Treatability Studies Work Plan
Hudson River PCBs Superfund Site

General Electric Company
Albany, New York

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1. Introduction

This *Treatability Studies Work Plan* (TS Work Plan) was prepared on behalf of General Electric Company (GE) and presents the approach for collecting additional data to support the design of the remedy selected by the United States Environmental Protection Agency (USEPA) to address polychlorinated biphenyls (PCBs) in sediments of the Upper Hudson River, located in New York State. The TS Work Plan objective is to provide the framework for conducting treatability studies necessary to support the development of the Remedial Design (RD), as described in the *Remedial Design Work Plan* (RD Work Plan) dated August 2003 (Blasland, Bouck & Lee, Inc. [BBL], 2003a). The activities described in the RD Work Plan are being conducted under an Administrative Order on Consent for Hudson River Remedial Design and Cost Recovery (RD AOC), effective August 18, 2003 (Index No. CERCLA-02-2003-2027) (USEPA/GE, 2003).

This TS Work Plan was developed consistent with the following relevant USEPA guidance documents:

- *Guide for Conducting Treatability Studies under CERCLA (*USEPA, 1992); and
- *Remedial Design/Remedial Action Handbook* (USEPA, 1995).

1.1 Project Setting

The Hudson River is located in eastern New York State and flows approximately 300 miles in a generally southerly direction from its source, Lake Tear-of-the-Clouds in the Adirondack Mountains, to the Battery, located in New York City at the tip of Manhattan Island. On February 1, 2002, the USEPA issued a Superfund Record of Decision (ROD), calling for, among other things, the removal and disposal of approximately 2.65 million cubic yards (cy) of PCB-contaminated sediments from the Upper Hudson River (USEPA, 2002).

The USEPA divided the Upper Hudson River into three sections (River Section 1, River Section 2, and River Section 3) (hereafter referred to as the "Upper Hudson River") for the sediment remediation activities described in the USEPA's 2002 ROD. The location of each section is described below:

- **River Section 1:** Former location of Fort Edward Dam to Thompson Island Dam (approximately 6.3 miles);
- **River Section 2:** Thompson Island Dam to Northumberland Dam (approximately 5.1 miles); and
- **River Section 3:** Northumberland Dam to the Federal Dam at Troy (approximately 29.5 miles).

The dredging will be performed in two phases (with remedial dredging of a reduced volume during the first phase). The remedy also calls for backfilling dredged areas with clean material to isolate the residual PCBs and thereby expediting habitat recovery, as well as monitored natural attenuation (MNA), in the river after dredging.

Following removal, dredged sediment will be transported via barge or pipeline to sediment processing/transfer facilities (hereinafter called "processing facilities") for dewatering and, if necessary, stabilization. Processed sediment will then be transported via rail and/or barge to an appropriate licensed offsite landfill(s) for disposal. If beneficial use of some portion of the dredged material is determined to be viable, then an appropriate transportation method (which may include trucking) will be determined. Upon completion of the dredging program, various monitoring programs will be implemented to confirm that remediation goals are reached. Finally, the remedy calls for the implementation (or modification) of appropriate institutional controls, such as fish consumption advisories and fishing restrictions by the responsible authorities, until relevant remediation goals are met.

A more detailed description of the major components of the USEPA-selected remedy can be found in the USEPA's 2002 ROD (pages ii-iv and 94-96) (USEPA, 2002a), as well as the RD Work Plan (BBL, 2003a).

1.2 Treatability Studies Overview

Treatability studies will provide data to guide equipment selection and sizing during the RD. The studies will also be used to validate, on a small scale, performance specifications of processes developed during the RD. Samples (sediment and water) will be collected from the river and submitted for pre-treatment characterization and treatability tests. The treatability test results will be used to assist in the design of the remedy set forth in the ROD (USEPA, 2002). As described in the RD Work Plan, the TS Work Plan was developed while the Preliminary Design stage is progressing through the initial identification of critical unit processes and as data from pre-design characterization activities are received. Both of these items are critical to the efficient execution of the treatability studies so that only relevant unit processes are evaluated and tests are conducted on representative sediment and water samples. Therefore, Intermediate Design decision points which influence this TS Work Plan may influence the scope of the testing as the Intermediate Design is advanced prior to and during the execution of the treatability studies program.

Some design objectives that influence the treatability studies have not yet been established. For instance, the effluent limits which will be placed on water discharges from the sediment and water processing facilities have

not been set. Without these effluent limits the design of key unit operations will not be possible during the execution of the initial treatability studies, and any additional tests necessary to finalize their design will need to be completed during supplemental treatability studies. Furthermore, there are inherent uncertainties associated with the representativeness of treatability studies, both in the scale and range of conditions that can be effectively tested. While the treatability test program described in this work plan was developed to try and address the expected range of variability, it will only be upon completion of the tests when a final determination can be made as to the sufficiency and completeness of the results (relative to supporting RD decisions) and the need for supplemental tests.

Another sampling and testing program with the objective of obtaining engineering design-related data from in situ sediment samples was proposed under the *Supplemental Engineering Data Collection Work Plan* (SEDC Work Plan) (BBL, 2003b). While the SEDC Program involves geotechnical tests on in-situ sediments to obtain engineering properties relevant to the design, the treatability testing involves analytical and geotechnical testing of sediment samples collected from the river, which are then manipulated to simulate certain processes. Testing will typically simulate unit processes and/or produce data on the behavior of dredged sediment or associated water subjected to these operations. Completing the treatability studies is identified in sub-section 4.3.2 of the RD Work Plan as a necessary precursor to completing the Intermediate Design.

1.2.1 Treatability Study Objectives

The primary purpose of the treatability studies is to provide data to guide equipment selection and sizing during RD. The studies will also be used to validate, on a small scale, performance specifications of processes developed in the RD. Specifically, the treatability studies will provide data to support the design relative to the following Data Quality Objectives (DQOs) (these objectives are also presented in Table 2):

- Collect baseline sediment and water data for use in the treatability studies.
- Develop sediment-water slurries that have properties similar to those expected of dredged material.
- Determine the potential for water quality impacts caused by dredging.
- Develop the sediment dewatering design to meet anticipated landfill acceptance or beneficial use determination (BUD) requirements.
- Develop the water processing design to meet anticipated discharge requirements.
- Develop the disposal design to meet anticipated landfill acceptance requirements.

The relationship of the individual treatability studies to the design of the unit processes in the Intermediate Design is further detailed in Section 2.

1.3 TS Work Plan Organization

This TS Work Plan is organized into the sections shown in Table 1, below.

Table 1 – TS Work Plan Organization

Section	Description
1 – Introduction	Presents background information and project objectives.
2 – Treatability Studies Process and Rationale	Describes the process, DQOs, methods, and activities to be conducted as part of the treatability studies.
3 – Project Management	Describes the project management roles for the treatability studies activities.
4 – Documentation, Reporting, and Schedule	Briefly describes the information that will be reported (to be included as part of the *Intermediate Design Reports*) and a schedule for completion of the work.
5 – References	Presents references used to prepare this TS Work Plan.
Tables	Provides tables that are referenced in this TS Work Plan.
Figures	Provides figures that are referenced in this TS Work Plan.
Appendices	Provides the American Society for Testing and Materials (ASTM) standards, standard operating procedures (SOPs), and other guidance that pertain to the treatability studies.

This TS Work Plan is supplemented by the following documents, which were previously prepared by GE and its consultants and submitted to, and/or approved by, the USEPA under the Sediment Sampling AOC (USEPA/GE, 2002):

- *Sediment Sampling and Analysis Program – Field Sampling Plan* (SSAP-FSP) (Quantitative Environmental Analysis, LLC [QEA], 2002a) and *Supplemental Sediment Sampling and Analysis Program – Field Sampling Plan* (Supplemental FSP) (QEA, 2003a): describes the pre-design Sediment Sampling and Analysis Program (SSAP). This plan was approved by the USEPA as part of the Sediment Sampling AOC (USEPA/GE, 2002). The Supplemental FSP has not been formally approved. Both plans have been implemented and supplemental FSP activities are expected to be completed during the 2004 field season.

- *Sediment Sampling and Analysis Program – Quality Assurance Project Plan* (SSAP-QAPP) (Environmental Standards, Inc. [ESI], and QEA, 2002): presents the quality assurance/quality control (QA/QC) protocols to be followed during sediment sampling and laboratory analytical efforts. The SSAP-QAPP (ESI and QEA, 2002) was submitted to the USEPA in connection with the Sediment Sampling AOC (USEPA/GE, 2002) and approved by the USEPA on October 1, 2002.

Further, this TS Work Plan is supplemented by the following documents, which were previously prepared by GE and its consultants and submitted to, and/or approved by, the USEPA under the RD AOC (USEPA/GE, 2003):

- *Baseline Monitoring Quality Assurance Project Plan* (Baseline Monitoring QAPP) (QEA and ESI, 2003): presents the QA/QC protocols to be followed during baseline monitoring (water and fish) sampling and laboratory analytical efforts. The Baseline Monitoring QAPP (QEA and ESI, 2003) was submitted to the USEPA in September 2003.

- The *Revised Community Health and Safety Plan* (Revised CHASP) (BBL, 2003c): presents protocols for protection of the community during completion of the field investigation activities to be performed as part of the RD Work Plan (BBL, 2003a) and future sampling activities under the Sediment Sampling AOC (USEPA/GE, 2002). The revised CHASP was approved by the USEPA, and is appended to the RD AOC (USEPA/GE, 2003) as Appendix 2.

- *Revised Health and Safety Plan* (Revised HASP) (BBL, 2003d): submitted under the RD AOC (USEPA/GE, 2003) on September 18, 2003 represents a revision of the SSAP-HASP (QEA, 2002c), which was previously submitted to the USEPA under the Sediment Sampling AOC (USEPA/GE, 2002). The Revised HASP (BBL, 2003d) presents the occupational, safety, and health program in place during the SSAP activities and a contingency plan in the event of an accident or emergency during those activities. The Revised HASP (BBL, 2003d) will also cover additional field activities to be performed under the RD Work Plan (BBL, 2003a).

- The SEDC Work Plan (BBL, 2003b): submitted under the RD AOC (USEPA/GE, 2003) following its execution and describes additional field activities to be conducted by GE for engineering data collection to support the development of the RD. The SEDC Work Plan (BBL, 2003b) also presents additional project management procedures, SOPs, and DQOs covering sample collection and laboratory analytical efforts not

included in the SSAP-QAPP (QEA and ESI, 2002) and *Baseline Monitoring Program – Quality Assurance Project Plan* (BMP-QAPP) (QEA and ESI, 2003).

Finally, this TS Work Plan, submitted pursuant to the RD AOC (USEPA/GE, 2003), presents protocols for specialized testing of water and sediment samples collected from the river to support the effective design of the remedy. This TS Work Plan also addresses necessary modifications to the SSAP-QAPP (ESI and QEA, 2002) related to the treatability studies activities. A list of the testing and analyses to be performed, and the document or appendix where the SOP can be located, is presented in Table 3.

2. Treatability Studies Process and Rationale

This section describes the steps used to develop the treatability studies program to provide data on equipment selection and sizing needed to develop the Intermediate Design. The studies will also be used to validate, on a small scale, performance specifications of equipment for various process options. The scale limitations of these small volumetric tests (along with any supplemental studies) must be recognized when used in the RD.

The treatability studies development process began with identifying relevant DQOs. As presented in Table 2, the following primary (Level 1) DQOs were identified for the treatability studies:

1. Collect baseline sediment and water data for use in the treatability studies.
2. Develop sediment-water slurries that have properties similar to those expected of dredged material.
3. Determine the potential for water quality impacts caused by dredging.
4. Develop the sediment dewatering design to meet anticipated landfill acceptance and BUD requirements.
5. Develop the water processing design to meet anticipated discharge requirements.
6. Develop the disposal design to meet anticipated landfill acceptance requirements.

These DQOs represent broad design goals and generally it is not possible to address these goals with absolute precision. The goal of the treatability testing is to reasonably reduce the uncertainty in our understanding so informed design decisions can be made. As a starting point, these DQOs were based on the DQOs presented in the SEDC Work Plan (BBL, 2003b). However, since the completion and submission of the SEDC Work Plan, the TS DQOs have been further refined to address the specific data needs identified during the development of the Preliminary Design (note that DQOs 2 through 6 listed above now pertain directly to RD project elements).

To understand the development of the treatability test program a discussion of the overall project from dredging to disposal is useful. Figure 1 shows a conceptual process flow for the remediation project, illustrating the major process components that will be developed in the Intermediate Design. Sediment will be dredged using hydraulic and/or mechanical methods, and dredged sediment will be transported via barge and/or pipeline to processing facilities for dewatering and/or stabilization (if necessary). Processed sediment will then be transported via rail and/or barge to an appropriate licensed offsite landfill(s) for disposal. Design process flow diagrams for these scenarios are depicted on Figures 2 and 3. Figure 2 is derived from the conceptual process flow diagram, illustrating the process components that would be associated with a mechanically dredged and

mechanically offloaded scenario, and indicates where the data from individual treatability tests (described in the TS Work Plan) will be used in the design of that component. Similarly, Figure 3 illustrates the process components and associated treatability tests for a hydraulically or mechanically dredged with hydraulic offloading scenario. The above-listed DQOs address treatability-related data necessary to develop the Intermediate Design for this remedy.

Detailed DQOs (Levels 2, 3, and 4) were identified for each Level 1 DQO and are presented in Table 2. The following subsections discuss the detailed DQOs and associated treatability study(ies) developed to address each Level 1 DQO.

2.1 DQO 1 - Collect baseline sediment data for use in the treatability studies

Two detailed Level 2 DQOs were identified to address this objective:

1a. Determine baseline solid phase chemical and physical properties.
1b. Determine baseline aqueous phase chemical and physical properties.

These data provide a characterization of the inputs that the dredge to disposal process will have to manage. The treatability studies activities to address these Level 2 DQOs are described below.

2.1.1 Collect sediment samples and analyze chemical and physical properties (DQO 1a.)

Representative samples of sediment will be collected for use in the treatability studies identified in this work plan. The sample collection approach is designed to consider the specific treatability studies and the key variables that will affect the results of those studies as they affect the design. While many different factors will ultimately influence the overall project design, two variables are prominently consistent from the DQO evaluation:

- Grain size distribution of the sediments; and
- PCB concentration in the sediments.

Recognizing the importance of these two variables and the general relationship that exists between PCB concentration and sediment type (i.e., historical data for the site indicates that higher PCB concentrations are associated with fine-grained sediments), four categories of PCB concentration/sediment type were identified to

represent the anticipated range of sediments present in removal areas. Descriptions of these four sediment categories and approximate volumes needed for the treatability tests are presented in Table 4.

Table 4 – Sediment Category Summary Table

Sediment Category Designation	Physical Characteristics	Chemical Characteristics	Approximate Volume Needed
S1	Coarse-grained sediment	Assumed to have relatively low PCB concentrations	360 liters (l) (100 gallons [gal])
S2	Mixture of coarse- and fine-grained sediment	Assumed to have moderate PCB concentrations	170 l (40 gal)
S3	Fine-grained sediment	Assumed to have relatively high PCB concentrations	330 l (90 gal)
S4	Fine-grained sediment with oils and/or lower bulk density	Assumed to have the highest PCB concentrations	300 l (80 gal)

The relationship between PCB concentration and grain size is a generalization that applies to much of the river (particularly to River Sections 2 and 3), but not for all areas. This was addressed by including the S2 and S4 categories. The S4 category was added to address fine-grained sediment containing high PCB concentrations, the potential to contain PCB oil, and/or low density. The separate categories were created because each material type may create unique conditions that need to be considered in the design of dredging equipment/approach and resuspension containment systems. In addition, the sediment dewatering and water treatment design will also need to consider the unique characteristics of these different sediments. It is important to note, that this sampling strategy is intended to address the bulk of sediments to be dredged and not the extreme PCB levels (high or low) or odd combinations of grain size and PCB concentration. It is believed that the data generated will provide a reasonable basis to extrapolate to these more rare situations.

The S2 category was created to address areas of the river containing a mixture of fine- and coarse-grained sediment. This category will also address coarse-grained sediment areas that contain wood materials. Note that the presence of wood materials may be associated with elevated PCB concentrations as compared to other coarse-grained sediments that do not contain wood materials. This category recognizes that some areas cannot

be classified as either fine-grained or coarse-grained and that PCB concentrations in these areas represent a mixture of materials.

A range of PCB concentrations and grain-size mixtures will likely exist within each of these four general categories. To address this, the treatability test feed samples will be chosen from locations based on the results of the SSAP. Two general areas within the upper Hudson River have been identified as containing sediments representative of each of the four categories, and an equal volume of sediment will be collected from both areas (eight sediment sample locations). Sediment collection areas were selected based on the SSAP PCB concentration (average concentrations are presented in Table 5) and grain-size results. Grain size was evaluated based on visual classification of cores, coupled with side-scan sonar data and grain-size data (when available). Approximate sample collection areas are shown on Figures 4 through 10.

The approach to collect sediment samples for the treatability studies is based on the concept that the studies should reflect conditions over a relatively small area, as opposed to a single point location. This approach is more representative of the project implementation. One-half of the required volume for that category will be collected at each of the eight treatability test feed sample areas. The material will be collected from within the ¼-acre area and the specific sampling locations within this area will be selected at random. This approach is designed to provide sediment representative of that in a typical 1,000-cy scow (a volume approximating a ¼-acre area with an average dredge cut of 2 feet). The material collected from the two locations representing each category will then be composited into a single sample (four composites total).

Approximately 20 to 50 gallons of sediment will be collected from each sampling area using vibra-coring techniques. To the extent possible, core-tube penetration will be controlled in a manner that will result in recovery of approximately the same depth of sediment that is anticipated to be dredged (based on SSAP cores previously collected in each area). Procedures for the collection, storage, and shipment of treatability studies sediment samples to treatability studies lab(s) will follow the protocols presented in Appendix 1 – SOP for Sample Collection for Treatability Tests.

Each of the four composites will be submitted for analytical testing of physical properties and analytical chemistry. The analytical results will provide pre-processing data for the treatability tests, and may allow for analysis of treatability test results across the full wide range of sediment types anticipated to be handled during remedy implementation. The analytical results will also be used to confirm that the collected sediment is

representative of its designated category (i.e., grain size distribution and relative PCB concentrations are as expected). Each sediment sample will be analyzed for:

- PCB (GEHR Modified Method 8082);
- PAH (SW-846 8270C);
- TOC (Lloyd Kahn);
- Target Analyte List (TAL) metals (SW-846 Method 6010B/7471A);
- PCDD/PCDF (USEPA 1613B);
- Total P/PO_4 (USEPA 365.2);
- NH_3/TKN (USEPA 350.3/351.3);
- Bulk density (ASTM D4531-86, modified);
- Water content (USEPA 160.3);
- Grain-size distribution (from Sieve Analysis, ASTM D422);
- Grain-size distribution for finer fraction (from Hydrometer Analysis, ASTM D1140); and
- Visual observations during sample collection.

The PCB and grain size analysis results will be reviewed to determine whether the composite sample is representative of the appropriate sediment category. If it is unacceptable, additional samples will be collected, composited, analyzed, and reviewed until an acceptable sample is confirmed.

The collected sediment will then be used for the treatability tests described in the following sub-sections.

2.1.2 Collect water samples and analyze chemical and physical properties (DQO 1b.)

Representative surface water will be collected for use in the treatability studies identified in this work plan. Approximately 8,400 l (2,200 gal) of surface water will be collected from the Thompson Island sampling station located at river mile (RM) 187.5, approximately one foot below the water surface, following protocols presented in Appendix 1. Water samples will be collected throughout the treatability studies program on an as-needed basis for each test, to avoid difficulties associated with shipment and storage of large volumes of water.

Following collection, a representative water sample will be submitted for analytical testing of chemical properties. The analytical results will be used to provide pre-processing data for the treatability tests. In

addition, the results will determine the representativeness of the sample (compared to historical water testing results). The water sample will be analyzed for:

- PCB (Modified Green Bay Mass Balance Method);
- TSS (USEPA 160.2, with modifications consistent with ASTM D3977-97, Test Method B - Filtration);
- Turbidity (USEPA 180.1);
- TOC (Lloyd Kahn);
- Field pH (probe measurement);
- Field DO (probe measurement);
- TAL metals (USEPA 200.7/245.1);
- PCDD/PCDF (USEPA 1613B); and
- Visual observations during sample collection.

TOC (Lloyd Kahn) analyses will also be conducted on the filtered fraction of the water sample and on TSS present in the collected water sample.

2.2 DQO 2 – Determine the effect of dredging on sediment properties relevant to handling and processing

Several detailed DQOs were identified to address this objective:

2a. Develop sediment-water slurry that has properties similar to mechanical dredging and mechanical offloading.
2b. Develop sediment-water slurry that has properties similar to mechanical dredging and hydraulic offloading.
2c. Develop sediment-water slurry that has properties similar to hydraulic dredging and hydraulic offloading.

The treatability study activities to address these Level 2 DQOs are described below.

2.2.1 Develop sediment-water slurries that have properties similar to a range of dredging and offloading scenarios (DQO 2a. to 2c.)

Dredged material may be generated from a variety of sediment environments and by two different general dredging methods: hydraulic and/or mechanical. Since the actual dredging method(s) has not been determined,

the treatability testing will be performed to simulate both possibilities. In addition, if the dredged sediment is hydraulically transported, the solids content of the slurry will likely vary depending on actual conditions encountered during dredging. As such, processing and treatment facilities will need to be flexible and capable of handling varying hydraulic and solids loadings.

Sediment slurries will be prepared to simulate the typical slurries generated by three dredging and transport/offloading scenarios. Dredged material slurry simulations will be prepared by mixing sediment samples with varying quantities of river water following the protocols outlined in Appendix 2 (SOP – Dredged Material Slurry Simulations). Slurries will be mixed to simulate dredging conditions as summarized below in Table 6.

Table 6 – Dredged Material Slurry Simulations Summary Table

Slurry Designation	Sediment/Solids to Water Ratio	Purpose
M1	80:20 (sediment:water, volumetric proportions)	To simulate mechanically dredged material with a typical amount of entrained water.
H1	25:75 (solids:water, weight proportions)	To simulate high-solids content material that was mechanically dredged, but hydraulically transported.
H2	5:95 (solids:water, weight proportions)	To simulate hydraulically dredged material with a typical solids content.

Samples from each of the four sediment categories will be tested to determine the range of sediment properties that must be accommodated by the material handling and treatment facilities. Dredged material slurry simulations will be prepared for each of the sediment categories, producing the following dredged material slurries:

- M1S1, H1S1, and H2S1 will be prepared from Sediment S1;
- M1S2, H1S2, and H2S2 will be prepared from Sediment S2;
- M1S3, H1S3, and H2S3 will be prepared from Sediment S3; and
- M1S4, H1S4, and H2S4 will be prepared from Sediment S4.

Each of the above slurries will be submitted for analytical testing for water content (USEPA 160.3) to verify that acceptable slurries have been prepared.

The slurries will provide a "feedstock" of materials to be used in dewatering and water treatment tests identified in this TS Work Plan. Feedstock will be used within a 3-day period of preparation to reduce the potential for changes in the chemical composition of the slurry. Feedstock will be mixed immediately prior to use to re-suspend settled material. Many tests will be prepared on desanded sediment (as described in later subsections), which will reduce the non-homogeneity between feedstock aliquots due to settling.

These treatability studies are being performed on samples within a wide range continuum of sediment environments and dredging slurry concentrations. The test material sediment environments will include sediment particle sizes ranging from sand and gravel to silts, clays, and organics in various mixes that represent the bulk of materials to be removed from the river. The range of percent solids in the slurry (5 to 80%) provides a reasonable range likely to be produced by the dredge methods. The treatability studies results will be used to estimate sizing and performance information for a number of sediment and water processing technologies. All of the processing technologies are fairly common; sizing practices and responses to variable inputs have been studied and reported in the literature. As a result, it is not necessary to evaluate every possible combination of input variables in the testing program. Rather, the number of tests, the selected input variables (including percentage solids and material types) are expected to reflect the range of conditions that could be encountered. It is recognized that some unexpected or anomalous conditions may be encountered, which may require supplemental treatability studies to resolve uncertainties or confirm observed trends.

The remainder of Section 2 describes the unit process-specific treatability tests that will provide the data necessary to advance the project design. Many of the tests are closely interrelated, with the residuals from one test used as the feed materials for a subsequent test. Figures 11 through 19 provide a graphic representation of the individual treatability tests that will be performed on each of the dredged material slurry simulations.

2.3 DQO 3 – Determine the potential for water quality impacts caused by dredging

Two detailed DQOs were identified to address this objective:

3a. Determine the required removal efficiencies of resuspension controls.

- 3a. (1) Determine an estimate of PCB release (dissolved phase and suspended particulate fraction) to the water column from the dredge head.
- 3a. (2) Determine an estimate of release of non-PCB constituents (dissolved phase and suspended particulate fraction) to the water column from the dredge head.

The treatability studies activities to address these Level 3 DQOs are described below.

2.3.1 PCB release to the water column from the dredge head (DQO 3a.)

Given the level of uncertainty associated with estimating sediment resuspension impacts, the technical approach for the Hudson River Remedial Design includes a combination of bench-scale testing and numerical modeling. The resuspension treatability method will not be representative of the interactions between the dredging process, sediment properties, and river dynamics. Bench-scale resuspension estimates developed using these techniques will be highly qualitative and are intended to provide an order-of-magnitude estimate of source strength, and as a result, engineering judgment will weigh significantly in design decisions for resuspension controls. The models for simulating sediment and contaminant resuspension from a dredging operation have not been rigorously validated by field testing. However, this analysis may provide useful insights into resuspension that might aid in evaluating the need and type of resuspension controls. This TS Work Plan describes the bench-scale testing that will be completed as part of the treatability studies to support the development of resuspension estimates. The results of numerical modeling of resuspension to estimate the effects on the water column PCB levels will be presented in the Phase 1 and 2 Intermediate Designs.

Bench-scale tests will be conducted using protocols developed by the USACE (presented in Appendix 3 – Dredge Elutriate Tests). Results of these tests will be used to qualitatively assess control needs for sediment and PCB (i.e., particulate and dissolved) loads from the immediate vicinity of the dredge head.

In the dredge elutriate test (DRET) procedure (Appendix 3), undisturbed sediment and site water are combined to yield a 10 g/L slurry. After 60 minutes of mechanical shaking and aeration by compressed air, the combined sample is allowed to settle for one hour before a sample is withdrawn from the supernatant. The test method identifies constituent release as the soluble fraction of constituents found in the supernatant after the one-hour settling period. The USACE has also modified the sampling protocol to include analysis of the suspended particulate fraction in addition to the dissolved phase (Averett, 1989). This same modification is proposed for the Hudson River treatability tests. These additional data will assist in estimating the total amount of PCBs that may migrate downstream of the dredging operation. The particulate-phase data will also be used to help define the extent of PCB desorption and the degree to which desorption may be described using conventional equilibrium partitioning assumptions.

Filtered and unfiltered water samples will be analyzed for:

- PCB (Modified Green Bay Mass Balance Method);
- TSS (USEPA 160.2, with modifications consistent with ASTM D3977-97, Test Method B – Filtration);
- Turbidity (probe measurement);
- TOC (Lloyd Kahn);
- pH (probe measurement);
- DO (probe measurement); and
- Visual observations during sample collection.

Suspended particulate fraction samples will be analyzed for:

- PCB (GEHR Modified Method 8082).

The DRET will be conducted on one sediment sample in each of the four sediment categories (S1, S2, S3, and S4). Three replicates will be conducted for each sample to account for variability. This will yield a total of 12 DRET tests. Prior to conducting the DRET, one sediment sample in each of the four sediment categories (S1, S2, S3, and S4) will be analyzed for:

- PCB (Modified Green Bay Mass Balance Method).

Data obtained from the DRET will be used as an input parameter for numerical modeling of resuspension on the water column. As will be further described in the Preliminary Design, this numerical modeling will be completed during the Phase 1 and Phase 2 Intermediate Designs to help assess the need for and type of resuspension controls necessary to achieve the applicable Performance Standards.

2.3.2 Non-PCB release to the water column from the dredge head (DQO 3b.)

To determine the release of other (non-PCB) constituents to the water column from the dredge head, filtered and unfiltered water samples from the DRET tests will be submitted for the following analyses:

- TAL metals (USEPA 200.7/245.1);
- pH (probe measurement);
- DO (probe measurement);
- Visual observations during sample collection;
- TSS (USEPA 160.2, with modifications consistent with ASTM D3977-97, Test Method B – Filtration); and

- Turbidity (USEPA 180.1).

2.4 DQO 4 – Develop the sediment dewatering design to meet anticipated landfill acceptance or BUD requirements

Several detailed DQOs were identified to address this objective:

4a. Develop the sediment processing design for mechanically dredged/mechanically offloaded sediment.

4a. (1) Evaluate the need for solidification agents and effect of dosage (mechanically dredged/mechanically offloaded sediment).

4b. Develop the sediment processing design for mechanically dredged/hydraulically offloaded sediment.

4b. (1) Evaluate size separation.

4b. (1a) Evaluate size separation technologies (based on particle size and density distribution) and evaluate the chemical properties of the separated solid fractions.

4b. (1b) Evaluate the drainage characteristics of the coarse fraction.

4b. (2) Determine primary sedimentation efficiency for removal of regulated chemicals bound to the particulate phase.

4b. (2a) Evaluate the effects of polymer treatment on solids removal.

4b. (2b) Evaluate the effects of primary settling on solids removal.

4b. (3) Quantify plate and frame filter press size and performance.

4b. (3a) Determine efficiency of filter press for dewatering raw slurries and settled solids (evaluate dewatering polymers, evaluate mixing/floc sensitivity to mixing or shear, and evaluate cake release).

4b. (3b) Optimize hydraulic and mass loading to plate and frame filter presses.

4b. (3c) Evaluate centrifugation.

4b. (4) Evaluate need for solidification agents on raw slurries and filter cake and evaluate effect of dosage.

4b. (5) Determine the mixing energy needed to keep slurries in suspension.

4c. Develop the sediment processing design for hydraulically dredged/hydraulically offloaded sediment.

4c. (1) Evaluate size separation.

4c. (1a) Evaluate size separation technologies (based on particle size and density distribution) and evaluate the chemical properties of the separated solid fractions.

4c. (1b) Evaluate the drainage characteristics of the coarse fraction.

4c. (2) Determine primary sedimentation efficiency for removal of regulated chemicals bound to the particulate phase.

4c. (2a) Evaluate the effects of polymer treatment on solids removal.

4c. (2b) Evaluate the effects of primary settling on solids removal.

4c. (3) Quantify plate and frame filter press size and performance.

4c. (3a) Determine efficiency of filter press for dewatering raw slurries and settled solids (evaluate dewatering polymers, evaluate mixing/floc sensitivity to mixing or shear, and evaluate cake release).

4c. (3b) Optimize hydraulic and mass loading to plate and frame filter presses.

4c. (3c) Evaluate centrifugation.

4c. (4) Evaluate need for solidification agents on raw slurries and filter cake and evaluate effect of dosage.

4c. (5) Determine the mixing energy needed to keep slurries in suspension.

The treatability studies activities to address these Level 3 and Level 4 DQOs are described below.

2.4.1 Solidification agents and effect of dosage on mechanically dredged/mechanically offloaded sediment [DQO 4a. (1)]

Pursuant to disposal facility requirements, processed sediments will have to pass the Paint Filter Liquids Test (USEPA SW-846 Method 9095A) (Appendix 4) to demonstrate that free liquids are not present prior to disposal. In addition, processed materials that would be designated for disposal in a Subtitle D landfill facility must not be classified as hazardous waste under RCRA. Solidification and stabilization (S/S) evaluations will be conducted to evaluate the effectiveness of S/S in reducing free liquid, as well as to assess the potential for sediment to exhibit hazardous waste characteristics following S/S treatment. Appendix 5 presents example protocols for S/S testing.

S/S evaluations will be conducted on slurries M1S1, M1S2, M1S3, and M1S4, and on the dewatered hydraulic simulation slurries (as identified in Section 2.4.9) to determine the effectiveness of S/S in reducing free liquid, as well as assess the affects on hazardous characteristics of the sediment. Initially, each slurry will be subject to the paint filter test to evaluate the need to add solidification agents. Slurries that do not pass the paint filter test will be subjected to the S/S tests described below.

As presented in Appendix 5, the S/S reagents to be tested may include Portland cement, lime, fly ash, and a propriety reagent (if appropriate based on vendor and equipment supplier information). The S/S reagents will be

added to aliquots of the slurries at 5%, 10%, and 20% doses (by weight). Upon curing (3 days), the samples will be tested to determine if the specific landfill disposal requirements (e.g., free liquid content, RCRA hazardous waste characteristics) can be met.

It is anticipated that testing for landfill physical requirements will include the Paint Filter Liquids Test (USEPA SW-846 Method 9095A), consolidation (ASTM D2435), and unconfined compressive strength (ASTM D2850), and that chemical requirements will include RCRA hazardous waste characterization. Each solidified sediment sample will be analyzed for Paint Filter Liquids Test (USEPA SW-846 Method 9095A. In addition, two solidified sediment samples from each slurry simulation (selected based on the paint filter results and visual observations) will be analyzed for:

- PCB (GEHR Modified Method 8082);
- TAL metals (SW-846 Method 6010B/7471A);
- TCLP metals (SW-846 Method 1311/3010A/6010B/7470A);
- TCLP volatiles (SW-846 Method 1311/8260B);
- TCLP semivolatiles (SW-846 Method 1311/3510C/3520C/8270C);
- TCLP pesticides (SW-846 Method 1311/3510C/3520C/8281A);
- TCLP herbicides (SW-846 1311/8151A);
- pH (USEPA 9040A/9041B/9045C);
- PCDD/PCDF (USEPA 1613B);
- TOC (Lloyd Kahn);
- Unconfined compressive strength (ASTM D2850);
- Consolidation (ASTM D2435);
- Specific gravity (ASTM D854);
- Atterberg limits (ASTM D4318);
- Grain-size distribution (from Sieve Analysis, ASTM D422);
- Grain-size distribution for finer fraction (from Hydrometer Analysis, ASTM D1140);
- Water content (USEPA 160.3); and
- Visual observations during sample collection.

2.4.2 Chemical properties evaluation of the separated solid fractions using size and density separation technologies [DQO 4b. (1a) & 4c. (1a)]

Based on the SSAP particle-size distribution data (as reported in the DSRs [QEA, 2003]), it is expected that much of the dredged sediment will contain significant portions of sand and, in some cases, gravel. It can be cost-effective to selectively remove larger particles to allow smaller sizing of facilities to dewater the finer particles. Conversely, it is possible that selective removal of coarse particles may make subsequent dewatering processes more difficult, as flocculation and dewatering processes may react differently to a matrix consisting only of fine particles than to a wider distribution particle size. Therefore, dewatering processes will be tested using dredged material that has been separated based on size and on dredged material that has not been subjected to size separation processes. Appendix 6 presents example protocols for size and density separation testing. As presented in Appendix 6, size-separated fractions will be obtained using standard sieve analysis methods and density-separated fractions will be obtained using high-density liquid methods.

Size separation (sometimes referred to as desanding) processes may consist of physical (e.g., bars and screens) or hydraulic (e.g., hydrocyclones) systems. Particle-size distribution data are used to design the separation equipment, but confirmation using laboratory equipment can also be appropriate prior to full-scale implementation. In addition, larger laboratory desanding equipment are often required to generate sufficient quantities of desanded sediment to test downstream dewatering and water treatment pilot operations. Size separation processing facilities may not be directly applicable to mechanically dredged sediments unless those sediments are transported hydraulically (i.e., slurried for hydraulic transport at or to land-based facilities).

One objective of performing size separation is to evaluate different disposal options (e.g., non-TSCA), an accompanying reduction in the volume or mass of dredged material requiring more restrictive landfill disposal, or potentially beneficial use for each size cut. This could reduce the volume of dredged material requiring more restrictive disposal (e.g. TSCA landfill). Since PCBs tend to preferentially adsorb to fine-grained materials and organic solids, the PCB content of separated coarse particles, with or without additional washing steps, may meet non-TSCA (Subtitle D) or BUD acceptance criteria. Therefore, PCB data will be obtained from each fraction during size-separation and density-separation testing.

As shown on Figures 12, 13, 16, and 17, size separation testing will be performed on slurries H1S1, H1S2, H2S1, and H2S2. Only the sediment samples with larger coarse fractions (i.e., S1 and S2) are being tested at this time as it is anticipated that size separation will be more productive for these environments. A sample will

be collected from each solid fraction (i.e., fraction retained on each sieve and each separated density fraction) and submitted for the following analysis:

- PCB (GEHR Modified Method 8082);
- pH (USEPA 9040A/ 9041B/9045C);
- TAL metals (SW-846 Method 6010B/7471A);
- Grain-size distribution (from Sieve Analysis, ASTM D422);
- Grain-size distribution for finer fraction (from Hydrometer Analysis, ASTM D1140);
- Specific gravity (ASTM D854); and
- Atterberg limits (ASTM D4318).

In addition, the coarse fraction from the size-separation tests (i.e., the fraction retained on or above the #200 sieve) will be analyzed for TOC (Lloyd Kahn).

A second purpose of these separation tests is to generate quantities of desanded sediment for use in subsequent dewatering and water treatment steps. Dredged material slurries will be desanded by passing across a 0.074 millimeter (mm) screen. Low density (e.g. woody) material encountered will be removed prior to testing. The quantities of sand/gravel retained on the 0.074 mm screen will be weighed relative to each measured unit volume of desanded sediment.

2.4.3 Drainage characteristics of the coarse fraction [DQO 4b. (1b) & 4c. (1b)]

Additional testing will evaluate gravity drainage of water from the coarse fraction of slurry H1S1, H1S2, H2S1, and H2S2 (the fraction retained on 0.074 mm screen in the size separation tests). Example protocols for the drainage tests are presented in Appendix 7. Samples of the drained material will be submitted for analytical testing for water content (USEPA 160.3).

2.4.4 Evaluate the effects of polymer treatment on solids removal [DQO 4b. (2a) & 4c. (2a)]

Polymer treatment tests will be performed as an initial step in evaluating their efficiency in improving the removal efficiency of primary sedimentation. Polymers to be tested may include reagents such as poly-diallyl-dimethyl ammonium chloride, dimethylamine epichlorohydrin copolymer, polyamines, and/or melamine formaldehyde resins. Polymers to be tested will be selected based on information provided by the reagent

vendors and equipment suppliers. The results will be used to determine the preferred polymer treatment for use in the primary (column) settling tests described below (Subsection 2.4.5).

The polymer treatment tests will evaluate four polymers at five doses using bench-scale multiple-place mixers (ASTM D2035 - Standard Practice for Coagulation-Flocculation Jar Test of Water) (ASTM, 1997) (presented in Appendix 8). Slurries H1S2, H1S3, H2S1, H2S2, and H2S3 will be used in the polymer treatment tests. The resulting supernatant from each slurry will be submitted for testing for turbidity (USEPA 180.1) reduction versus dosage. Visual observations of the resulting supernatant from each slurry will be recorded during sample collection. Appendix 9 presents guidance on selecting optimum dosage using turbidity measurements.

2.4.5 Evaluate the effects of primary settling on solids removal [DQO 4b. (2b) & 4c. (2b)]

Slurry thickening through gravity settling may be performed prior to mechanical dewatering of hydraulically dredged sediments. Column settling tests will be performed to quantify design variables for this process, including overflow rate and detention time.

Column settling tests will be performed on slurries H1S2, H1S3, H2S2, H2S3, and H2S4 following procedures in *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual* (ERDC/EL TR-03-1), Appendix B (USACE, 2003) (presented in Appendix 10). Slurries may be conditioned using the preferred polymer treatment determined from the testing described above in Section 2.4.4 (if a preferred polymer is identified). During the column settling tests, supernatant samples will be acquired at heights of 2, 4, 6, and 8 feet. Samples are typically collected at settling durations of 0, 2, 8, and 24 hours. The durations may be adjusted, once the settling rate is experimentally observed. The analyst will record the height of the sediment/water interface at these times.

Solids samples will be collected after the 24-hour test and analyzed for:

- PCB (GEHR Modified Method 8082);
- Water content (USEPA 160.3);
- TOC (Lloyd Kahn); and
- Visual observations of drainage characteristics.

Aliquots of supernatant will be collected and analyzed for the following parameters:

- TSS (USEPA 160.2, with modifications consistent with ASTM D3977-97, Test Method B – Filtration); and
- Visual observations during sample collection.

In addition, filtered and unfiltered supernatant samples will be analyzed for TOC (Lloyd Kahn).

Supernatant collected from the 6-foot height from the 24-hour duration will also be analyzed for PCBs (GEHR Modified Method 8082). In addition, floatable material (if observed during primary sedimentation testing) will be sampled and submitted for PCB analysis (GEHR Modified Method 8082).

Samples of settled sediment, after 24 hours of settling, will be retained for subsequent filter press testing.

2.4.6 Efficiency of filter press for dewatering raw slurries and settled solids [DQO 4b. (3a) & 4c. (3a)]

Sediments that are hydraulically dredged, transported, or offloaded will likely need to be mechanically dewatered using a combination of polymer conditioning and filter press treatment. Polymers to be tested may include reagents such as poly-diallyl-dimethyl ammonium chloride, dimethylamine epichlorohydrin copolymer, polyamines, and/or melamine formaldehyde resins. Polymers to be tested will be selected based on information provided by the reagent vendors and equipment suppliers. Section 2.4.7 presents tests for evaluating laboratory filter press treatment. The following bench-scale tests evaluate the performance of several reagents to determine the preferred polymer conditioning for this treatment.

- Dewatering polymer screening tests;
- Preferred polymer confirmation test;
- Mixing sub-study; and
- Cake release screening study.

Dewatering Polymer Screening Tests

An initial study of approximately four polymer types at four dosages will be performed using bench-scale Buchner funnel test apparatus (American Public Health Association [APHA] et. al., 1998) (presented in Appendix 11) and a bench-scale pressure filter test apparatus (example protocols are presented in Appendix 12). Filtrate sample volumes (versus time) from both testing apparatus will be measured versus polymer dosage. Bench-scale testing will be conducted on:

- Raw slurries H1S1, H1S3, H1S4, and H2S1; and
- Settled solids from primary sedimentation testing of slurry H2S2 and H2S4.

In addition, filter cake samples will be tested for water content (USEPA 160.3). Optimal polymer and reagent dosages will be selected per the guidance presented in Appendix 9. The optimal polymer and reagent doses will be used for the pilot-scale filter press tests discussed below.

Preferred Polymer Confirmation Test

Once the optimal polymer and treatment dose is chosen, preferred polymer confirmation tests will be performed to test the conditioning treatment on different slurry types. The bench-scale Buchner funnel testing, as well as bench-scale pressure filter testing, will be performed as part of the confirmation tests (using the protocols described in Appendix 11 and Appendix 12, respectively). The preferred polymer and dosage will be utilized in tests on:

- Raw slurries H1S2 and H2S3; and
- Settled solids from primary sedimentation testing of slurry H1S3.

Filtrate sample volumes (versus time) will be measured versus dosage and filter cake samples will be tested for water content (USEPA 160.3). Additional polymer screening tests will be conducted should positive results not be achieved during initial polymer testing.

Mixing Sub-Study

The floc produced by most polymers is sensitive to shear from over-mixing; however, some media and some polymers are more sensitive to floc shear than others. A set of Buchner funnel tests will be performed to compare the sensitivity of several polymers to shear due to over-mixing when treating the simulated dredged material slurries. This will assist in selecting a preferred flocculant, but will also help guide the design of mixing and flocculation facilities. Mixing sub-studies will be conducted on slurries H1S3, H2S1, and H2S2 (example protocols for the mixing sub-studies are included in Appendix 9, SOP – Determine Optimum Polymer Dose, as a sub-study). In addition, filter cake samples will be tested for water content (USEPA 160.3).

Cake Release Screening Study

Additional characterization of cake properties will be obtained from filter leaf testing, using several polymer dosages selected based on the results of the Buchner funnel tests. Filter leaf tests evaluate cake releaseability from a variety of filter media fabrics and weave tightnesses. These tests will be performed on the filter cake from slurries H1S2, H1S3, H2S1, and H2S3 following the Buchner funnel tests with optimal conditioning treatment. Tests will be performed using a Pocket-leaf filter unit (Perlmutter, 2003) (using the protocols presented in Appendix 13) or several media fabrics can be tested on the bench-scale filter press.

2.4.7 Optimize hydraulic and mass loading to plate and frame filter presses [DQO 4b. (3b) & 4c. (3b)]

The following series of treatability tests will be performed to address this DQO:

- Plate and frame filter press tests;
- Cake solids vs. time sub-study; and
- High-volume filter press.

Tests will be conducted on mechanically dredged/hydraulically offloaded and hydraulically dredged/ hydraulically offloaded dredged material slurry simulations as outlined below.

Plate and Frame Filter Press Tests

Plate and frame (P&F) filter press testing will be conducted to size the full-scale filter press. The filter press will be a 1-square-foot plate and frame filter with one to five plates. This testing will be performed on hydraulically dredged material slurry simulations. Example P&F filter press testing protocols are presented in Appendix 14. Filter press testing will be conducted on:

- Raw slurries H1S2 and H1S3; and
- Settled solids from the primary sedimentation tests on slurries H2S2 and H2S4.

Press filtrate volume (and samples) will be measured at 0.5, 1, 2, 3, and 4 hours (or modified, based on test experience).

Filtrate constituents will be analyzed for:

- PCB (GEHR Modified Method 8082); and
- TSS (USEPA 160.2, with modifications consistent with ASTM D3977-97, Test Method B – Filtration).

Filter cake samples will be analyzed for:

- Water content (USEPA 160.3); and
- Paint Filter Liquids Test (USEPA SW-846 Method 9095A).

Cake Solids vs. Time Sub-Study

A cake solids vs. time sub-study will be conducted using the same equipment as the P&F filter press tests. This test will evaluate the changes in filter cake solid content during the above-described P&F filter press tests, to optimize the length of the press run. This sub-study will be conducted on slurries H1S3, H2S1, and H2S3. Filter cake samples will be collected at 1, 2, 3, and 4 hours (or modified, based on test experience) and submitted for analysis of:

- Water content (USEPA 160.3); and
- Paint Filter Liquids Test (USEPA SW-846 Method 9095A).

High-Volume Filter Press

High-volume P&F filter runs will be conducted on slurries H1S1, H1S3, H1S4, H2S1, H2S2, H2S3, and H2S4 using preferred polymer dosage and optimal press times, as determined through the tests described above. The purpose of the high-volume P&F filter runs is to produce filtrate for further water treatment testing, as described in Section 2.5. Another objective is to produce filter cake for landfill acceptance testing and possibly S/S testing (if cake fails paint filter test).

Filtrate samples will be analyzed for:

- PCB (GEHR Modified Method 8082);
- TSS (USEPA 160.2, with modifications consistent with ASTM D3977-97, Test Method B – Filtration);
- Turbidity (USEPA 180.1);

- TOC (Lloyd Kahn);
- pH (probe measurement); and
- Visual observations during sample collection.

Filter cake samples will be analyzed for:

- PCB (GEHR Modified Method 8082);
- TAL metals (SW-846 Method 6010B/7471A));
- PCDD/PCDF (USEPA 1613B);
- TCLP metals (SW-846 Method 1311/3010A/6010B/7470A);
- TCLP volatiles (SW-846 Method 1311/8260B);
- TCLP semivolatiles (SW-846 Method 1311/3510C/3520C/8270C);
- TCLP pesticides (SW-846 Method 1311/3510C/3520C/8281A);
- TCLP herbicides (SW-846 1311/8151A); and
- Paint Filter Liquids Test (USEPA SW-846 Method 9095A).

Filter cake generated by these tests will also be collected and retained for use in subsequent S/S testing (described in Section 2.4.9)

2.4.8 Evaluate centrifugation [DQO 4b. (3c) & 4c. (3c)]

Centrifuge tests will be conducted on hydraulically dredged/hydraulically offloaded and mechanically dredged/ hydraulically offloaded dredged material slurry simulations. Example protocols for the laboratory centrifuge test are presented in Appendix 15). Slurry simulations H1S4, H2S3, and H2S4, as well as two slurries with polymers at optimal dose based on preferred dewatering polymer test results, each will be screened using a laboratory centrifuge capable of handling at least 0.5-liter volumes. Polymers to be tested may include reagents such as poly-diallyl-dimethyl ammonium chloride, dimethylamine epichlorohydrin copolymer, polyamines, and/or melamine formaldehyde resins. Polymers to be tested will be selected based on information provided by the reagent vendors and equipment suppliers. Centrate volumes and cake weights will be measured and cake moisture will be determined for comparison to similar results from the filter press tests. Centrate samples will be submitted for analysis of:

- PCB (GEHR Modified Method 8082); and

- TSS (USEPA 160.2, with modifications consistent with ASTM D3977-97, Test Method B – Filtration).

Cake samples will be collected and submitted for analysis of water content (USEPA 160.3). In addition, cake samples resulting from optimal polymer additions will also be analyzed for:

- PCB (GEHR Modified Method 8082); and
- Water content (USEPA 160.3).

A laboratory centrifuge is not sufficient to develop full-scale performance or design conditions; however, centrate residual suspended solids and cake moisture content can be compared to filter press results. If centrifuge test results indicate that centrifuges would be an appropriate technique for dewatering (e.g., preferred over filter presses), then use of centrifuges might be examined further in Intermediate Design and supplemental treatability studies.

2.4.9 Evaluate need for solidification agents on raw slurries and filter cake and evaluate effect of dosage [DQO 4b. (4) & 4c. (4)]

S/S testing will also be conducted on hydraulically dredged and mechanically dredged/hydraulically offloaded slurry simulations. To comply with transportation and disposal facility requirements, processed sediments will have to pass the Paint Filter Liquids Test (USEPA SW-846 Method 9095A) (presented in Appendix 4) to demonstrate that free liquids are not present. S/S evaluations will be conducted on slurries H1S3 and H2S1. Example protocols are presented in Appendix 5. Slurries will be first subject to the paint filter test to evaluate the need to add solidification agents. Slurries that do not pass the paint filter test, or contain obvious free liquids will be subjected to the S/S tests in Section 2.4.1.

In addition, S/S testing will be conducted on filter press cakes from high-volume plate and filter tests on slurries H1S1, H1S4, H2S3, and H2S4 if cake dryness goals (passing paint filter test) are not attained.

The S/S reagents to be tested will be based on information provided by reagent vendors and may include Portland cement, lime, fly ash, and if appropriate, a proprietary reagent. Upon curing for the method-specified period, the samples will be tested to determine if the specific landfill disposal requirements (i.e., free liquid content, RCRA hazardous waste characteristics, and TSCA requirements) can be met. The S/S reagents will be added to aliquots of the slurries or filter cake at 5%, 10%, and 20% doses (by weight). The dosage may be extended if particularly moist material (<40% solids) is encountered.

It is anticipated that landfill physical acceptance requirements will comprise the paint filter test, consolidation (ASTM D2435), and unconfined compressive strength (ASTM D2850). Additionally, processed materials that would be designated for disposal in a Subtitle D landfill facility must not be classified as hazardous waste under RCRA or be subject to TSCA regulations. Therefore, each solidified sediment will be analyzed for paint filter (USEPA SW-846 Method 9095A). In addition, two solidified sediment samples (selected based on the results of the paint filter tests and visual observations) from each slurry simulation will be submitted for laboratory analysis for:

- PCB (GEHR Modified Method 8082);
- PCDD/PCDF (USEPA 1613B);
- TOC (Lloyd Kahn);
- TAL metals (SW-846 Method 6010B/7471A);
- TCLP metals (SW-846 Method 1311/3010A/6010B/7470A);
- TCLP volatiles (SW-846 Method 1311/8260B);
- TCLP semivolatiles (SW-846 Method 1311/3510C/3520C/8270C);
- TCLP pesticides (SW-846 Method 1311/3510C/3520C/8281A);
- TCLP herbicides (SW-846 1311/8151A);
- Unconfined compressive strength (ASTM D2850);
- Consolidation (ASTM D2435);
- pH (USEPA 9040A/9041B/9045C);
- Specific gravity (ASTM D854);
- Atterberg limits (ASTM D4318);
- Grain-size distribution (from Sieve Analysis, ASTM D422);
- Grain-size distribution for finer fraction (from Hydrometer Analysis, ASTM D1140);
- Water content (USEPA 160.3); and
- Visual observations during sample collection.

Some of these analyses may be eliminated based on the sediment and water pre-characterization results.

2.4.10 Evaluate the mixing energy needed to keep slurries in suspension [DQO 4b. (5) & 4c. (5)]

During the implementation of the remedial action, a portion of the dredged material may need to be temporarily stored prior to treatment for equalization purposes. However, dredged material consists of settleable particulates that will either need to be kept in suspension, or solids-removal mechanisms will need to be provided in the storage facilities. Mixers may be used to keep stored solids in suspension until they are removed for treatment. Tests of several mixing configurations and mixer energy inputs are required to confirm design selections. A sequence of several mixing intensities (velocity gradient, G, of 100/second to 800/second) will be applied to 5-gallon samples, with surface and bottom-suspended solids testing to evaluate adequacy of mixing. Intermediate Design mixer selections would be based on solids concentrations at corresponding velocity gradients, particle-size distributions, and specific gravity of solids introduced to storage facilities. Example protocols for the mixing energy study are presented in Appendix 16. To assist in the design, mixing energy tests will be conducted on slurries H1S1, H1S2, H2S1, H2S2, and H2S3, following desanding. Visual observations will be recorded during the tests.

2.5 DQO 5 – Develop the water processing design to meet anticipated discharge requirements

Dredged material slurries contain excess water that will be removed during dewatering operations. Hydraulic dredging typically produces dredged material slurries containing substantially more water than from mechanical dredging. However, in some cases, mechanical dredging can use hydraulic slurrying to transport dredged material from a barge to processing facilities. The applicable water treatment technologies are similar for both dredging methods, but the quantities and composition of separated water may differ considerably. The water treatment step might first combine several water sources, including barge pump outs (from mechanical dredging), thickener overflows, filter press filtrate, site storm waters from treatment and rail loading facilities, and decontamination wash waters. However, the majority of the water to be treated is expected to originate from the carriage water (water entrained in the dredged sediment) in the dredging process. The testing program presented herein will evaluate a range of water treatment situations expected from different dredging locations and techniques.

Components of the water treatment testing will consider chemical treatments for precipitation/flocculation, as well as other treatment tests (sedimentation, filtration, and carbon adsorption).

Several detailed DQOs were identified to address this objective:

5a. Determine the removal efficiency for the water treatment train.

5a. (1) Evaluate treatment and settling of dewatering filtrate.

5a. (2) Demonstrate the removal efficiencies, effluent quality and sensitivity to hydraulic and mass loading of multimedia filters (MMF).

5a. (3) Demonstrate the removal efficiencies, effluent quality and sensitivity to hydraulic and mass loading of carbon adsorption.

The treatability studies activities to address these Level 3 DQOs are described below.

2.5.1 Evaluate treatment and settling of dewatering filtrate [DQO 5a. (1)]

Filtrates from dewatering facilities will likely require further treatment. Precipitation/flocculation and sedimentation facilities may be required to enhance the settling characteristics of the particulate matter remaining in the filtrate. This will be evaluated through the following tests:

- P&F filtrate settling; and
- Column settling tests.

Tests will be conducted on filtrate samples from the high volume filter press runs as outlined below.

P&F Filtrate Settling

P&F filtrate settling tests will be conducted on the filtrate from the high volume filter press runs for slurries H1S1, H1S3, H1S4, H2S1, H2S2, H2S3, and H2S4. These tests will evaluate the performance of precipitating/flocculation polymers. An initial sequence of approximately four polymer types at four dosages will be tested on bench-scale multiple-place mixers (ASTM D2035 - Standard Practice for Coagulation-Flocculation Jar Test of Water) (ASTM, 1997) (presented in Appendix 8). Polymers to be tested will be selected as described in Section 2.4.4. Supernatant samples will be tested for turbidity (USEPA 180.1) and turbidity reduction versus dosage will be calculated using the results. Visual observations will be recorded during sample collection. Results from these tests will be used to establish chemical addition rates (or determine no additions are required) for the column settling tests.

Column Settling Tests

Column settling tests will be performed on the filtrate from the high volume filter press runs for slurries H1S1, H1S3, H1S4, H2S1, H2S2, H2S3, and H2S4. Settling will be performed in 8- or 12-in-diameter columns using procedures described in *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual* (ERDC/EL TR-03-1) (presented in Appendix 10), Appendix B (USACE, 2003). Chemical (polymer) treatment will likely be required in this step, and will be applied based on the results of the above-described P&F filtrate settling tests.

Supernatant samples will be acquired at heights of 2, 4, 6, and 8 feet at settling durations of 0, 1, 2, 4, 8, and 24 hours and analyzed turbidity (USEPA 180.1). These settling times may be adjusted as test experience is gained. The sediment-water interface height will be recorded at these times and quantities of supernatant will be collected for analyses.

Aliquots of supernatant collected at the 6-foot height from the 24-hour duration test will also be analyzed for:

- PCB (GEHR Modified Method 8082);
- PCDD/PCDF (USEPA 1613B);
- TAL metals (USEPA 200.7/245.1); and
- pH (probe measurement).

After completion of the 24-hour settling duration, the settled solids will be resuspended via mixing. The slurry will be allowed to settle for 2 hours and the resulting supernatant will be decanted and used in the filtration testing described in Subsection 2.5.2.

2.5.2 Removal efficiencies, effluent quality and sensitivity to hydraulic and mass loading of MMF [DQO 5a. (2)]

Effluent from dewatering processes may also be treated by MMF. The primary objective of water filtration tests is to determine the PCB and suspended solids that can be expected to be removed following multimedia filtration at typical design loading conditions (2 to 10 gallons per minute per square foot [gpm/ft^2]).

MMF tests will be conducted on effluent from the column settling tests, described in Section 2.5.1 (with and without polymer addition) from slurries H1S1, H1S3, H1S4, H2S1, H2S2, H2S3, and H2S4. Example protocols

for MMF tests are presented in Appendix 17). Each of the settled water samples will be fed to a 4-inch-diameter by 6-foot-high column containing 1.5 to 2 mm anthracite over 0.5 mm filter sand. The filters will be fed at hydraulic loading rates of 2, 6, and 10 (gpm/ ft^2). Samples of influent and effluent will be obtained after filtration of 10 bed volumes (minimum) at each hydraulic loading rate. The filter column will be backwashed to a 2:1 expansion volume after each hydraulically dredged material simulation is fed at the three hydraulic loading rates.

Aliquots of influent and effluent filtered samples will be analyzed for:

- PCB (Modified Green Bay Mass Balance Method);
- TSS (USEPA 160.2, with modifications consistent with ASTM D3977-97, Test Method B – Filtration);
- Turbidity (USEPA 180.1);
- BOD_5 (USEPA 405.1);
- COD (USEPA 410.4)
- TOC (Lloyd Kahn);
- pH (probe measurement);
- DO (probe measurement);
- TAL metals (USEPA 200.7/245.1);
- PCDD/PCDF (USEPA 1613B);
- Total P/PO_4 (USEPA 365.2);
- PAH (SW-846 Method 8270C/3510C);
- $NH_3/TKN/NO_2/NO_3$ (USEPA 350.3/354.1/351.3, Standard Method 418A); and
- Visual observations during sample collection.

The effluent from each of the MMF tests will be retained for use in the carbon adsorption tests described below.

2.5.3 Removal efficiencies, effluent quality, and sensitivity to hydraulic and mass loading of carbon adsorption [DQO 5a. (3)]

It is anticipated that most of the aqueous-phase PCBs will be associated with suspended solids, and thus removed by the sedimentation and filtration processes. However, carbon adsorption may be needed to achieve effluent PCB discharge criteria that are yet to be established for this project. The primary objective of carbon adsorption tests is to determine the PCB removal efficiency and loading capacity that can be expected following

carbon adsorption at typical design loading conditions. The tests will also be used to determine influent limits to design pretreatment. Design loadings in the range of 20 to 40 minutes of empty-bed contact time (EBCT) are common for PCB removal.

The following series of treatability tests will be performed to address this DQO:

- Rapid small-scale column tests (RSSCTs) (Appendix 18); and
- Pilot column adsorption tests (Appendix 19).

Tests will be conducted using filtrate samples from the MMF columns as outlined below.

RSSCTs

Pilot carbon adsorption systems are typically run to exhaustion to determine adsorption capacity and to observe the breakthrough profiles of various organics. It is expected that run lengths of several months to one year or more may occur before breakthrough with low PCB loadings (OBG, 1982). Instead of performing such time-consuming tests, carbon RSSCTs will be used to estimate carbon consumption rates and removal efficiencies. RSSCTs will be used to compare the performance of various carbon sources and the influences of waters from different dredging environments. RSSCTs will be conducted using filtrate samples from the MMF columns from slurry H1S1, H1S3, H1S4, H2S1, H2S2, H2S3, and H2S4 runs. Example RSSCT protocols are presented in Appendix 18. Medias to be tested will be based on past experience and data, including adsorption isotherms, provided by the vendors. If this data is not available, adsorption isotherms may have to be developed to select carbons to be tested.

Effluent water will be collected at six points during the course of each RSSCT (to be determined upon consultation with treatability test vendors), and will be analyzed for:

- PCB (GEHR Modified Method 8082); and
- TOC (Lloyd Kahn).

Carbon Column Tests

Carbon column (granulated activated carbon [GAC]) tests will be used to further evaluate carbon consumption rates and removal efficiency. Example carbon column text protocols are presented in Appendix 19. Filtrates from the MMF columns from slurry H1S1, H1S3, H1S4, H2S1, H2S2, H2S3, and H2S4 runs will be fed to two carbon columns, arranged in series. The carbon columns will be fed at EBCT of 60, 20, and 12 minutes, corresponding to the upstream MMF loading rates of 2, 6, and 10 gpm/ft^2, respectively. The second carbon column in series will represent EBCT of 120, 40, and 24 minutes, respectively. Samples of the mid-point (i.e., effluent from the first column) and end-point effluent will be obtained after feeding 10 bed volumes (minimum) at each hydraulic loading rate. The carbon columns will be backwashed after each hydraulically dredged material simulation feed at the three specified loading rates.

Influent and effluent water from the pilot carbon column tests will be analyzed for:

- PCB (Modified Green Bay Mass Balance Method);
- TSS (USEPA 160.2, with modifications consistent with ASTM D3977-97, Test Method B – Filtration);
- Turbidity (USEPA 180.1);
- BOD_5 (USEPA 405.1);
- COD (USEPA 410.4)
- TOC (Lloyd Kahn);
- pH (probe measurement);
- DO (probe measurement);
- TAL metals (USEPA 200.7/245.1);
- PCDD/PCDF (USEPA 1613B);
- Total P/PO_4 (USEPA 365.2);
- PAH (SW-846 Method 8270C/3510C);
- $NH_3/TKN/NO_2/NO_3$ (USEPA 350.3/354.1/351.3, Standard Method 418A); and
- Visual observations during sample collection.

2.6 DQO 6 – Develop the disposal design to meet anticipated landfill acceptance requirements

Disposal of processed material in one or more licensed commercial landfills will require compliance with several requirements. Unless specifically exempted by permit modification, landfills cannot accept materials

containing free liquids. In addition, Subtitle D facilities (i.e., "nonhazardous" landfills) generally cannot accept solid wastes that are determined to have RCRA hazardous waste characteristics or that are subject to TSCA regulation.

One detailed DQO was identified to address this objective:

6a. Determine the potential for water to be released from processed material during transport.

The treatability studies activities to address this Level 2 DQO are described below.

2.6.1 Potential for water to be released from processed material during transport [DQO 6a.]

Handling, storing, and transporting processed (i.e., dewatered and/or stabilized) materials via rail and/or barge may have the undesirable effect of liberating free liquids, which would require additional treatment at the landfill prior to acceptance of the material for disposal. Shake/vibration testing of processed sediments will be performed to discern if free liquids could be liberated from the materials as a result of handling and transportation. Storage/transportation stability shaker tests will be performed on the raw slurries (M1 and H1 series) and filter cakes (H2 series) from slurries M1S1, M1S2, M1S3, M1S4, H1S1, H1S3, H1S4, H2S1, H2S3, and H2S4 after these slurries/filter cakes have been stabilized via S/S testing (if necessary, as described in Sections 2.4.1 and 2.4.9). Example storage/transport test protocols are presented in Appendix 20, and example S/S test protocols are presented in Appendix 5. Following this testing, samples will be subject to the paint filter test (SW-846 Method 9095A) to determine their potential acceptability at a disposal facility. Visual observations will be recorded during sample collection. Unaffected samples and samples that have layering will have solids analyzed for:

- Consolidation measured in cm^2/s and kPa (ASTM D2435, Appendix 21);
- Specific gravity (ASTM D854); and
- Atterberg limits (ASTM D4318).

3. Project Management

This section describes project management roles for the treatability studies activities, organized into the following sub-sections:

- Project management organization;
- Project execution tasks; and
- QA/QC Program.

3.1 Project Management Organization

GE will have overall responsibility for the management of the treatability studies. BBL will have technical responsibility for completing the treatability studies. It is anticipated that BBL will also be responsible for managing data collection efforts under the treatability studies. Specific project roles and responsibilities for key project personnel are anticipated to include:

- Treatability Studies Manager – directly responsible for all treatability studies activities performed by the respective personnel and subcontractors.

- QA Program Manager – will oversee all QA aspects of the project.

- Treatability Site Coordinator – responsible for day-to-day supervision of all field and treatability testing laboratory activities conducted as part of the treatability studies program.

- Health and Safety Coordinator – responsible for enforcing the Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910.120) regarding health and safety concerns.

- Treatability Lab Managers(s) – will oversee all subcontractor lab(s) activities conducted as part of the treatability studies program.

3.2 Project Execution Tasks

This sub-section presents the project execution tasks that will be necessary for the successful completion of the treatability studies.

3.2.1 Task 1 - Identification, Pre-qualification, and Contracting

A critical first task will be the identification of qualified sediment and water sample collection contractors, appropriately licensed sample shipping companies, experienced and properly equipped treatability test laboratories, and qualified analytical laboratories. Treatability testing of sediments and dredged material is a relatively specialized expertise, and the number of qualified contractors is expected to be limited. Initial efforts have already been initiated to identify these contractors, and existing relationships with sample collection, processing and analytical laboratories can be utilized; however, appropriate time will be required to ensure properly qualified contractors for the treatability tests. The labs must be able to meet the requirement of TSCA to receive and test TSCA regulated samples. In addition, it is critical for the treatability testing laboratories to secure the necessary regulatory approvals (e.g., under TSCA) to perform the tests with the quantities of sediment and water described in this TS Work Plan.

The SOPs provided with this work plan are standard methods from the literature or project-specific procedures developed for this TS Work Plan. To ensure that the full capabilities and experience of all parties is incorporated into this effort, revised SOPs maybe provided by the contracted analytical and treatability laboratories prior to initiation of field work.

3.2.2 Task 2 - Collection of Sediment and Water Samples

The treatability testing program will be performed on the representative sediment and water samples described in Section 2. These samples will be collected by a contractor who will mobilize the appropriate equipment (e.g., vibracore platform, support boats, sample containers) to the site and collect the relatively large quantities of sediment and water samples necessary for the treatability tests. Individual core samples will be collected and transported to a central processing facility for visual inspection and compositing into the four representative sediment samples. At this time, it is anticipated that water samples will be collected during several sampling events, to provide water for treatability tests on an as-needed basis and to avoid long-term storage of large quantities of water.

3.2.3 Task 3 - Processing of Sediment and Water Samples

The individual core samples will be composited to form the four representative sediment samples. The composite samples will be aliquoted into appropriate quantities for shipment initially to the selected analytical laboratory for pre-characterization chemical and physical analyses, and in subsequent steps for shipment to the treatability testing laboratories for test execution. Appropriate storage, chain-of-custody, and manifesting procedures will be followed so sample integrity remains intact and all appropriate permitting requirements are met, including final disposal of treatability test residuals.

3.2.4 Task 4 - Treatability Testing

The TS Work Plan identifies over 120 individual treatability tests to be performed on one or more sediment or water samples. At this time, it is not certain whether all of these tests can be performed by a single contractor or at a central facility. Additionally, several treatability tests are executed in sequence, where the product of one test is used as the input for a subsequent test. Careful management of the shipment of sediment and water samples from the central processing facility to the treatability test vendors and coordination of the subsequent shipment of test residuals from one laboratory to the next (if required) will be critical to the timely and successful completion of the treatability tests. The specific details regarding sample custody, transport/ shipment, and other coordination requirements will be developed once the treatability testing contracting is completed.

3.2.5 Task 5 - Analysis of Treatability Test Residuals

The residuals (e.g., supernatants, filtrates, settled solids, stabilized dredged material) from the treatability tests will be subsampled as appropriate and shipped to the appropriate analytical laboratory for chemical and physical analysis of the identified critical parameters. Proper chain-of-custody, sample packing, and shipment procedures will be required to preserve the integrity of the testing results. It is anticipated that individual treatability testing laboratories will be responsible, under the direct supervision of the Treatability Site Coordinator, for the preparation and shipment of the samples for analysis. The protocols for chain-of-custody, packaging, and shipping are expected to be consistent with the SSAP protocols.

3.2.6 Task 6 - Analytical Data Verification

As with the analytical data collected under the SSAP and SEDC programs, the analytical results will be subjected to a verification process to ensure the data meets the project data quality requirements. Verified data sets will then be provided to GE and the design team. The details of the QA/QC Program for the treatability studies are contained in Section 3.3

3.2.7 Task 7- Evaluation of Treatability Test Results

The final step in the execution of the Treatability Studies will be the compilation of the operational and analytical data produced during each test. Operating conditions, visual observations, deviations from SOPs, and other relevant information will be integrated with the associated analytical results into the text, tables, and figures necessary to support their use in the Intermediate Design Reports. At this time, it is anticipated that the results of the individual treatability tests will be presented in the Phase 1 and Phase 2 Intermediate Design Reports (as relevant).

3.3 QA/QC Program

The SSAP and BMP QAPPs presents the project management structure and protocols for data acquisition, assessment and oversight, and data validation and usability, as they pertain to their respective program. The treatability studies program will be conducted in general conformance with the QA/QC protocols presented in the SSAP QAPP and the BMP QAPP, but modified consistent with the standards of practice for dredged material treatability test programs outlined below.

Decontamination Procedures: The treatability studies program will generally follow the decontamination protocols presented in Section B2.4.2 of the SSAP and BMP QAPPs, except for the plate and frame and MMF test apparatus. Decontamination procedures for the plate and frame and carbon column test apparatus are presented in Appendix 22 – SOP for Decontamination Procedures.

The treatability studies decontamination procedures may be further modified under the following circumstances:

- Input from the treatability studies subcontractors indicates that the above procedures are not practicable, or not necessary to achieve project DQOs.

- The results of QA samples (i.e., rinse blanks) indicate that QA requirements are not being met to achieve project DQOs and that further decontamination is necessary.

Sample Handling and Custody Procedures: The treatability studies program includes collection and composition and/or aliquoting of sediment and water samples, sample processing and preparation of slurry simulations, transfer of samples/slurry simulations to one or more treatability studies laboratories for testing, and submission of sediment, water, and treatment residual samples for laboratory analysis. The sample handling and custody protocols to be followed during these activities are presented in Appendix 23 – SOP for Sample Handling and Custody Requirements. These protocols generally follow the procedures outlined in the SSAP and BMP QAPPs.

Analytical Procedures: The analytical procedures to be followed during the treatability studies testing are listed in Table 3. Chemical and physical parameters, analytical methods, as well as anticipated target detection and reporting limits are presented in Table 7. Sample containers, preservation, and holding times are presented in Table 8. The analytical procedures generally follow the procedures outlined in the SSAP and BMP QAPPs, as supplemented by the analytical method SOPs provided with this TS Work Plan.

QA/QC Samples: QA/QC samples, including duplicate samples and matrix spike/matrix spike duplicates, field blanks, temperature blanks, and rinse blanks, will be collected during the treatability studies program and will be used to assess the technical usability of the treatability studies data. Each category of QA/QC samples, except for the rinse blank samples, will be collected at a frequency of 1 per 20 samples or 1 sample per batch (which ever is greater), or at a lesser frequency as required by the analytical method. A "batch" is defined as one run of one treatability test, or one day of baseline sample collection for each type of media sampled. One rinse blank sample will be collected for each batch using decontaminated equipment. Estimated numbers of QA/QC samples are presented in Table 9.

Additional QA/QC samples, such as control and replicate samples, will be collected as part of the treatability tests. It is anticipated that, in general, one control sample will be included with each treatability study batch and that replicates will be collected at a frequency of 1 per 10 samples. The QA/QC sample collection requirements for each individual treatability test will be developed with input from the treatability studies laboratory(ies) and will be specified in the SOP for the test.

Data Management Plan: A data management system will be implemented during the treatability testing program so that all of the necessary data are accurate and readily accessible to meet the analytical and reporting objectives of the project. The treatability studies data management plan has five elements: 1) sample designation system, 2) field activities, 3) sample tracking and management, 4) data management system, and 5) document control and inventory, which are described in Appendix 24 – Data Management Plan.

Data Verification and Validation: Field data, as well as observations and results from the treatability studies laboratory(ies), will be evaluated in general conformance with the procedures presented in Section D2.1.1 of the SSAP QAPP. These procedures are performed to validate measurements and various quality control analyses were properly performed and documented. The data documented include data generated during measurement of field parameters, observations, results of any quality control sample analyses, and field instrument calibrations.

Data validation will assess the technical usability of the analytical data for making decisions pertaining to satisfying the project objectives outlined in Section 2. The treatability studies data validation program will not employ a PE or electronic validation system. Full data validation will be performed on 10% of the analytical results for the treatability study testing using guidance from the Region II, Standard Operating Procedures for the Validation of Organic and Inorganic Data Acquired Using SW-846 Method (various SOPs and issue dates), "*US EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*," (October 1999), and the "*US EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*," (February 1994). Data validation will be performed on additional results as deemed necessary based on the initial 10% validation.

These protocols generally follow the procedures outlined in the SSAP and BMP QAPPs.

Field Audits: The appropriate Treatability Site Coordinator will monitor field performance. Field performance audit summaries will contain an evaluation of field activities to verify that activities are performed according to established protocols. The QA Program Manager will review field reports and communicate concerns to the Treatability Studies Manager and/or Treatability Site Coordinator, as appropriate. In addition, the QA Program Manager will review the rinse and trip blank data to identify potential deficiencies in field sampling and cleaning procedures. In addition, systems audits comparing scheduled QA/QC activities from this document with actual QA/QC activities completed will be performed. The Treatability Studies Manager and QA Program Manager will periodically confirm that work is being performed consistent with this TS Work Plan. These

protocols generally follow the procedures outlined in the SSAP QAPP, and will use checklists similar to those employed during this program.

Treatability Laboratory Audits: The QA Program Manager will review the rinse and trip blank data generated by treatability testing activities to identify potential deficiencies in treatability testing and cleaning procedures. Systems audits will be performed comparing scheduled QA/QC activities from this document with actual QA/QC activities completed.

In addition, one audit of each treatability study laboratory used during the treatability studies program will be conducted by BBL auditors to document the quality of the treatability studies procedures and to verify that the procedures as described in the work plan and SOPs are being followed by the treatability studies laboratory(ies). The treatability studies laboratory audits will be conducted in general conformance with the protocols outlined in Appendix 31 of the SSAP QAPP, using checklists developed with input from the treatability studies laboratory(ies). Additional audits may be performed during the course of the project, as deemed necessary.

Analytical Laboratory Audits: Analytical laboratory audits are not planned during the course of the treatability studies program. BBL reserves the right to conduct an onsite audit of the laboratory prior to the start of analyses for the project. Additional audits may be performed during the course of the project, as deemed necessary.

4. Documentation, Reporting, and Schedule

4.1 Documentation and Records

A centralized filing system will be established for documents (new forms/logs generated for this TS Work Plan) that document the sampling and analysis activities described in this TS Work Plan. GE and its various consultants/contractors are custodians of, and will maintain, the contents of centralized files for the treatability study activities, including all relevant records, correspondence, reports, logs, data, field reports, field logs, pictures, video, subcontractor reports, analytical data, and data reviews. This information will be made available to the USEPA upon request.

4.2 Proposals for Supplemental Work

If the need for supplemental investigation work to support the treatability studies proposed in this Work Plan is identified (based on review of existing or ongoing investigations), such activities will be proposed as addenda to this TS Work Plan. The need for any supplemental treatability studies will be determined during the Intermediate Design for each phase of the dredging project and the scope of recommended supplemental studies will be described in the Intermediate Design Report for that phase, along with a proposal for such supplemental studies if warranted.

4.3 Treatability Studies Reporting

The results (description of the test runs and associated analytical data) of the treatability studies will be presented in the Phase 1 and Phase 2 Intermediate Design Reports, as appropriate. The Intermediate Design Reports will present the results of the activities and analyses described in Section 2. As described in the RD Work Plan (BBL, 2003a), the results of the treatability studies will be used throughout the design process. If supplemental treatability studies are proposed in the Intermediate Design Report for Phase 1 or Phase 2, their results will be presented and utilized in the Final Design Report for such phase.

4.4 Schedule for Treatability Studies Activities

The schedule for the treatability studies program is presented in Table 10, below.

Table 10 – Schedule for Deliverables/Approvals for Treatability Studies

Activity	Date/Deadline
Submit draft TS Work Plan to the USEPA	Document received.
Submit final TS Work Plan to the USEPA	Document received.
Initiate identification and pre-qualification of sampling, transportation, analytical, and treatability test contractors	Complete by February 15, 2004.
Execute contracts with sampling, transport, analytical, and treatability test contractors	Within 30 days from USEPA approval of the TS Work Plan.
Initiate field sampling work (commencement of treatability studies)	7 days from execution of sampling contract(s) or receipt of any necessary regulatory approvals for the treatability tests, whichever is later – contingent on weather and seasonal constraints allowing safe performance of the field sampling. An attempt should be made to safely take advantage of typical low-water window between ice-out and spring flood (typically in late March/early April).
Complete field sampling work	15 days from initiation of field work.
Complete pre-treatment characterization	15 days from completion of sediment and water sample collection.
Deliver samples to treatability test contractor(s)	7 days from receipt of acceptable pre-treatment characterization analyses.
Complete treatability studies	90 days from treatability test contractor(s)' receipt of samples for the final treatability tests.
Report results of the treatability studies to USEPA	Part of Intermediate Design Reports for Phase 1 (for results affecting Phase 1 of project) and Phase 2 (for results affecting Phase 2 of project).
Perform and report on supplemental treatability studies (if necessary)	Per schedule relating to treatability studies in Intermediate Design Report for Phase 1 and/or Phase 2 (as relevant), as approved or modified by USEPA.

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Tables

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Treatability Studies Work Plan

Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
1. Collect baseline sediment and water data for use in the treatability studies.	1a. Determine baseline solid phase chemical and physical properties.			Collect sediment samples from a range of representative sediment environments (sediment environment designations: S1, S2, S3, and S4) and analyze each sample for: • PCB measured in μg/kg (GEHR Modified Method 8082); • PAH measured in mg/kg (SW-846 8270C); • TOC measured in mg/kg (Lloyd Kahn); • TAL metals measured in mg/kg (SW-846 Method 6010B/7471A); • PCDD/PCDF measured in μg/kg (USEPA 1613B); • Total P/PO_4 measured in mg/kg (USEPA 365.2); • NH_3/TKN measured in mg/kg (USEPA 350.3/351.3); • Bulk density (ASTM D4531-86, modified); • Water content measured in % (USEPA 160.3); • Grain-size distribution measured in mm (from Sieve Analysis, ASTM D422); • Grain-size distribution for finer fraction in mm (from Hydrometer Analysis, ASTM D1140; and • Visual observations during sample collection.	• *Data Summary Reports* • SEDC activities • Treatability studies
	1b. Determine baseline aqueous phase chemical and physical properties.			Collect water samples from a representative location and analyze each sample for: • PCB (WT) measured in μg/L (Modified Green Bay Mass Balance Method); • TSS (WT) measured in mg/L (USEPA 160.2); • Turbidity (WT) measured in NTU (USEPA 180.1); • TOC (WT, WF) measured in mg/L (Lloyd Kahn); • Field pH (WT) measured in SU (probe measurement); • Field DO (WT) measured in mg/L (probe measurement); • TAL metals (WT) measured in mg/L (USEPA 200.7/245.1); • PCDD/PCDF (WT) measured in ng/L (USEPA 1613B); and • Visual observations during sample collection.	• Baseline monitoring activities • Treatability studies

See notes on pages 17 and 18.

Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
2. Develop sediment-water slurries that have properties similar to those expected of dredged material.	2a. Develop sediment-water slurry that has properties similar to mechanical dredging and mechanical offloading (80:20 volumetric proportions).			Step 1: Prepare sediment and water mixtures to simulate mechanical dredging slurry from a range of sediment environments (slurry designations: M1S1, M1S2, M1S3, and M1S4). Analyze the slurries for: • Water content measured in % (USEPA 160.3). Step 2: Prepare a mass balance to determine physical and chemical properties of the slurries.	• Treatability studies
	2b. Develop sediment-water slurry that has properties similar to mechanical dredging and hydraulic offloading (25:75 weight proportions).			Step 1: Prepare sediment and water mixtures to simulate hydraulic rehandling slurry of mechanically dredged material from a range of sediment environments (slurry designations: H1S1, H1S2, H1S3, and H1S4). Analyze the slurries for: • Water content measured in % (USEPA 160.3). Step 2: Prepare a mass balance to determine physical and chemical properties of the slurries.	• Treatability studies
	2c. Develop sediment-water slurry that has properties similar to hydraulic dredging and hydraulic offloading (5:95 weight proportions).			Step 1: Prepare sediment and water mixtures to simulate hydraulic dredging slurry from a range of sediment environments that is hydraulically offloaded (slurry designations: H2S1, H2S2, H2S3, and H2S4). Analyze the slurries for: • Water content measured in % (USEPA 160.3). Step 2: Prepare a mass balance to determine physical and chemical properties of the slurries.	• Treatability studies
3. Determine the potential for water quality impacts caused by dredging.	3a. Determine the required removal efficiencies of resuspension controls.	3a. (1) Determine an estimate of PCB release (dissolved phase and suspended particulate fraction) to the water column from the dredge head.		Perform the DRET on a sediment sample from the S1, S2, S3, and S4 sediment environments. Analyze each water sample for: • PCB (WT, WF) measured in ng/L (Modified Green Bay Mass Balance Method); • TSS (WT) measured in mg/L (USEPA 160.2); • Turbidity (WT) measured in NTU (USEPA 180.1); • TOC (WT, WF) measured in mg/L (Lloyd Kahn); • pH (WT) measured in SU (probe measurement);	• Baseline monitoring activities • Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				• DO (WT) measured in mg/L (probe measurement); and • Visual observations during sample collection. Analyze suspended particulate fraction for: • PCB measured in μg/kg (GEHR Modified Method 8082).	
		3a. (2) Determine an estimate of release of non-PCB constituents (dissolved phase and suspended particulate fraction) to the water column from the dredge head.		Perform the DRET on a sediment sample from the S1, S2, S3, and S4 sediment environments. Analyze each water sample for: • TAL metals (WT, WF) measured in mg/L (USEPA 200.7/245.1); • Calcium and Magnesium (WT, WF) measured in mg/L (USEPA 200.7); • pH (WT) measured in SU (probe measurement); • DO (WT) measured in mg/L (probe measurement); • Visual observations during sample collection; • TSS (WT) measured in mg/L (USEPA 160.2); and • Turbidity (WT) measured in NTU (USEPA 180.1).	• Treatability studies
4. Develop the sediment dewatering design to meet anticipated landfill acceptance or BUD requirements.	4a. Develop the sediment processing design for mechanically dredged/mechanically offloaded sediment.	4a. (1) Evaluate need for solidification agents and effect of dosage.		Step 1: Perform paint filter tests on slurries M1S1, M1S2, M1S3, and M1S4. • Paint filter measured in free liquids (SW-846 Method 9095A). Step 2: Perform S/S testing on slurries M1S1, M1S2, M1S3, and M1S4 (paint filter test failures only). Analyze the S/S test for: • Paint filter measured in free liquids (SW-846 Method 9095A). Two S/S test samples from each slurry that pass the paint filter test will then be analyzed for: • PCB measured in μg/kg (GEHR Modified Method 8082); • TAL metals measured in mg/kg (SW-846 Method 6010B/7471A); • TCLP metals measured in mg/L (SW-846 Method 1311/3010A/6010B/7470A); • TCLP volatiles measured in mg/L (SW-846 Method	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				1311/8260B); • TCLP semivolatiles measured in mg/L (SW-846 Method 1311/3510C/3520C/8270C); • TCLP pesticides measured in mg/L (SW-846 Method 1311/3510C/3520C/8281A); • TCLP herbicides measured in mg/L (SW-846 1311/8151A); • pH measured in SU (USEPA 9040A/ 9041B/9045C); • PCDD/PCDF measured in μg/kg (USEPA 1613B); • TOC measured in mg/kg (Lloyd Kahn); • Unconfined compressive strength measured in psf (ASTM D2850); • Consolidation measured in kPa and cm/s^2 (ASTM D2435); • Grain-size distribution measured in mm (from Sieve Analysis, ASTM D422); • Grain-size distribution for finer fraction in mm (from Hydrometer Analysis, ASTM D1140; • Specific gravity (ASTM D854); • Atterberg limits measured in % (ASTM D4318); • Water content measured in % (USEPA 160.3); and • Visual observations during sample collection.	
	4b. Develop the sediment processing design for mechanically dredged/hydraulically offloaded sediment.	4b. (1) Evaluate size separation.	4b. (1a) Evaluate size separation technologies (based on particle size and density distribution) and evaluate the chemical properties of the separated solid fractions.	Perform size and density testing on slurries H1S1 and H1S2. Analyze each separated solid fraction from the size and density tests for: • PCB measured in ug/kg (GEHR Modified Method 8082); • pH measured in SU (USEPA 9040A/ 9041B/9045C); • TAL metals measured in mg/kg (SW-846 Method 6010B/7471A); • TOC measured in mg/kg (Lloyd Kahn); • Grain-size distribution measured in mm (from Sieve Analysis, ASTM D422); • Grain-size distribution for finer fraction in mm (from Hydrometer Analysis, ASTM D1140); • Specific gravity (ASTM D854); and • Atterberg limits measured in % (ASTM D4318).	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
			4b. (1b) Evaluate the drainage characteristics of the coarse fraction.	Perform the drainage study on slurry H1S1 and H1S2 (coarse fraction from the size and density tests under 4b(1a)). Analyze samples from the drainage study for: • Water content measured in % (USEPA 160.3).	• Treatability studies
		4b. (2) Determine primary sedimentation efficiency for removal of regulated chemicals bound to the particulate phase.	4b. (2a) Evaluate the effects of polymer treatment on solids removal.	Perform chemical treatment jar tests on slurries H1S2 and H1S3 using: • Standard Practice for Coagulation-Flocculation Jar Test measured in mg/L (ASTM D2035) (WT, WF). Analyze supernatant samples for: • Turbidity (WT) measured in NTU (USEPA 180.1); and • Visual observations during sample collection.	• Treatability studies
			4b. (2b) Evaluate the effects of primary settling on solids removal.	Perform primary sedimentation tests on slurries H1S2, H1S3 (following addition of preferred polymer from chemical treatment jar tests under 4b(2a), if necessary. One test will be performed on each slurry without the addition of polymers. Analyze solid fraction samples for: • PCB measured in μg/kg (GEHR Modified Method 8082); • Water content measured in % (USEPA 160.3); • TOC measured in mg/kg (Lloyd Kahn); and • Visual observations of drainage characteristics. Analyze supernatant samples for: • PCB (WT, WF) measured in μg/L (GEHR Modified Method 8082); • TSS (WT) measured in mg/L (USEPA 160.2); and • Visual observations during sample collection. Analyze floatable oil samples (if observed) for: • PCB (WT) measured in μg/L (GEHR Modified Method 8082).	• Treatability studies
		4b. (3) Quantify plate and frame filter press size and performance.	4b. (3a) Determine efficiency of filter press for dewatering raw slurries and	Step 1: Perform dewatering polymer screening tests on raw slurries H1S1, H1S3, and H1S4 using: • Buchner funnel tests. Measure and plot 1-min filtrate volume vs. dosage in mg/L; and	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
			settled solids: • Evaluate dewatering polymers. • Evaluate mixing/ floc sensitivity to mixing or shear. • Evaluate cake release.	• Bench scale filter press tests. Measure and plot 1-min filtrate volume vs. dosage in mg/L. Analyze filter cake samples from the dewatering polymer screening tests for: • Water content measured in % (USEPA 160.3). Step 2: Perform preferred polymer confirmation tests on raw slurry H1S2 and filtrate cake sample H1S3 using: • Buchner funnel tests. Measure and plot 1-min filtrate volume vs. dosage in mg/L; and • Bench scale filter press tests Measure and plot 1-min filtrate volume vs. dosage in mg/L. Analyze filter cake samples from the preferred polymer confirmation tests for: • Water content measured in % (USEPA 160.3). Step 3: Perform a mixing sub-study on slurry H1S3 using: • Buchner funnel tests. Measure and plot 1-min filtrate volume vs. dosage in mg/L. Analyze filter cake samples from the mixing sub-study for: • Water content measured in % (USEPA 160.3). Step 4: Perform a cake release screening study on slurries H1S2 and H1S3 using: • Pocket-leaf filter unit (record visual observations).	
			4b. (3b) Optimize hydraulic and mass loading to plate and frame filter presses.	Step 1: Perform plate and frame filter press tests on slurries H1S2 (desanded) and H1S3. Analyze filtrate samples for: • PCB (WT) measured in μg/L (GEHR Modified Method 8082); and • TSS (WT) measured in mg/L (USEPA 160.2). Analyze filter cake samples for: • Water content measured in % (USEPA 160.3); and • Paint filter measured in free liquids (SW-846 Method 9095A).	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				Step 2: Perform cake solids vs. time sub-study on slurry H1S3. Analyze filter cake samples for: • Water content measured in % (USEPA 160.3); and • Paint filter measured in free liquids (SW-846 Method 9095A). Step 3: Perform high-volume filter press runs on slurries H1S1, H1S3, and H1S4, using optimal polymer dosage and press run conditions. Analyze filtrate samples for: • PCB (WT, WF) measured in μg/L (GEHR Modified Method 8082); • TSS (WT) measured in mg/L (USEPA 160.2); • Turbidity (WT) measured in NTU (USEPA 180.1); • TOC (WT, WF) measured in mg/L (Lloyd Kahn); • pH (WT) measured in SU (probe measurement); and • Visual observations during sample collection. Analyze filter cake samples for: • PCB measured in μg/kg (GEHR Modified Method 8082); • TAL metals measured in mg/kg (SW-846 Method 6010B/7471A); • PCDD/PCDF measured in μg/kg (USEPA 1613B); • TCLP metals measured in mg/L (SW-846 Method 1311/3010A/6010B/7470A); • TCLP volatiles measured in mg/L (SW-846 Method 1311/8260B); • TCLP semivolatiles measured in mg/L (SW-846 Method 1311/3510C/3520C/8270C); • TCLP pesticides measured in mg/L (SW-846 Method 1311/3510C/3520C/8281A); • TCLP herbicides measured in mg/L (SW-846 1311/8151A); and • Paint filter measured in free liquids (SW-846 Method 9095A).	

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
			4b. (3c) Evaluate centrifugation.	Perform laboratory centrifuge tests on slurry H1S4. Analyze centrate for: • PCB (WT) measured in μg/L (GEHR Modified Method 8082); and • TSS (WT) measured in mg/L (USEPA 160.2). Measure solid fraction volume and analyze samples for: • PCB measured in μg/kg (GEHR Modified Method 8082); and • Water content measured in % (USEPA 160.3).	• Treatability studies
		4b. (4) Evaluate need for solidification agents on raw slurries and filter cake and evaluate effect of dosage.		Step 1: Perform paint filter tests on raw slurry H1S3 and on slurries H1S1 and H1S4 (cake solids from high-volume plate and filter press tests under 4b(3b)). • Paint filter measured in free liquids (SW-846 Method 9095A). Step 2: Perform S/S testing on the above slurries (paint filter test failures only). Analyze the S/S test for: • Paint filter measured in free liquids (SW-846 Method 9095A). Two S/S test samples from each slurry that pass the paint filter test will then be analyzed for: • PCB measured in μg/kg (GEHR Modified Method 8082); • PCDD/PCDF measured in μg/kg (USEPA 1613B); • TOC measured in mg/kg (Lloyd Kahn); • TAL metals measured in mg/kg (SW-846 Method 6010B/7471A); • TCLP metals measured in mg/L (SW-846 Method 1311/3010A/6010B/7470A); • TCLP volatiles measured in mg/L (SW-846 Method 1311/8260B); • TCLP semivolatiles measured in mg/L (SW-846 Method 1311/3510C/3520C/8270C); • TCLP pesticides measured in mg/L (SW-846 Method 1311/3510C/3520C/8281A);	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				• TCLP herbicides measured in mg/L (SW-846 1311/8151A); • Unconfined compressive strength measured in psf (ASTM D2850); • Consolidation measured in kPa and cm/s^2 (ASTM D2435); • pH measured in SU (USEPA 9040A/ 9041B/9045C); • Grain-size distribution measured in mm (from Sieve Analysis, ASTM D422); • Grain-size distribution for finer fraction in mm (from Hydrometer Analysis, ASTM D1140; • Specific gravity (ASTM D854); • Atterberg limits measured in % (ASTM D4318); • Water content measured in % (USEPA 160.3); and • Visual observations during sample collection.	
		4b. (5) Determine the mixing energy needed to keep slurries in suspension.		Perform mixing energy tests on slurries H1S1 and H1S2. • Record visual observations during test.	• Treatability studies
	4c. Develop the sediment processing design for hydraulically dredged and transported sediment.	4c. (1) Evaluate size separation.	4c. (1a) Evaluate size separation technologies (based on particle size and density distribution) and evaluate the chemical properties of the separated solid fractions.	Perform size and density testing on slurries H2S1 and H2S2. Analyze each separated solid fraction from the size and density tests for: • PCB measured in μg/kg (GEHR Modified Method 8082); • pH measured in SU (USEPA 9040A/ 9041B/9045C); • TAL metals measured in mg/kg (SW-846 Method 6010B/7471A); • Grain-size distribution measured in mm (from Sieve Analysis, ASTM D422); • Grain-size distribution for finer fraction in mm (from Hydrometer Analysis, ASTM D1140); • Specific gravity (ASTM D854); and • Atterberg limits measured in % (ASTM D4318).	• Treatability studies
			4c. (1b) Evaluate the drainage characteristics of the coarse fraction	Perform a drainage study on slurry H2S1 and H2S2 (coarse fraction from the size and density tests under 4c(1a)).	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				Analyze samples from the drainage study for: • Water content measured in % (USEPA 160.3).	
		4c. (2) Determine primary sedimentation efficiency for removal of regulated chemicals bound to the particulate phase.	4c. (2a) Evaluate the effect of polymer treatment on solids removal.	Perform chemical treatment jar tests on slurries H2S1, H2S2, and H2S3 using: • Standard Practice for Coagulation-Flocculation Jar Test measured in mg/L (ASTM D2035) (WT, WF). Analyze supernatant samples for: • Turbidity (WT) measured in NTU (USEPA 180.1); and • Visual observations during sample collection.	• Treatability studies
			4c. (2b) Evaluate the effects of primary settling on solids removal.	Perform primary sedimentation tests on slurry H2S2 (desanded), H2S3 and H2S4 (following addition of preferred polymer from chemical treatment jar tests, if necessary. One test will be performed on each slurry without the addition of polymers). Analyze solid fraction samples for: • PCB measured in μg/kg (GEHR Modified Method 8082); • Water content measured in % (USEPA 160.3); • TOC measured in mg/kg (Lloyd Kahn); and • Visual observations of drainage characteristics. Analyze supernatant samples for: • PCB (WT, WF) measured in μg/L (GEHR Modified Method 8082); • TSS (WT) measured in mg/L (USEPA 160.2); and • Visual observations during sample collection. Analyze floatable oil samples (if observed) for: • PCB (WT) measured in μg/L (GEHR Modified Method 8082).	• Treatability studies
		4c. (3) Quantify plate and frame filter press size and performance.	4c. (3a) Determine efficiency of filter press for dewatering raw slurries and settled solids: • Evaluate dewatering	<u>Step 1:</u> Perform dewatering polymer screening tests on raw slurries H2S1 and on settled solids from primary sedimentation tests under 4c(2b) H2S2 and H2S4 using: • Buchner funnel tests. Measure and plot 1-min filtrate volume vs. dosage in mg/L; and • Bench scale filter press tests. Measure and plot 1-min filtrate volume vs. dosage in mg/L.	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
			polymers • Evaluate mixing/ floc sensitivity to mixing or shear. • Evaluate cake release.	Analyze filter cake samples from the dewatering polymer screening tests for: • Water content measured in % (USEPA 160.3). Step 2: Perform preferred polymer confirmation tests on raw slurries H2S3 using: • Buchner funnel tests. Measure and plot 1-min filtrate volume vs. dosage in mg/L; and • Bench scale filter press tests. Measure and plot 1-min filtrate volume vs. dosage in mg/L. Analyze filter cake samples from the preferred polymer confirmation tests for: • Water content measured in % (USEPA 160.3). Step 3: Perform a mixing sub-study on slurries H2S1 and H2S2 using: • Buchner funnel tests. Measure and plot 1-min filtrate volume vs. dosage in mg/L. Analyze filter cake samples from the mixing sub-study for: • Water content measured in % (USEPA 160.3). Step 4: Perform a cake release screening study on slurries H2S1 and H2S3 using: • Pocket-leaf filter unit (record visual observations during test).	
			4c. (3b) Optimize hydraulic and mass loading to plate and frame filter presses.	Step 1: Perform plate and frame filter press tests on slurry H2S2 (desanded) and slurry H2S4 (settled solids from primary sedimentation). Analyze filtrate samples for: • PCB (WT) measured in μg/kg (GEHR Modified Method 8082); and • TSS (WT) measured in mg/L (USEPA 160.2). Analyze filter cake samples for: • Water content measured in % (USEPA 160.3); and • Paint filter measured in free liquids (SW-846 Method	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				9095A). Step 2: Perform cake solids vs. time sub-study on slurries H2S1 and H2S3. Analyze filter cake samples for: • Water content measured in % (USEPA 160.3); and • Paint filter measured in free liquids (SW-846 Method 9095A). Step 3: Perform high-volume filter press runs on slurries H2S1, H2S2, H2S3, and H2S4 using optimal polymer dosage and press run conditions. Analyze filtrate samples for: • PCB (WT, WF) measured in μg/L (GEHR Modified Method 8082); • TSS (WT) measured in mg/L (USEPA 160.2); • Turbidity (WT) measured in NTU (USEPA 180.1); • TOC (WT, WF) measured in mg/L (Lloyd Kahn); • pH (WT) measured in SU (probe measurement); and • Visual observations during sample collection. Analyze filter cake samples for: • PCB measured in μg/kg (GEHR Modified Method 8082); • TAL metals measured in mg/kg (SW-846 Method 6010B/7471A); • PCDD/PCDF measured in μg/kg (USEPA 1613B); • TCLP metals measured in mg/L (SW-846 Method 1311/3010A/6010B/7470A); • TCLP volatiles measured in mg/L (SW-846 Method 1311/8260B); • TCLP semivolatiles measured in mg/L (SW-846 Method 1311/3510C/3520C/8270C); • TCLP pesticides measured in mg/L (SW-846 Method 1311/3510C/3520C/8281A); • TCLP herbicides measured in mg/L (SW-846 1311/8151A); and • Paint filter measured in free liquids (SW-846 Method	

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				9095A).	
			4c. (3c) Evaluate centrifugation.	Perform laboratory centrifuge tests on slurries H2S3 and H2S4. Analyze centrate for: • PCB (WT, WF) measured in μg/L (GEHR Modified Method 8082); and • TSS (WT) measured in mg/L (USEPA 160.2). Measure solid fraction volume and analyze samples for: • PCB measured in μg/kg (GEHR Modified Method 8082); and • Water content measured in % (USEPA 160.3).	• Treatability studies
		4c. (4) Evaluate need for solidification agents on raw slurries and filter cake and evaluate the effect of dosage.		Step 1: Perform paint filter tests on raw slurry H2S1 and on slurries H2S3 and H2S4 (cake solids from high-volume plate and filter press tests under 4c(3b)). • Paint filter measured in free liquids (SW-846 Method 9095A). Step 2: Perform S/S testing on the above slurries (paint filter test failures only). Analyze the S/S test for: • Paint filter measured in free liquids (SW-846 Method 9095A). Two S/S test samples from each slurry that pass the paint filter test will then be analyzed for: • PCB measured in μg/L (GEHR Modified Method 8082); • PCDD/PCDF measured in μg/kg (USEPA 1613B); • TOC measured in mg/kg (Lloyd Kahn); • TAL metals measured in mg/kg (SW-846 Method 6010B/7471A); • TCLP metals measured in mg/L (SW-846 Method 1311/3010A/6010B/7470A); • TCLP volatiles measured in mg/L (SW-846 Method 1311/8260B); • TCLP semivolatiles measured in mg/L (SW-846 Method 1311/3510C/3520C/8270C); • TCLP pesticides measured in mg/L (SW-846 Method	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				1311/3510C/3520C/8281A); • TCLP herbicides measured in mg/L (SW-846 1311/8151A); • Unconfined compressive strength measured in psf (ASTM D2850); • Consolidation measured in kPa and cm/s^2 (ASTM D2435); • pH measured in SU (USEPA 9040A/ 9041B/9045C); • Grain-size distribution measured in mm (from Sieve Analysis, ASTM D422); • Grain-size distribution for finer fraction in mm (from Hydrometer Analysis, ASTM D1140; • Specific gravity (ASTM D854); • Atterberg limits measured in % (ASTM D4318); • Water content measured in % (USEPA 160.3); and • Visual observations during sample collection.	
		4c.(5) Evaluate the mixing energy needed to keep slurries in suspension.		Perform mixing energy tests on slurries H2S1, H2S2 and H2S3. • Record visual observations during test.	• Treatability studies
5. Develop the water processing design to meet anticipated discharge requirements.	5a. Determine the removal efficiency for the water treatment train.	5a. (1) Evaluate treatment and settling of dewatering filtrate.		<u>Step 1:</u> Perform P&F filtrate settling – polymer screening tests using slurries H1S1, H1S3, H1S4, H2S1, H2S2, H2S3, and H2S4 (filtrate from high volume filter press runs under 4b(3b) and 4c(3b)): • Standard Practice for Coagulation-Flocculation Jar Test measured in mg/L (ASTM D2035) (WT, WF). Analyze supernatant samples for: • Turbidity (WT) measured in NTU (USEPA 180.1); and • Visual observations during sample collection. <u>Step 2:</u> Perform column settling tests using the same slurries as above (filtrate from high volume filter press runs under 4b(3b) and 4c(3b)), with preferred polymer addition (as necessary). Analyze effluent for: • PCB (WT) measured in μg/L (GEHR Modified 8082 Method); • PCDD/PCDF (WT) measured in ng/L (USEPA 1613B);	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				• TAL metals (WT) measured in mg/L (USEPA 200.7/245.1); • Turbidity (WT) measured in NTU (USEPA 180.1); and • pH (WT) measured in SU (probe measurement).	
		5a. (2) Demonstrate the removal efficiencies, effluent quality and sensitivity to hydraulic and mass loading of MMF.		Perform MMF filtration tests using slurries H1S1, H1S3, H1S4, H2S1, H2S2, H2S3, and H2S4 (effluent from the column settling tests under 5a(1)). Analyze effluent for: • PCB (WT) measured in μg/L (Modified Green Bay Mass Balance Method); • TSS (WT) measured in mg/L (USEPA 160.2); • Turbidity (WT) measured in NTU (USEPA 180.1); • BOD_5 (WT) measured in mg/L (USEPA 405.1); • COD (WT) measured in mg/L (USEPA 410.4); • TOC (WT, WF) measured in mg/L (Lloyd Kahn); • pH (WT) measured in SU (probe measurement); • DO (WT) measured in mg/L (probe measurement); • TAL metals (WT) measured in mg/L (USEPA 200.7/245.1); • PCDD/PCDF (WT) measured in ng/L (USEPA 1613B); • Total P/PO_4 (WT) measured in mg/L (USEPA 365.2); • PAH (WT) (SW-846 Method 8270C/3510C); • $NH_3/TKN/NO_2/NO_3$ (WT) measured in mg/L (USEPA 350.3/354.1/351.3, Standard Method 418A); and • Visual observations during sample collection.	• Treatability studies
		5a. (3) Demonstrate the removal efficiency, effluent quality and sensitivity to hydraulic and mass loading of carbon adsorption.		Perform rapid small-scale column tests on slurries H1S1, H1S3, H1S4, H2S1, H2S2, H2S3, and H2S4 (filtrate from the MMF filtration tests under 5a(2)). Analyze effluent for: • PCB (WT) measured in μg/L (GEHR Modified Method 8082); and • TOC (WT, WF) measured in mg/L (Lloyd Kahn). Perform carbon column (GAC) tests on slurries H1S1, H1S3, H1S4, H2S1, H2S2, H2S3 and H2S4 (filtrate from the MMF filtration tests under 5a(2)).	• Treatability studies

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Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Level 1 DQO	Level 2 DQO	Level 3 DQO	Level 4 DQO	Data and Measurement	Data Source(s)
				Analyze effluent for: • PCB (WT) measured in μg/L (Modified Green Bay Mass Balance Method); • TSS (WT) measured in mg/L (USEPA 160.2); • Turbidity (WT) measured in NTU (USEPA 180.1); • BOD_5 (WT) measured in mg/L (USEPA 405.1); • COD (WT) measured in mg/L (USEPA 410.4); • TOC (WT, WF) measured in mg/L (Lloyd Kahn); • pH (WT) measured in SU (probe measurement); • DO (WT) measured in mg/L (probe measurement); • TAL metals (WT) measured in mg/L (USEPA 200.7/245.1); • PCDD/PCDF (WT) measured in ng/L (USEPA 1613B); • Total P/PO_4 (WT) measured in mg/L (USEPA 365.2); • PAH (WT) (SW-846 Method 8270C/3510C); • $NH_3/TKN/NO_2/NO_3$ (WT) measured in mg/L (USEPA 350.3/354.1/351.3, Standard Method 418A); and • Visual observations during sample collection.	
6. Develop the disposal design to meet anticipated landfill acceptance requirements.	6a. Determine the potential for water to be released from processed material during transport.			Perform storage/transportation stability shaker tests on filter cakes or slurries M1S1, M1S2, M1S3, M1S4, H1S1, H1S3, H1S4, H2S1, H2S3, and H2S4 (solids following s/s tests under 4a(1), 4b(4) and 4c(4)). Observe samples for formation of separate layers. If layers are present, decant and measure liquid volume (relative to original volume). For unaffected sediments and samples that had layering, test the remaining solids for: • Consolidation measured in kPa and cm/s^2 (ASTM D2435); • Specific gravity (ASTM D854); and • Atterberg limits measured in % (ASTM D4318).	• Treatability studies

See notes on pages 17 and 18.

Table 2 – Treatability Studies Data Quality Objectives (DQOs)

Notes:

1. Acronyms:

ASTM = American Society for Testing and Materials
BOD_5 = biochemical oxygen demand, 5-day
BUD = Beneficial use determination
cm = centimeter
DO = dissolved oxygen
DRET = Dredge Elutriate Test
GAC = granular activated carbon
H1S_ = Mechanical dredging with hydraulic offloading slurry simulation, the last number denotes the sediment type used to prepare the slurry (see S1 through S4 below)
H2S_ = Hydraulic dredging slurry simulation, the last number denotes the sediment type used to prepare the slurry (see S1 through S4 below)
hrs = hours
kg = kilogram
kPa = kilopascals
L = liter
M1S_ = Mechanical dredging slurry simulation, the last number denotes the sediment type used to prepare the slurry (see S1 through S4 below)
mg = milligram
min = minute
mm = millimeter
MMF = multimedia filter
ng = nanograms
NTU = nephelometric turbidity unit
P&F = plate and frame
Total P/PO_4 = total phosphorus/phosphate
PAC = powdered activated carbon
PAH = polynuclear aromatic hydrocarbon
PCB = polychlorinated biphenyl
PCDD/PCDF = polychlorinated dibenzodioxins/polychlorinated dibenzofurans
ppm = parts per million
RCRA = Resource Conservation and Recovery Act
s = seconds
S/S = stabilization/solidification
S1 = Coarse-grained sediment (assumed to have relatively low PCB concentrations)
S2 = Mixture of coarse- and fine-grained sediment (assumed to have moderate PCB concentrations)
S3 = Fine-grained sediment (assumed to have relatively high PCB concentrations)
S4 = Fine-grained sediment with oils (assumed to have the highest PCB concentrations)
SEDC = Supplemental Engineering Data Collection
SSAP = Sediment Sampling and Analysis Program
SU = standard units
TAL = Target Analyte Metals

Table 2 – Treatability Studies Data Quality Objectives (DQOs)

TCLP = Toxicity Characteristic Leaching Procedure
TKN/NO_2/NO_3 = total Kjeldahl nitrogen/nitrite/nitrate
TOC = total organic carbon
TSCA = Toxic Substances Control Act
TSS = total suspended solids
μg = micrograms
w/w = percent by weight
WF = water (filtered)
WT = water (total or unfiltered)

2. The DQOs listed in this table correspond to the shaded DQOs included in the SEDC Work Plan (BBL, 2003d).

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Table 3 – Treatability Studies SOP Sources

Data and Measurement Needs	Source[2]
1. Grain-size distribution measured in mm (from Sieve Analysis, ASTM D422).	SSAP-QAPP – Appendix 10
2. Grain-size distribution for finer fraction in mm (from Hydrometer Analysis, ASTM D1140).	SSAP-QAPP – Appendix 10
3. Specific gravity (ASTM D854).	SSAP-QAPP – Appendix 12
4. Atterberg limits measured in % (ASTM D4318).	SSAP-QAPP – Appendix 11
5. Water content measured in % (USEPA 160.3).	SSAP-QAPP – Appendices 6 and 7
6. PCB measured in μg/kg (SW-846 Method 8082) (sediment analysis).	SSAP-QAPP – Appendix 5
7. PCB measured in μg/L (SW-846 Method 8082) (water analysis).	SSAP-QAPP – Appendix 5
8. PCB measured in μg/L (Modified Green Bay Mass Balance Method) (water analysis).	BMP-QAPP – Appendix 9
9. TSS measured in mg/L (USEPA 160.2) (water analysis).	BMP-QAPP – Appendix 18
10. TAL metals measured in mg/kg (SW-846 Method 6010B/7471A) (sediment analysis).	SSAP-QAPP – Appendix 29
11. TAL metals measured in mg/L (USEPA 200.7/245.1) (water analysis).	BMP-QAPP – Appendices 15 and 16
12. Calcium and Magnesium measured in mg/L (USEPA 200.7) (water analysis).	BMP-QAPP – Appendices 15 and 16
13. Turbidity measured in NTU (USEPA 180.1).	TS Work Plan – Appendix 30
14. Dredge Elutriate Test.	TS Work Plan – Appendix 3
15. BOD_5 measured in mg/L (USEPA 405.1).	TS Work Plan – Appendix 25
16. TOC measured in mg/kg (Lloyd Kahn) (sediment analysis).	SSAP-QAPP – Appendix 15
17. TOC measured in mg/L (Lloyd Kahn) (water analysis).	BMP-QAPP – Appendix 19
18. pH measured in SU (USEPA 9040B/ 9041A/9045C) (sediment analysis).	TS Work Plan – Appendix 26
19. pH measured in SU (probe measurement) (water analysis).	BMP-QAPP – Appendix 2
20. DO measured in mg/L (probe measurement).	BMP-QAPP – Appendix 2
21. PAH measured in mg/kg (SW-846 Method 8270C) (sediment analysis).	TS Work Plan – Appendix 27
22. PAH measured in μg/L (SW-846 Method 8270C/3510C) (water analysis).	TS Work Plan – Appendix 27
23. PCDD/PCDF measured in μg/kg (USEPA 1613B) (sediment analysis).	SSAP-QAPP – Appendix 28

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Table 3 – Treatability Studies SOP Sources

Data and Measurement Needs	Source[2]
24. PCDD/PCDF measured in ng/L (USEPA 1613B) (water analysis).	BMP-QAPP – Appendix 20
25. Total P/PO_4 measured in mg/kg (USEPA 365.2) (sediment analysis).	TS Work Plan – Appendix 28
26. Total P measured in mg/L (USEPA 365.2) (water analysis).	BMP-QAPP – Appendix 13
27. NH_3/TKN measured in mg/kg (USEPA 350.3/351.3) (sediment analysis).	TS Work Plan – Appendix 29, BMP-QAPP – Appendix 12
28. NH_3/TKN/NO_2/NO_3 measured in mg/L (USEPA 350.3/354.1/351.3/ASTM 418A) (water analysis).	TS Work Plan – Appendix 29, BMP-QAPP – Appendices 10, 11, and 12
29. Bulk density measured in g/cm^3 (ASTM D4531, modified).	SSAP-QAPP – Appendix 13
30. Dredged material slurry simulations.	TS Work Plan – Appendix 2
31. Mixing energy study.	TS Work Plan – Appendix 16
32. Size separation testing.	TS Work Plan – Appendix 6
33. Drainage study of coarse fraction.	TS Work Plan – Appendix 7
34. Standard Practice for Coagulation-Flocculation Jar Test measured in mg/L (ASTM D2035).	TS Work Plan – Appendix 8
35. Primary sedimentation column testing (USACE ERDC/EL TR-03-1).	TS Work Plan – Appendix 10
36. Buchner funnel tests (Standard Method 2710H).	TS Work Plan – Appendix 11
37. Bench-scale pressure filter test.	TS Work Plan – Appendix 12
38. Determine optimal polymer dose.	TS Work Plan – Appendix 9
39. Cake release screening – filter leaf tests (Perlmutter 2003).	TS Work Plan – Appendix 13
40. Pilot Plate & Frame filter test.	TS Work Plan – Appendix 14
41. Laboratory centrifuge tests.	TS Work Plan – Appendix 15
42. Settling column tests (USACE ERDC/EL TR-03-1).	TS Work Plan – Appendix 10
43. Rapid small-scale column tests (Crittenden et al., 1991).	TS Work Plan – Appendix 18
44. Pilot Multimedia Filter tests.	TS Work Plan – Appendix 17
45. Pilot carbon column (GAC).	TS Work Plan – Appendix 19
46. Solidification/stabilization testing (Andromelos & Ameel, 2003).	TS Work Plan – Appendix 5
47. TCLP metals measured in mg/L (SW-846 Method 1311/3010A/6010B/7470A).	SSAP-QAPP – Appendix 26
48. TCLP volatiles measured in mg/L (SW-846 Method 1311/8260B).	SSAP-QAPP – Appendix 22

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Table 3 – Treatability Studies SOP Sources

Data and Measurement Needs	Source[2]
49. TCLP semivolatiles measured in mg/L (SW-846 Method 1311/3510C/3520C/8270C).	SSAP-QAPP – Appendix 23
50. TCLP pesticides measured in mg/L (SW-846 Method 1311/3510C/3520C/8281A).	SSAP-QAPP – Appendix 24
51. TCLP herbicides measured in mg/L (SW-846 Method 1311/8151A).	SSAP-QAPP – Appendix 25
52. Paint filter measured in free liquids (SW-846 Method 9095A).	TS Work Plan – Appendix 4
53. Unconfined compressive strength measured in psf (ASTM D2850).	SEDC Work Plan – Appendix A
54. Consolidation measured in cm^2/s and kPa (ASTM D2435).	TS Work Plan – Appendix 21
55. Storage/transport study – 1 week of shaking in the laboratory.	TS Work Plan – Appendix 20
56. Sample collection for treatability tests	TS Work Plan – Appendix 1
57. Sampling custody and handling procedures	TS Work Plan – Appendix 23
58. COD measured in mg/L (USEPA 410.4)	TS Work Plan – Appendix 31

Notes:
1. Acronyms:

ASTM = American Society for Testing and Materials
BOD_5 = biochemical oxygen demand, 5-day
cm = centimeter
COD = chemical oxygen demand
DO = dissolved oxygen
GAC = granular-activated carbon
hrs = hours
kg = kilogram
kPa = kilopascals
L = liter
mg = milligram
min = minute
mm = millimeter
MMF = multimedia filter
ng = nanograms
NTU = Nephelometric Turbidity Units
P&F = plate and frame
Total P/PO_4 = total phosphorus/phosphate
PAC = powdered activated carbon
PAH = polynuclear aromatic hydrocarbon
PCB = polychlorinated biphenyl
PCDD/PCDF = polychlorinated dibenzodioxins/polychlorinated dibenzofurans
ppm = parts per million
RCRA = Resource Conservation and Recovery Act
s = seconds
SEDC = Supplemental Engineering Data Collection
SOP = Standard Operating Procedure
SSAP = Sediment Sampling and Analysis Program

Table 3 – Treatability Studies SOP Sources

SU = standard units
TCLP = Toxicity Characteristic Leaching Procedure
$TKN/NO_2/NO_3$ = total Kjeldahl nitrogen/nitrite/nitrate
TOC = total organic carbon
TSCA = Toxic Substances Control Act
TSS = total suspended solids
μg = micrograms

2. The sources of the methods are referenced in the following documents:

   TS Work Plan = *Treatability Studies Work Plan*
   SEDC Work Plan = *Supplemental Engineering Data Collection Work Plan*
   BMP-QAPP = *Baseline Monitoring Program Quality Assurance Project Plan*
   SSAP-QAPP = *Sediment Sampling and Analysis Program Quality Assurance Project Plan*

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Table 5 - Method Reporting Limits and Action Limits

Sample Location	Bulk Density – Average (g/cm^3)	Total PCBs – Average (mg/kg)
S1 – River Section 1	1.19	11
S1 – River Section 3	0.48	7
S2 – River Section 1	0.83	125
S2 – River Section 2	0.67	81
S3 – River Section 1	0.90	161
S3 – River Section 3	0.87	110
S4 – River Section 1	0.63	185
S4 – River Section 2	0.76	312

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Table 7 - Method Reporting Limits and Action Limits

	Water (ug/L)		Solids[6] (ug/kg)	
	Laboratory	Laboratory	Laboratory	Laboratory
Analyte	**MDL**	**RL**	**MDL**	**RL**
PAH (SW-846 8270C)				
Naphthalene	TBD	TBD	TBD	TBD
Acenaphthylene	TBD	TBD	TBD	TBD
Acenaphthene	TBD	TBD	TBD	TBD
Fluorene	TBD	TBD	TBD	TBD
Phenanthrene	TBD	TBD	TBD	TBD
Anthracene	TBD	TBD	TBD	TBD
Fluoranthene	TBD	TBD	TBD	TBD
Pyrene	TBD	TBD	TBD	TBD
Benzo(a)anthracene	TBD	TBD	TBD	TBD
Chrysene	TBD	TBD	TBD	TBD
Benzo(b)fluoranthene	TBD	TBD	TBD	TBD
Benzo(k)fluoranthene	TBD	TBD	TBD	TBD
Benzo(a)pyrene	TBD	TBD	TBD	TBD
Indeno(1,2,3-cd)pyrene	TBD	TBD	TBD	TBD
Dibenz(a,h)anthracene	TBD	TBD	TBD	TBD
Benzo(g,h,i)perylene	TBD	TBD	TBD	TBD
PCBs (GEHR Modified SW-846 8082)				
Aroclor 1016	TBD	TBD	TBD	TBD
Aroclor 1221	TBD	TBD	TBD	TBD
Aroclor 1232	TBD	TBD	TBD	TBD
Aroclor 1242	TBD	TBD	TBD	TBD
Aroclor 1248	TBD	TBD	TBD	TBD
Aroclor 1252	TBD	TBD	TBD	TBD
Aroclor 1260	TBD	TBD	TBD	TBD
PCBs (Modified Green Bay Mass Balance)				
Total PCB (sum of congeners)	--	--	TBD	TBD
PCDD/PCDF (USEPA 1613B)				
Total-TCDD	TBD	TBD	TBD	TBD
Total-TCDF	TBD	TBD	TBD	TBD
2378-TCDF	TBD	TBD	TBD	TBD
Total PeCDD	TBD	TBD	TBD	TBD
12378-PeCDD	TBD	TBD	TBD	TBD
Total PeCDF	TBD	TBD	TBD	TBD
12378-PeCDF	TBD	TBD	TBD	TBD
23478-PeCDF	TBD	TBD	TBD	TBD
Total HxCDD	TBD	TBD	TBD	TBD
123478-HxCDD	TBD	TBD	TBD	TBD
123678-HxCDD	TBD	TBD	TBD	TBD
123789-HxCDD	TBD	TBD	TBD	TBD
Total HxCDF	TBD	TBD	TBD	TBD
123478-HxCDF	TBD	TBD	TBD	TBD
123678-HxCDF	TBD	TBD	TBD	TBD
123789-HxCDF	TBD	TBD	TBD	TBD
234678-HxCDF	TBD	TBD	TBD	TBD

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Table 7 - Method Reporting Limits and Action Limits

	Water (ug/L)		Solids[6] (ug/kg)	
	Laboratory	Laboratory	Laboratory	Laboratory
Analyte	MDL	RL	MDL	RL
PCDD/PCDF (USEPA 1613B) (cont.)				
Total HpCDD	TBD	TBD	TBD	TBD
1234678-HpCDD	TBD	TBD	TBD	TBD
Total HpCDF	TBD	TBD	TBD	TBD
1234678-HpCDF	TBD	TBD	TBD	TBD
1234789-HpCDF	TBD	TBD	TBD	TBD
OCDD	TBD	TBD	TBD	TBD
OCDF	TBD	TBD	TBD	TBD
TAL Metals (SW-846 6010B/7471A)				
Silver	TBD	TBD	TBD	TBD
Aluminum	TBD	TBD	TBD	TBD
Arsenic	TBD	TBD	TBD	TBD
Barium	TBD	TBD	TBD	TBD
Beryllium	TBD	TBD	TBD	TBD
Calcium	TBD	TBD	TBD	TBD
Cadmium	TBD	TBD	TBD	TBD
Cobalt	TBD	TBD	TBD	TBD
Chromium	TBD	TBD	TBD	TBD
Copper	TBD	TBD	TBD	TBD
Iron	TBD	TBD	TBD	TBD
Mercury	TBD	TBD	TBD	TBD
Potassium	TBD	TBD	TBD	TBD
Magnesium	TBD	TBD	TBD	TBD
Manganese	TBD	TBD	TBD	TBD
Sodium	TBD	TBD	TBD	TBD
Nickel	TBD	TBD	TBD	TBD
Lead	TBD	TBD	TBD	TBD
Tin	TBD	TBD	TBD	TBD
Selenium	TBD	TBD	TBD	TBD
Thallium	TBD	TBD	TBD	TBD
Vanadium	TBD	TBD	TBD	TBD
Zinc	TBD	TBD	TBD	TBD
TCLP-Volatiles (SW-846 1311/8260B)				
benzene	TBD	TBD	--	--
chlorobenzene	TBD	TBD	--	--
carbon tetrachloride	TBD	TBD	--	--
chloroform	TBD	TBD	--	--
1,2-dichloroethane	TBD	TBD	--	--
1,1-dichloroethene	TBD	TBD	--	--
2-butanone	TBD	TBD	--	--
tetrachloroethene	TBD	TBD	--	--
trichloroethene	TBD	TBD	--	--
vinyl chloride	TBD	TBD	--	--

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Table 7 - Method Reporting Limits and Action Limits

	Water (ug/L)		Solids[6] (ug/kg)	
	Laboratory	Laboratory	Laboratory	Laboratory
Analyte	**MDL**	**RL**	**MDL**	**RL**
TCLP-Semivolatiles (SW-846 1311/3510C/3520C/8270C)				
2-methylphenol	TBD	TBD	--	--
3/4-methylphenol	TBD	TBD	--	--
1,4-dichlorobenzene	TBD	TBD	--	--
2,4-dinitrotoluene	TBD	TBD	--	--
hexachlorobenzene	TBD	TBD	--	--
hexachlorobutadiene	TBD	TBD	--	--
hexachloroethane	TBD	TBD	--	--
nitrobenzene	TBD	TBD	--	--
pentachlorophenol	TBD	TBD	--	--
pyridine	TBD	TBD	--	--
2,4,5-trichlorophenol	TBD	TBD	--	--
2,4,6-trichlorophenol	TBD	TBD	--	--
TCLP-Pesticides (SW-846 1311/3510C/3520C/8281A)				
chlordane	TBD	TBD	--	--
endrin	TBD	TBD	--	--
heptachlor	TBD	TBD	--	--
TCLP-Pesticides (SW-846 1311/3510C/3520C/8281A) (cont.)				
heptachlor epoxide	TBD	TBD	--	--
gamma-BHC	TBD	TBD	--	--
methoxychlor	TBD	TBD	--	--
toxaphene	TBD	TBD	--	--
TCLP-Herbicides (SW-846 1311/8151A)				
2,4-D	TBD	TBD	--	--
2,4,5-TP	TBD	TBD	--	--
TCLP-Metals (SW-846 1311/3010A/6010B/7470A)				
arsenic	TBD	TBD	--	--
barium	TBD	TBD	--	--
cadmium	TBD	TBD	--	--
chromium	TBD	TBD	--	--
lead	TBD	TBD	--	--
selenium	TBD	TBD	--	--
silver	TBD	TBD	--	--
mercury	TBD	TBD	--	--

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Table 7 - Method Reporting Limits and Action Limits

	Water (ug/L)		Solids[6] (ug/kg)	
	Laboratory	Laboratory	Laboratory	Laboratory
Analyte	**MDL**	**RL**	**MDL**	**RL**
Other				
pH (USEPA 9040B/9041A/9045C)	TBD	TBD	--	--
Total PO_4 (USEPA 1613B)	TBD	TBD	--	--
Total P (USEPA 1613B)	TBD	TBD	--	--
NH_3 (USEPA 350.3/351.3)	TBD	TBD	TBD	TBD
TKM (USEPA 350.3/351.3)	TBD	TBD	TBD	TBD
NO_2 (USEPA 350.3/351.3/351.3)	--	--	TBD	TBD
NO_3 (USEPA 350.3/351.3/351.3)	--	--	TBD	TBD
TOC (Lloyd Kahn)	TBD	TBD	TBD	TBD
Paint Filter (SW-846 Method 9095A)	TBD	TBD	--	--
Specific Gravity (ASTM D854)	TBD	TBD	--	--
Grain size (ASTM D422/ASTM D1140)	TBD	TBD	--	--
Atterberg limits (ASTM D4318)	TBD	TBD	--	--
Compressive Strength (ASTM D2850)	TBD	TBD	--	--
Bulk Density (ASTM D4531, modified)	TBD	TBD	--	--
Water Content (USEPA 160.3)	TBD	TBD	--	--
Consolidation (ASTM D2435)	TBD	TBD	--	--
Biochemical Oxygen Demand (EPA 405.1)	--	--	TBD	TBD
Chemical Oxygen Demand (EPA 410.4)			TBD	TBD
Suspended Solids (TSS) (EPA 160.2)	--	--	TBD	TBD
Turbidity (USEPA 180.1)	--	--	TBD	TBD

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Table 7 - Method Reporting Limits and Action Limits

Notes:

1. USEPA. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste SW-846 3rd ed. Washington, D.C. 1996.*
2. APHA. Standard Methods for the Examination of Water and Wastewater. Washington, DC 1998,
3. USEPA. *Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry. EPA 821/R-98-002. 1999.*
4. USEPA. *Methods for Chemical Analysis of Water and Waste*. EMSL-Cincinnati. 1983.
5. The target reporting limits are based on wet weight. The actual reporting limits will vary based on sample weight and moisture content.
6. TBD = To be determined.
7. Laboratory MDLs and RLs are to be determined based on laboratory EPA SW-846 SOPs (to be provided after contracting).
8. MDL = Method Detection Limit
9. RL = Reporting Limit

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Table 8 - Sample Containers, Preservation, and Holding Times

Parameter	Bottle Type	Preservation	Holding Time[2]
Solids			
PAH (SW-846 8270C)	1-8oz glass jar with Teflon®-lined lid	Cool to 4°C	14 days to extraction
			40 days to analysis
PCDD/PCDF (USEPA 1613B)			14 days to extraction
			40 days to analysis
PCBs (GEHR Modified SW-846 8082)			14 days to extraction
			40 days to analysis
TAL Metals (SW-846 6010B/7471A)	1-4oz wide mouth glass jar	Cool to 4°C	180 days to analysis
Mercury (SW-846 6010B/7471A)			28 days to analysis
TCLP-Volatiles (SW-846 1311/8260B)	1-4oz glass jar with Teflon®-lined lid	Cool to 4°C	14 days to TCLP extraction
			14 days to analysis
TCLP-Semivolatiles (SW-846 1311/3510C/3520C/8270C)	1-8oz glass jar with Teflon®-lined lid	Cool to 4°C	14 days to TCLP extraction
			7 days to extract prep
			40 days to analysis
TCLP-Pesticides (SW-846 1311/3510C/3520C/8281A)			14 days to TCLP extraction
			7 days to extract prep
			40 days to analysis
TCLP-Herbicides (SW-846 1311/8151A)			14 days to TCLP extraction
			7 days to extract prep
			40 days to analysis
TCLP-Metals (Except Mercury) (SW-846 1311/3010A/6010B)	1-4oz wide mouth glass jar	Cool to 4°C	180 days to TCLP extraction
			180 days to analysis
TCLP-Mercury (SW-846 1311/3010A/7470A)			28 days to TCLP extraction
			28 days to analysis
pH (USEPA 9040B/9041A/9045C)	1-4oz wide mouth glass jar	Cool to 4°C	48 hours to analysis
Total P/PO_4 (USEPA 365.4)	1-4oz wide mouth glass jar	Cool to 4°C	28 days to analysis
NH_3/TKN (USEPA 350.3/351.3)	1-4oz wide mouth glass jar	Cool to 4°C	28 days to analysis
Grain size (ASTM D422/ASTM D1140)	large Ziploc® bag	NS	NS
Paint Filter (SW-846 Method 9095A)	1-4oz wide mouth glass jar	Cool to 4°C	7 days to analysis
TOC (Lloyd Kahn)	1-125ml glass jar	Cool to 4°C	28 days to analysis
Water Content (USEPA 160.3)	small Ziploc® bag	3 to 30°C	As soon as practical
Atterberg limits (ASTM D4318)	large Ziploc® bag	NS	NS
Compressive Strength (ASTM D2850)	2 large Ziploc® bags	NS	NS
Specific Gravity (ASTM D854)	large Ziploc® bag	NS	NS
Bulk Density (ASTM D4531, modified)	Undisturbed Sample (i.e., Shelby tube)	NS	NS
Consolidation (ASTM D2435)	Undisturbed Sample (i.e., Shelby tube)	NS	NS
Water			
PAH (SW-846 Method 8270C/3510C)	2-1 liter amber glass bottles with Teflon®-lined lid	Cool to 4°C	7 days to extraction
			40 days to analysis
PCDD/PCDF (USEPA 1613B)	2-1 liter amber glass bottles with Teflon®-lined lid	Cool to 4°C	7 days to extraction
			40 days to analysis
PCBs (GEHR Modified SW-846 8082)	2-1 liter amber glass bottles with Teflon®-lined lid	Cool to 4°C	7 days to extraction
			40 days to analysis
PCBs (Modified Green Bay Mass Balance)	2-1 liter amber glass bottles with Teflon®-lined lid	Cool to 4°C	7 days to extraction
			40 days to analysis
TAL Metals (Except Mercury) (USEPA 200.7/425.1)	1liter plastic bottle	HNO_3 to pH<2	180 days to analysis
Mercury (USEPA 200.7/425.1)		Cool to 4°C	28 days to analysis
Calcium and Magnesium (USEPA 200.7)		HNO_3 to pH<2	180 days to analysis
Suspended Solids (TSS) (EPA 160.2)	500ml plastic bottle	Cool to 4°C	7 days to analysis
NH_3/TKN/NO_2/NO_3 (USEPA 350.3/345.1/351.3)	1liter plastic bottle	H_2SO_4 to pH<2, Cool to 4°C	28 days to analysis
Total Phosphorus (EPA 365.2)			28 days to analysis
Biochemical Oxygen Demand (EPA 405.1)			28 days to analysis
Chemical Oxygen Demand (EPA 410.4)			28 days to analysis
Total Organic Carbon (Lloyd Kahn)			28 days to analysis
Bacteria	100 ml plastic bottle	Cool to 4°C	24 hours to analysis
Turbidity (USEPA 180.1)	2-1liter plastic bottles	Cool to 4°C	48 hours to analysis

Notes:

1 USEPA. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste. SW-846 3rd ed. Washington, D.C. 1996.*
USEPA. Methods for Chemical Analysis of Water and Waste. EMSL-Cincinnati. 1983:
APHA. *Standard Methods for the Examination of Water and Wastewater.* Washington, DC. 1998.
ASTM International. 2003. *Annual Book of ASTM Standards 2003 Section 4 Construction* , Volume 04.08. West Conshohocken, PA. ASTM International
Department of the Army. 1986. *Engineering Manual Laboratory Soils Testing* . Washington, D.C. Department of the Army, Office of the Chief of Engineers

2 All holding times are measured from date of collection.

3 NS = Not Specified

4 NA = Not Applicable

5 Sample container requirements may be modified based on laboratory EPA SW-846 SOPs (to be provided after contracting).

General Electric Company
Hudson River PCBs Superfund Site
Treatability Studies Work Plan

Table 9 - Sample Quantities and Quality Control Frequencies

Parameter	Estimated Test Batches	Estimated Environmental Sample Quantity	Treatability Laboratory/Field QC Analyses[8]						Analytical Laboratory QC Sample						Total
			Trip Blank		Rinse Blank		Field Duplicate		Matrix Spike		Matrix Spike Duplicate		Lab Duplicate		
			Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	Freq.	No.	
Solids															
PAH (SW-846 8270C)	1	TBD	NA	--	1/batch	TBD	1/batch	TBD	1/batch	TBD	1/batch	TBD	NA	--	TBD
PCBs (GEHR Modified SW-846 8082)	31	TBD	NA	--	1/batch	TBD	1/batch	TBD	1/batch	TBD	1/batch	TBD	NA	--	TBD
PCDD/PCDF (USEPA 1613B)	12	TBD	NA	--	1/batch	TBD	1/batch	TBD	1/batch	TBD	1/batch	TBD	NA	--	TBD
TAL Metals (SW-846 6010B/7471A)	20	TBD	NA	--	1/batch	TBD	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
TCLP-Volatiles (SW-846 1311/8260B)	11	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	NA	--	TBD
TCLP-Semivolatiles (SW-846 1311/3510C/3520C/8270C)	11	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	NA	--	TBD
TCLP-Pesticides (SW-846 1311/3510C/3520C/8281A)	11	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	NA	--	TBD
TCLP-Herbicides (SW-846 1311/8151A)	11	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	NA	--	TBD
TCLP-Metals (SW-846 1311/3010A/6010B/7470A)	11	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	NA	--	TBD
pH (USEPA 9040B/9041A/9045C)	18	TBD	NA	--	NA	--	1/batch	TBD	NA	--	NA	--	1/batch	TBD	TBD
Total P/PO_4 (USEPA 1613B)	1	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
NH_3/TKM (USEPA 350.3/351.3)	1	TBD	NA	--	1/batch	TBD	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
TOC (Lloyd Kahn)	16	TBD	NA	--	NA	--	1/batch	TBD	NA	--	NA	--	1/batch	TBD	TBD
Paint Filter (SW-846 Method 9095A)	21	TBD	NA	--	NA	--	1/batch	TBD	NA	--	NA	--	1/batch	TBD	TBD
Specific Gravity (ASTM D854)	19	TBD	NA	--	NA	--	1/batch	TBD	NA	--	NA	--	1/batch	TBD	TBD
Grain size (ASTM D422/ASTM D1140)	9	TBD	NA	--	NA	--	1/batch	TBD	NA	--	NA	--	1/batch	TBD	TBD
Atterberg limits (ASTM D4318)	19	TBD	NA	--	NA	--	1/batch	TBD	NA	--	NA	--	1/batch	TBD	TBD
Compressive Strength (ASTM D2850)	10	TBD	NA	--	NA	--	1/batch	TBD	NA	--	NA	--	1/batch	TBD	TBD
Bulk Density (ASTM D4531, modified)	1	TBD	NA	--	NA	--	1/batch	TBD	NA	--	NA	--	1/batch	TBD	TBD
Water Content (USEPA 160.3)	59	TBD	NA		NA		1/batch	TBD	NA		NA		1/batch	TBD	TBD
Consolidation (ASTM D2435)	11	TBD	NA	--	1/batch	TBD	1/batch	TBD	NA	--	NA	--	1/batch	TBD	TBD
Dredge Elutriate Test															
PCBs (Modified Green Bay Mass Balance)	NA	32	NA	--	NA	--	NA	--	1/20	2	1/20	2	NA	--	36
PCDD/PCDFs SW-846(8280)	NA	16	NA	--	NA	--	NA	--	1/20	1	1/20	1	NA	--	18
TAL Metals (USEPA 200.7/425.1)	NA	16	NA	--	NA	--	NA	--	1/20	1	NA	--	1/20	1	18
Calcium and Magnesium (USEPA 200.7)	NA	16	NA	--	NA	--	NA	--	1/20	1	NA	--	1/20	1	18
Suspended Solids (TSS) (EPA 160.2)	NA	16	NA	--	NA	--	NA	--	1/20	1	NA	--	1/20	1	18
Total Organic Carbon (Lloyd Kahn)	NA	32	NA	--	NA	--	NA	--	1/20	2	NA	--	1/20	2	36
Water															
PAH (SW-846 Method 8270C/3510C)	42	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	1/batch	TBD	NA	--	TBD
PCBs (Modified Green Bay Mass Balance)	46	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	1/batch	TBD	NA		TBD
PCBs (GEHR Modified SW-846 8082)	60	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	1/batch	TBD	NA	--	TBD
PCDD/PCDF (USEPA 1613B)	53	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	1/batch	TBD	NA	--	TBD
TAL Metals (USEPA 200.7/425.1)	96	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
Calcium and Magnesium (USEPA 200.7)	0	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
Biochemical Oxygen Demand (EPA 405.1)	42	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
NH_3/TKN/NO_2/NO_3 (USEPA 350.3/345.1/351.3/ASTM 418A	42	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
Total Phosphorus (EPA 365.2)	42	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
Suspended Solids (TSS) (EPA 160.2)	78	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
Total Organic Carbon (Lloyd Kahn)	89	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD
Turbidity (USEPA 180.1)	43	TBD	NA	--	NA	--	1/batch	TBD	1/batch	TBD	NA	--	1/batch	TBD	TBD

Notes:
1. Sample counts are an approximation.
2. 1/batch = One QC sample treatability study batch or one per 20 samples, whichever is more frequent.
3. Rinse blanks not required when dedicated sampling equipment is used.
4. Freq = Frequency
5. NA = Not Applicable
6. No. = Number
7. QC = Quality Control
8. Treatability laboratory/analytical laboratory samples do not include control and/or replicate samples required by the treatability studies test standard operating procedures.
9. TBD = To be determined.