9/3/98

TABLE 3
POTENTIAL ACTION-SPECIFIC ARARS

ARAR	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS IF A REMEDY IS SELECTED FOR WHICH THESE REQUIREMENTS ARE ARAR
RCRA - Surface Impoundments Items (40 CFR 264.220 - 264.249)	This regulation details the design, construction, operation, monitoring, inspection and contingency plans for a RCRA surface impoundment. Also provides three closure options for CERCLA sites; clean closure, containment closure, and alternate closure.	To comply with clean closure, owner must remove or decontaminate all waste. To comply with containment closure, the owner must eliminate free liquid, stabilize remaining waste, and cover impoundment with a cover that complies with the regulation. Integrity of cover must be maintained, groundwater system monitored, and runoff controlled. To comply with alternate closure, all pathways of exposure to contaminants must be eliminated and long-term monitoring provided.
RCRA - Waste Piles (40 CFR 264.250 - 264.269)	Details procedures, operating requirements, and closure and post-closure options for waste piles. If removal or decontamination of all contaminated subsoils is not possible, closure and post-closure requirements for landfills must be attained.	According to RCRA, waste piles used for treatment or storage of non-containerized accumulation of solid, non-flowing hazardous waste may comply with either the waste pile or landfill requirements. The temporary storage of solid waste on-site, therefore, must comply with one or the other subpart.
RCRA - Landfills (40 CFR 264.300 - 264.339)	This regulation details the design, operation, monitoring, inspection, record keeping, closure, and permit requirements, for a RCRA landfill.	Disposal of contaminated materials if determined to be RCRA characteristic hazardous wastes from the river would be to a RCRA-permitted facility that complies with RCRA landfill regulations, including closure and post-closure. On-site disposal would include a RCRA-designed cap.
RCRA - Incinerators (40 CFR 264.340 - 264.599)	This regulation specifies the performance standards, operating requirements, monitoring, inspection, and closure guidelines of any incinerator burning hazardous waste.	On-site thermal treatment must comply with the appropriate requirements specified in this subpart of RCRA, if determined to be RCRA characteristic hazardous wastes.
RCRA - Miscellaneous Units (40 CFR 264.600 - 264.999)	These standards are applicable to miscellaneous units not previously defined under existing RCRA regulations for treatment, storage, and disposal units.	Units not previously defined under RCRA must comply with these requirements.

Source: Based on Table C 3-3 of the Phase I Report, updated 5/05/95 and 9/3/98

TABLE 3
POTENTIAL ACTION-SPECIFIC ARARS

ARAR	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS IF A REMEDY IS SELECTED FOR WHICH THESE REQUIREMENTS ARE ARAR
TSCA Disposal Requirements (40 CFR Part 761.60)	Liquid PCBs at concentrations greater than 50 ppm, but less than 500 ppm, must be disposed of either in an incinerator, or in a chemical waste landfill, or by another technology capable of providing equal treatment. Liquid PCBs at concentrations greater than 500 ppm must be disposed of in an incinerator or treated by an alternate technology capable of equal treatment. Dredged materials with PCB concentrations greater than 50 ppm may be disposed of by alternative methods which are protective of public health and the environment, if shown that incineration or disposal in a chemical waste landfill is not reasonable or appropriate.	PCB treatment must comply with these regulations during remedial action. Proposed revision to 40 CFR 761 clarifies that approval of Regional Administrator is required for any disposal method other than incineration per 761.70 or landfilling per 761.75. Only requirements applicable to non-liquid PCBs and dredged material are likely to be applicable for the Hudson River site.
OSHA - General Industry Standards (29 CFR Part 1910)	These regulations specify the 8-hour time-weighted average concentration for various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 9910.120.	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the specified concentrations. Workers performing remedial activities would be required to have completed specified training requirements.
OSHA - Safety and Health Standards (29 CFR Part 1926)	This regulation specifies the type of safety equipment and procedures to be followed during site remediation.	All appropriate safety equipment will be on-site. In addition, safety procedures will be followed during on-site activities.
OSHA - Record keeping, Reporting, and Related Regulations (29 CFR 1904)	This regulation outlines the record keeping and reporting requirements for an employer under OSHA.	These requirements apply to all site contractors and subcontractors and must be followed during all site work.
CWA - 40 CFR Part 403	This regulation specifies pretreatment standards for discharge to a publicly owned treatment works (POTW).	If a leachate collection system is installed and the discharge is sent to a POTW, the POTW must have an approved pretreatment program. The collected leachate runoff must be in compliance with the approved program. Prior to discharging, a report must be submitted containing identifying information, list of approved permits, description of operations, flow measurements, measurement of pollutants, certification by a qualified professional, and a compliance schedule.

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TABLE 3
POTENTIAL ACTION-SPECIFIC ARARS

ARAR	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS IF A REMEDY IS SELECTED FOR WHICH THESE REQUIREMENTS ARE ARAR
Regulations on Disposal Site Determinations Under the Water Act (40 CFR 231)	These regulations apply to all existing, proposed, or potential disposal sites for discharges of dredged or fill materials into U.S. waters, which include wetlands.	The dredged or fill material should not be discharged unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact on the wetlands.
DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1-171.5)	This regulation outlines procedures for the packaging, labeling, manifesting and transporting of hazardous materials.	Contaminated materials will be packaged, manifested and transported to a licensed off-site disposal facility in compliance with these regulations.
New York State Pollutant Discharge Elimination System (6 NYCRR 750-757; TOGS 1.3.4)	Establishes water quality standards, effluent limitations, standards of performance, toxic effluent standards and prohibitions, and pretreatment standards.	NYSDEC has determined that discharges of PCBs should be not detected, based on a practical analytical quantitation limit of 0.3 ug/L.
New York State RCRA Hazardous Waste Regulations (6 NYCRR 370-372)	Outlines design specifications and standards of performance for disposal facilities and treatments. Floodplain requirements in 6 NYCRR 372-2.	To be determined.
New York State RCRA Hazardous Waste Regulations (6 NYCRR 373)	Establishes requirements for the closure (clean closure and waste-in-place closure) and long-term management of a hazardous disposal facility.	To be determined.
New York State Solid Waste Regulations (6 NYCRR 360-361)	Requirements for landfill operation and closure, incineration, and other solid waste management activities. Facility siting requirements in 6 NYCRR Part 361.	To be determined.
New York State Air Pollution Control Regulations (6 NYCRR 200-221)	Establishes maximum ambient levels for criteria pollutants and establishes emissions limitations for sources which emit VOCs into the air.	To be determined. PCBs are not VOCs. NYSDEC Division of Air Resources Air Guide-1 may be applicable to PCB emissions.
NY Environmental Conservation Law, Title 15	Regulates excavation and fill of the navigable waters of the state.	To be determined; applicable to consideration of any alternative involving dredging or filling.

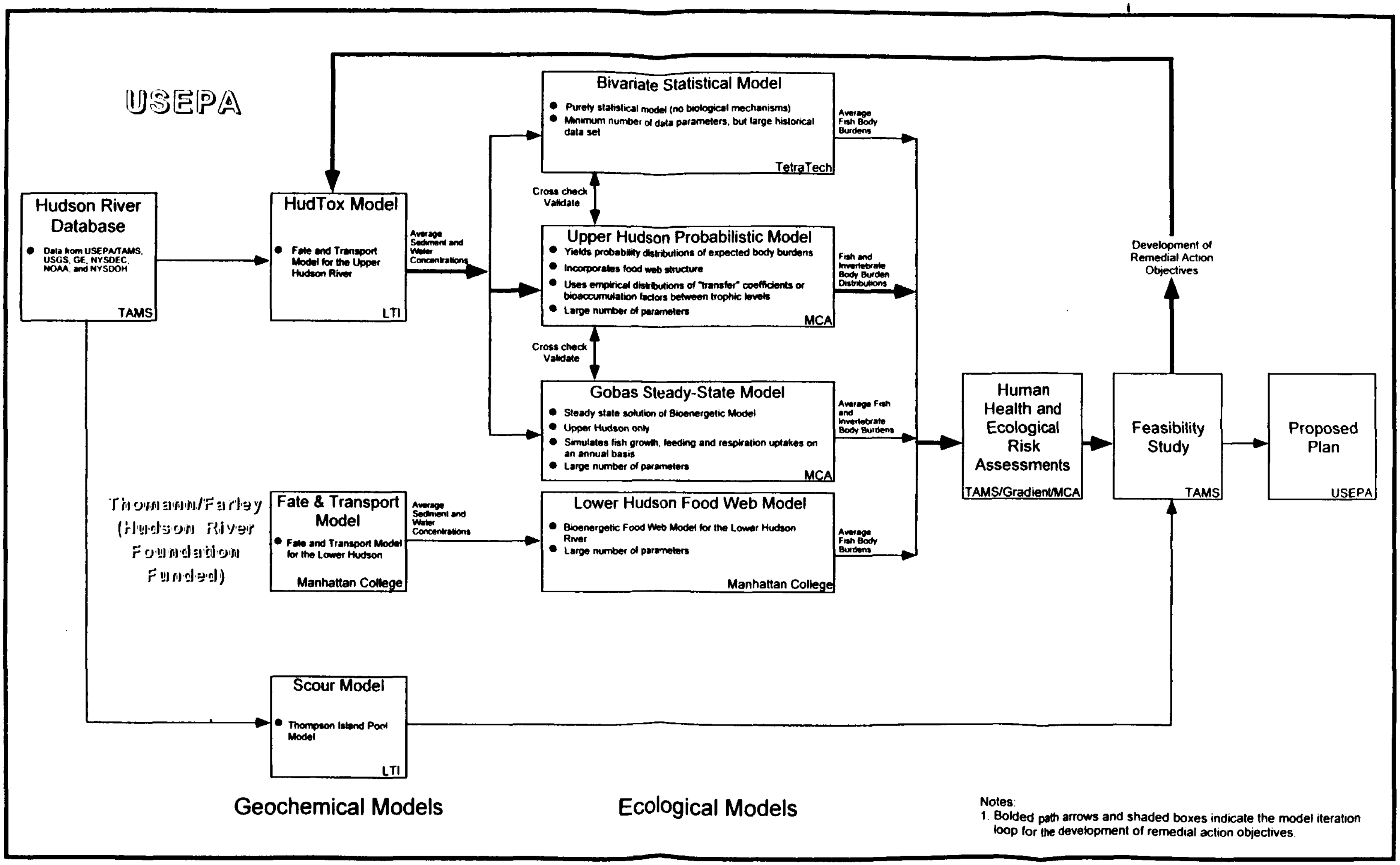
Source: Based on Table C 3-3 of the Phase I Report, updated 5/05/95 and 9/3/98

TABLE 4
INITIAL IDENTIFICATION OF GENERAL RESPONSE ACTIONS AND REMEDIAL TECHNOLOGIES

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY
1 NO ACTION	None (with or without continuation of existing monitoring and institutional controls)
2 MONITORED NATURAL ATTENUATION	None (with continuation of existing monitoring and institutional controls or additional monitoring and institutional controls)
3 CONTAINMENT	Subaqueous Capping Retaining Dikes and Berms Ground Freezing
4 IN SITU TREATMENT	Bioremediation Solidification/Stabilization Dechlorination/Solidification Solvent Extraction Chemical Dechlorination
5 REMOVAL	Environmental Dredging (with or without dispersion controls) Excavation
SEDIMENT PRETREATMENT	Dewatering Solids Classification
DISPOSAL	Beneficial Use Land Disposal (Landfills) Confined Disposal Facility
6 REMOVAL	Environmental Dredging (with or without dispersion controls)
SEDIMENT PRETREATMENT	Dewatering Solids Classification
EX SITU TREATMENT	Dechlorination Solvent Extraction Thermal Desorption Combined Physical Chemical Incineration Soil Washing Bioremediation Solidification/Stabilization Dechlorination/Stabilization
DISPOSAL	Beneficial Use Land Disposal (Landfills) Confined Disposal Facility

Note: Response action numbering on this table corresponds to numbering in Section 2.3.

FIGURES



TAMS Consultants, Inc.

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Figure 1
Hudson River PCBs Reassessment Feasibility Study Modeling Analysis Flowchart