APPENDIX A

ONONDAGA LAKE PRE-DESIGN INVESTIGATION: PHASE I SAMPLING AND ANALYSIS PLAN

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF FIGURES

SECTION A1

INTRODUCTION

This Sampling and Analysis Plan (SAP) describes the samples and data to be collected during implementation of the field work defined in the Onondaga Lake Phase I Pre-Design Investigation (PDI) Work Plan. The SAP describes sample locations, sample- and data-gathering methods, and it details the analyses and testing to be performed at each location. A detailed description of the analytical methods and quality assurance program supporting the field work is described in the Quality Assurance Project Plan (QAPP, Appendix B).

SECTION A2

MOBILIZATION AND LOGISTICS

The purpose of the PDI is to further characterize lake bottom sediments (chemical/ physical/geotechnical) and related media to support the remedial design. It will be conducted using a phased approach. This section covers the mobilization and logistics to support the Phase I PDI field tasks.

A2.1 HEALTH AND SAFETY

Parsons ranks health and safety as the highest priority. A copy of the Project Safety Plan (PSP) is presented in Appendix C and will be strictly followed by personnel. Copies of the plan will be maintained at the support zone and on each vessel. Each vessel will have the ability to communicate with land-based services by cell phone and marine VHF radio.

A2.2 SITE FACILITIES

A support zone and facilities will be established near existing permanent structures at the north end of Wastebed B, an area with an established road adjacent to the lakeshore. Figure A2.1 presents the proposed locations of the on-shore site facilities.

Movable and temporary facilities will be established to support the PDI field efforts. These will include a field office, sample processing trailer, equipment storage trailers, a refrigerated box for core sample storage, a chest freezer or commercial freezer for sample shipment supplies (ice), and a boat dock to facilitate movement of supplies to and from sampling vessels. Other equipment such as work boats, survey vessels, site vehicles, and a crane (if needed) for loading and unloading heavy equipment to and from barges and vessels will also be utilized during the field program.

A2.3 DECONTAMINATION AND WASTE HANDLING FACILITY

An onshore facility will be established to decontaminate equipment. Decontamination will also be conducted on the various barges and vessels. Non-dedicated equipment that contacts a sample will undergo a complete decontamination. Other equipment, such as drill rods and casing, will be washed with lake water on the barge deck prior to reuse (Parsons, 2003). The rinse water will be allowed to return to the lake. In locations where the drilling tools have NAPL, the equipment will be decontaminated with lake water and and rinse water will be containerized. Decontamination fluids from non-dedicated sampling equipment will be held in buckets or other containers and transferred to drums in the waste handling area for proper disposal.

A waste handling area will be set up in a relatively flat but well-drained area near the decontamination area. This area will have access for trucks to facilitate removal of waste materials to approved offsite disposal facilities. Honeywell will conduct offsite disposal of waste streams generated during the investigation. Waste steams classified as general refuse will be disposed of in the proper receptacles.

Figure A2.1 Proposed On-Shore Site Facilities

SECTION A3

FIELD TASKS

A3.1 BATHYMETRIC AND GEOPHYSICAL SURVEYS

The bathymetric and geophysical surveys will be conducted in accordance with U. S. Army Corps of Engineers (USACE) standard EM-1110-2-1003. For this project, vertical data will be corrected to the North American Vertical Datum 88 (NAVD 88) level; horizontal coordinates will be referenced to the New York State Plane Coordinate System. The many USGS stations on Onondaga Lake will be used as project benchmarks.

For the bathymetric survey, the vessel will be navigated over pre-set survey lines across the Lake (Figure A3.1). Lines are spaced at 200-ft intervals; SMU 8 and most of SMU 5 have sufficient quality control "cross-tie" lines. In the littoral SMUs (including select areas of SMU 5) line spacing has been set to 25 ft to obtain higher resolution data because dredging, capping, and habitat efforts will be focused in these areas. Additional high resolution data will be collected in SMU 8 adjacent to SMU 1 to support other evaluations.

The sub-bottom profile and magnetometry surveys will be on transects spaced 25 ft apart in SMUs 1, 2, 3, 4, 6, and 7. Spacing of 200-ft will be used in SMUs 5 and 8 except that line spacing will be 25 ft in:

- SMU 5 where dredging and capping are recommended
- SMU 8 at the three locations where significant historical resources are thought to exist (see Figure A3.2), and
- A portion of SMU 8 adjacent to SMU 1.

Side-scan sonar will be used to map bottom morphology, surface sediment distribution, and to identify objects resting on the sediment surface. Survey transects will be spaced 25 ft apart in littoral SMUs (except portions of SMU 5) and 200 ft apart in SMU 8 and SMU 5 (Figure A3.1). Tighter spacing will be used in portions of SMU 8 adjacent to SMU 1. In locations where potential historical resources were identified in Figure A3.2, additional transects will be run to delineate these targets.

When the field tasks are complete, project data will be processed and submitted with an operations report. The specific data products will be:

- Operations report and relevant figures
- Bathymetric survey drawings

- Processed, analyzed, and rectified sub-bottom profile data including cross-sectional stratigraphic presentations
- Processed, analyzed, and rectified magnetic intensity survey presented as plan view plots of magnetic targets
- Processed side-scan sonar imagery presented as a georeferenced bottom mosaic to identify the general geomorphology and highlight any targets or hard areas encountered.

The position of identified subsurface utilities or other possible boring obstructions (if any) will be plotted on drawings and discussed in the operations report. GIS formatted data for both the raw and final products of these data groups will be produced.

A3.2 SEDIMENT INVESTIGATION

The sediment investigation entails sample collection from the lakebed. The data developed will be used in design evaluations for removal operations, cap design, and sediment management considerations. The sampling objectives, locations, and analyses for the Phase I activities are presented below.

In general, sorbent booms will be placed on the water surface around the drilling area at locations where cores will be advanced into the sediment. Based on field observations and agreement between Honeywell and NYSDEC, the booms will be removed if deemed unnecessary.

This section of the SAP is organized by sampling type (for example, geotechnical sampling versus chemical sampling) and subsequently by SMU. Within each sub-category, the purpose and sampling scope are described. Tables A3.1 and A3.2 summarize the sampling scope by area and analysis. The symbols in the tables correspond to the sample stations in Figures A3.3 through A3.9. Table A3.3 presents a detailed list of the sample station IDs and analyses. This table corresponds with Figures A3.3 through A3.9.

A3.2.1 Geotechnical Investigation

Geotechnical sample frequency is based on the total number of samples per SMU, distribution of existing locations, and geology. *Although locations and depths of geotechnical samples are identified in the tables and on a figure in this document, the actual location or depth will be based on the field classification and determined by a geotechnical engineer or geologist. In general, the test locations will be selected as necessary to characterize the target areas.* Table A3.3 lists the approximate number of samples per boring in each SMU.

A3.2.1.1 SMU 1

In SMU 1, the objective is to determine the characteristics of the in-lake waste deposit (ILWD). This objective includes furthering the understanding of sediment strength and compression characteristics, and general geotechnical properties of the sediments in SMU 1. Results will be used to refine the estimate of consolidation from the sediment cap, and assess the potential for slope instability of the ILWD.

In general, two types of geotechnical activities will take place: cone penetrometer testing (CPT) and sediment collection from cores or borings. Additionally, two vane shear tests will be conducted in SMU 1. The final locations of these tests will be based on field decisions, but are currently planned for locations OL-STA-10014 and OL-STA-10025. Table A3.1 lists samples and tests that are proposed; Table A3.3 lists the sample IDs and analyses; Figure A3.3 identifies sample locations.

Cone Penetrometer Testing

Fourteen of the sixteen proposed CPT locations have been co-located with deep borings (discussed below). The other two were placed at independent locations just outside the SMU 1 boundary. CPTs that are co-located with geotechnical/chemical borings will be within 10 ft of the associated boring. The CPT will be advanced through the ILWD to the native sediment at all locations. Additionally, at three locations, the CPT will be advanced to firm material (rock/till).

Sediment Cores and Borings

Twenty-six locations will be sampled using a Vibracore to 13 or 20 ft below the sediment-water interface, depending on the location (Figure A3.3 and Table A3.3). At fourteen locations, drill borings will be advanced to native sediments, 50-75 ft below the sediment-water interface. These borings are co-located with Vibracores collected for chemical samples (see Chemical Characterization below).

Sediment samples will be selected for analysis based on field results (see chart). Sample frequency is on Table A3.3. Some of the seepage-induced consolidation tests will be correlated with the consolidation tests, and all of them will be correlated with the Index Test locations.

Sample Analyses	Deep Sample Analyses
Index tests: Moisture Content Grain size with Hydrometer Atterberg Limits Organic Content Specific Gravity Carbonate Content	Bulk Density Unconsolidated Undrained Triaxial Shear Strength Consolidated Undrained Triaxial Shear Strength* Consolidation Seepage-induced Consolidation
	* Each analysis consists of three tests on the same sediment from one Shelby tube. If insufficient sediment is available from one tube, sediment with similar index properties from adjacent tubes will be used. Similarity will be determined by field observations and classifications.

One 10-gal composite surface water sample will be collected from SMU 1 for use in the seepage-induced consolidation tests. This will be sufficient volume to conduct all seepage-induced tests in SMU 1.

A3.2.1.2 SMU 2

Geotechnical samples will be collected from both sediment cores (using a Vibracore) and borings (using a barge-mounted drill rig) to provide preliminary characteristics of the material in SMU 2.

Two types of geotechnical activities will take place: CPT and sediment collection from cores or borings. Table A3.1 lists samples and tests proposed; Table A3.3 lists the location IDs and analyses; Figure A3.4 shows sample locations.

Cone Penetrometer Testing

CPT will be conducted at fifteen locations to provide strength data characteristics of the subsurface. The CPT will be advanced to 40 ft below the sediment-water interface (Table A3.3, Figure A3.4).

Sediment Cores and Borings

Fifteen offshore borings will be advanced as part of the SMU 2 investigation and to provide additional information about the characteristics of SMU 2. The borings will be advanced to approximately 40 ft below the sediment-water interface and will be co-located with MIP, CPT, and chemical sample locations (Figure A3.4). Split-spoon samplers or Lexan tubes will collect sediment for geotechnical index properties. Three Shelby tubes will be collected in accordance with ASTM D1587 *Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes* (ASTM, 2004) and analyzed for moisture content, specific gravity, organic content and bulk density. This information will then be used to calculate porosity.

Samples for geotechnical analysis will be selected based on field results and the frequencies listed in Table A3.3. Samples from each location will be analyzed for moisture content, grain size (with hydrometer), Atterberg limits, organic content, specific gravity, and bulk density.

Offshore Proposed Barrier Wall Alignment Borings

To support the Willis/Semet barrier wall Interim Remedial Measures (IRM) along the shoreline in SMU 2, geotechnical borings may be advanced 40-100 ft into the sediments immediately offshore of the causeway area. These borings are currently being considered by Honeywell and NYSDEC. Upon agreement on number of borings and locations, these borings would be implemented under an amendment to this workplan.

Deep borings would be advanced 5 ft into the till or bedrock, whichever is encountered first. The total depth is estimated at 100 ft below the sediment-water interface. Split-spoon samples would be collected every 5 ft during drilling. The location would be double-cased to prevent any downward migration of contamination through the silt-clay layer. When the silt-clay layer is encountered, a casing would be set, and drilling would continue inside the outer casing. When abandoned, the hole would be grouted as the casing is withdrawn to form a seal. A geotechnical engineer or other qualified team member would select appropriate units or locations for the Shelby tube samples in each boring. In addition, split-spoon samples would be selected based on field observations for moisture content, grain size with hydrometer, Atterberg limits, organic content and specific gravity testing.

Shallow borings would be advanced 5 ft into the silt-clay unit. Split-spoon samples would be collected every 5 ft at each location and analyzed for index testing. Shelby tubes would be collected for strength and consolidation samples.

A3.2.1.3 SMUs 3, 4, 6, and 7

Geotechnical samples will be collected from both sediment cores and sediment borings in SMUs 3, 4, 6, and 7 to support the sediment cap design and the IRM investigation of Wastebeds 1 through 8.

Two types of geotechnical activities will take place: vane-shear testing and sediment collection from cores or borings. Before any intrusive work in SMU 3, all surface water samples will be collected.

Vane Shear Tests

Vane shear tests will be conducted as outlined on Table A3.1. Vane shear tests will be conducted in these SMUs in place of CPT, which typically do not provide data in the upper few feet of the subsurface. Starting from the top of the sediment-water interface, vane shear tests will be performed at 1-, 2-, and 3-ft depth intervals (distance measured from the sediment surface to the middle of the vane). To support the vane shear test, samples will be collected using a small hand-operated grab sampler and analyzed for Atterberg limits, and the results will be used to correct the vane shear readings. Vane shear test results will provide surface sediment strength classification data for areas that will be capped.

Sediment Cores and Borings

Geotechnical samples will be collected as shown in the chart below:

SMU	Equipment	Number	Depth
3	Vibracore	15	13 ft below sediment - water interface
	Drill rig	4	To slit-clay layer if present
4	Vibracore	1	13 ft below sediment - water interface
	Vibracore	2	To silt-clay layer if present
6	Vibracore	15	13 ft below sediment - water interface
	Drill rig	4	To silt-clay layer if present
7	Vibracore	4	20 ft
	Drill rig	4	To silt-clay layer if present

The objective of the deeper borings is to outline stratigraphy for input to the groundwater flow model and assist with the groundwater discharge evaluation.

Sediment samples for geotechnical analysis will be selected based on field results. Samples will be analyzed for moisture content, grain size with hydrometer, Atterberg limits, organic content and specific gravity. Sediment samples will also be collected from SMUs 4, 6, and 7 for seepage-induced consolidation tests. For these tests a composite 10-gallon surface water sample will be colleted from the SMU.

A3.2.2 Chemical Characterization

Chemical analysis will be conducted on the sediment samples from each SMU. The chemical samples, unlike the geotechnical samples, are typically based on predetermined depths and not directly related to the geology or stratigraphy.

Tables A3.1 and A3.2 summarize the sampling scope by area and analysis. The map symbols in the tables correspond to Figures A3.3 through A3.9. Table A3.3 lists the sample locations with each sample ID corresponding to Figures A3.3 through A3.9.

A3.2.2.1 SMUs 1, 3, 4, 6, and 7

Sediment samples will be collected from cores in SMUs 1, 3, 4, 6, and 7 to refine the dredge volume or capped area. The chemical parameters that will be analyzed in these SMUs are specified in the table below. These samples are co-located with the geotechnical sample stations. A Vibracore will be advanced to a depth sufficient to recover either 13 or 20 ft below the sediment/ water interface, depending on the location. The samples for chemical analysis will be taken from 3.3-ft (1-m) intervals along the length of the Vibracore, up to the maximum depth specified.

Once onboard the vessel the sediment core will be cut into 1 to 2 meter lengths and sealed to minimize volatilization of chemical compounds. The cores will be stored vertically on the vessel until they are delivered to the onshore sample processing area. Cores will be stored in a refrigerated area no more than 24 hr before processing and shipment to the laboratory. All samples will be collected and placed in appropriate sealable containers and will follow the appropriate procedures for shipping and tracking.

SMU-Specific Analytes for Sediment Chemical Characterization	
SMU 1, 3, 6 & 7	23 CPOIs, Benzene, Toluene, Phenol
SMU 4	Mercury and Phenol

A3.2.2.2 SMU 2

A MIP will be used at locations in SMU 2 adjacent to proposed borings to evaluate the potential for its use to identify NAPL (Figure A3.4). MIP is a direct-push tool that provides a vertical profile of relative total VOC concentrations. The MIP's heated probe is advanced into the sediment/soil and vaporizes VOCs in the soil/water. The VOCs diffuse across a semi-permeable membrane in the probe and are swept up to the barge at the lake surface by an inert gas. The detector's response indicates the relative total VOC concentration in the subsurface.

The MIP is an innovative field analytical method, and the results may not be sufficient to differentiate between concentrations representative of residual versus potentially mobile NAPL. Therefore, additional work may be required to refine the extent of potentially mobile NAPL in a later phase.

If the amount of NAPL in the sediment pore space is less than a threshold amount (the residual saturation), the NAPL will be held in the sediment as disconnected blobs and ganglia and will be unable to migrate. NAPL threshold concentrations are based on the expected NAPL density, sediment porosity, and residual NAPL saturation. These data are available from prior investigations of the onshore NAPL.

To correlate the MIP response and the presence of potentially mobile NAPL, eight MIPs will be advanced adjacent to eight of the proposed borings to evaluate the correlation between the response and the boring observations. The cores will be examined for staining, discoloration, and PID readings that may indicate the presence of NAPL.

Fifteen borings will be advanced 40 feet into the silt and clay layer. Three sample depth intervals will be selected from each offshore confirmation boring and analyzed for TCL VOCs and select SVOCs (dichlorobenzenes, trichlorobenzenes, naphthalene and phenol). The depths analyzed will be based on field observations, targeting low, medium, and high levels of NAPL presence. Additionally, NAPL samples may be collected, if available, and analyzed for TCL VOCs and select SVOCs (dichlorobenzenes, trichlorobenzenes and naphthalene). From each location, three soil samples will be collected using a Shelby tube (in an adjacent boring) to characterize porosity and density (unit weight). Porosity and density samples will be collected at the same three intervals as samples collected for chemical analysis.

A3.2.2.3 SMU 8

Gravity corer samples will be collected from the surficial sediments in SMU 8 to evaluate monitored natural recovery (MNR). The top 2 cm will be analyzed in SMU 8 since this was the depth previously sampled in the profundal zone during the initial phase of the RI in 1992. Thus, these data can be used to evaluate trends in the top 2 cm since 1992. Details regarding the investigation include:

- Taken at twenty locations (Figure A3.9, Table A3.1) from 0 to 0.05 ft (2 cm) depth interval
- Analyzed for mercury and specific gravity.

A3.2.3 Column Settling Tests and Effluent Elutriate Testing

Column settling tests (CST) and effluent elutriate tests (EET) will be performed on samples from SMUs 1 and 6 (Figures A3.3 and A3.7). Samples for these tests will be collected simultaneously. Results will be used for design of the dredging program and the sediment consolidation area (SCA). Sample locations may be changed based on field observation from cores and borings. Additionally, the use of coagulant aids during some of the testing, and solidification testing using additives is currently being evaluated. These tests would be executed under an addendum to this workplan, if necessary.

Column Settling Tests

For the CSTs, three sediment samples will be collected from SMU 1 and one from SMU 6 (Figures A3.3 and A3.7). Vibracores will be advanced through a majority of the estimated dredge prism (to a depth of 6.5 ft [2 m]) to collect approximately 10 gal of sediment at each location.

Unfiltered water will be collected from SMUs 1 and 6 using a peristaltic pump or equivalent system. Temperature, pH, dissolved oxygen, and conductivity will be measured during sample collection. Since 40 gal of water is required for each test, 120 gal will be collected from SMU 1 and 40 gal from SMU 6.

The CSTs will be performed in accordance with accepted methods (USACE 2003, USEPA-USACE 1998). The initial slurry concentration will be 110-150 g/L. The CST will be run for 15 days. Samples for suspended sediment will be collected at 1, 2, 4, 6, 12, 24, and 48 hr and at 4, 8, and 15 days after the test is started. The number of suspended sediment samples will depend on the slurry settling behavior. The column will have thirteen sampling ports (every 6 inches between the base and 6 ft). The maximum number of samples for each of the three sediments tested is 130 (thirteen ports multiplied by ten sampling events).

After the CST is completed, the laboratory will conduct a consolidation test (USACE 1110-2-5027) and a set of three laboratory vane shears tests (ASTM D4648-05) on the settled material. Specific details regarding the feasibility of accomplishing these tests will be addressed with the laboratory and will depend on the properties of the settled material.

Effluent Elutriate Tests

For the EETs, three sediment samples will be collected from SMU 1 and one from SMU 6 (Figures A3.3 and A3.7). Vibracores will be advanced through a majority of the estimated dredge prism (to a depth of 6.5 ft) to collect 10 gal of sediment at each location. Unfiltered water will be collected from SMUs 1 and 6 using a peristaltic pump or equivalent system. Temperature, pH, dissolved oxygen, and conductivity will be measured during sample collection. Since 40 gal of water is required for each test, 120 gal will be collected from SMU 1 and 40 gal from SMU 6. Both the water and the sediment will be stored in clean inert containers in the dark at 4˚C.

EETs will be performed in accordance with accepted methods (USACE 2003 and USEPA-USACE 1998). Modifications may be made to generate enough supernatant for testing. Typically, the EET tests are performed on slurry in 4-L cylinders that yield 0.5 to 1.0 L of supernatant. Since up to 12 L of supernatant may be required, larger 40-L cylinders (if possible) may be used. The settling time for the EETs will be 24 hr.

In the laboratory, filtered and unfiltered supernatant from each EET will be collected and analyzed for parameters listed in Table A.3.4.

A3.2.4 Supernatant Treatability Testing

Preliminary bench-scale effluent water treatability testing will be completed to help to develop a water management strategy and provide initial data for preliminary design of the supernatant treatment plant. Therefore, additional bulk sediment samples will be collected separately from the CST and EET samples to analyze the supernatant treatability. One composite sample from two to four locations will be collected in SMU 1.

Using a Vibracore, approximately 25 gal of sediment will be collected at each location for bulk sampling. Samples will be collected from 0 to 6.5 ft (2 m) below the sediment-water interface. Sediment samples will not be homogenized but placed in a sealable bucket. Efforts will be made to minimize the loss of volatile compounds. Approximately 100 gal of surface water will be collected for this task.

As part of the supernatant treatability tests, the sediment sample will be mixed with surface water to create a slurry. This will be allowed to settle for 24 hours. Three samples will be collected for initial characterization: composited sediment, dewatered sediment, and aqueous supernatant (filtered and unfiltered). Based on historical sampling and current SPDES permit requirements for outfalls, each sample will be characterized for parameters listed in Table A.3.4.

It is anticipated that the following treatability testing will be conducted:

pH titrations will quantify the amount of acid and/or base required for pH adjustment, either to adjust for treatment and/or for final discharge. Titration curves will be developed to quantify overall chemical requirements as well as buffering capacity of the water.

Metals removal testing will be conducted in several steps. The first step will be using jar tests to understand the minimum solubility of the metals of concern. As per Table A.3.4, all TAL metals will be included in this analysis. Hydroxide and sulfide precipitation tests, and coagulant and flocculent testing will be conducted. Minimum hydroxide and sulfide solubility curves will be constructed for the metals selected.

VOCs removal will focus on air stripping and carbon adsorption. Air stripping will be evaluated using mathematical modeling. Carbon will be assessed using jar tests to develop an adsorption isotherm.

TSS removal will be evaluated using column settling and direct filtration tests. Settling column tests will be conducted with and without addition of coagulant or flocculent. The results will be used to construct a settling curve and to estimate initial settling velocity, percent TSS reduction, and surface overflow rate. For direct filtration, various pore-size laboratory filters will be used to ascertain a relationship between pore-size and TSS fraction removed.

Ammonia removal will focus on chemical precipitation (PO_4) and air stripping and/or oxidation (NH_3).

A3.2.5 Bulk Sampling for Supernatant Treatability Testing and Odor and Emissions Evaluations

To evaluate potential odors and emissions from the SCA during remedial activities, bulk sediment and surface water samples will be collected from areas proposed for dredging in SMUs 1, 6, and 7. The samples will target areas known to be high in volatilizing CPOIs. The objective is to provide sediments for the bench-scale test as part of the odor and emissions evaluation.

For each SMU, one composite sample of 10 gal of sediment will be collected from each of the identified sample locations (Figures A3.3, A3.7, and A3.8). Actual sample locations may be changed depending on field observations. Sample locations were selected to target areas with the highest concentrations of compounds that may cause odors or emissions.

Sediment cores will be collected and cut on the sampling vessel. The field geologist or engineer will evaluate the target interval for relatively high volatile chemical concentrations based on visual, olfactory, and PID headspace analysis. If the target interval does not have sufficiently high concentrations, a field decision will be made to continue sampling in the same location or to move to another location for additional sampling.

Samples will be composited by placing the selected interval from each core directly into a clean 5-gal bucket with a gasket lid until the bucket is full. Sample handling and aeration will be minimized. To reduce volatilization from the sediment, a water blanket will be maintained in the bucket. Prior to sample collection, a slurry of lake water and shallow sediment will be mixed and allowed to settle to provide a contaminated water blanket. This will reduce the rate of mass transfer from the sediment sample to the overlying water and headspace of the bucket. This procedure will apply to bulk sample collection for both the supernatant treatability testing and the odor and emissions evaluations.

To make the slurry, 2 to 3 gals of lake water will be collected in a 5-gal bucket. A grab sample of surface sediment will be collected directly in the bucket and mixed well. The slurry will be allowed to settle, with a lid on the bucket, until the overlying water is relatively clear of suspended sediment. As the sediment samples from the core target intervals are placed in the 5-gal bucket, a graduated container will be used to place water (with minimal suspended sediment) slowly and gently over the collected sediment to maintain a 1- to 2-inch water blanket. The volume of water will be recorded. The lid will be placed on the bucket when sediment or water is not being added.

When the bucket is full of sediment, the water blanket will overflow into a tray placed below the sample collection bucket, as the gasket lid is placed on the bucket. The volume of water that overflows into the tray will be measured and recorded. The difference between the volume of water added as a blanket and the volume of water in the tray equals the volume of water added to the sample. With this information, when solids content is measured, the *in situ* solids content can be calculated.

In addition to the gasket lid, packing tape will be used to secure the bucket seal. A custody seal will be placed on the bucket seal to prevent the opening of the sample container.

Enough lake water will be collected at each sampling location to total 40 gal for each SMU. The lake water will be used to dilute slurries of the sediment. The sediment and lake water samples will be shipped in appropriate packaging to the laboratory under chain of custody protocol. Excess materials will be containerized and disposed of in the proper facilities. Equipment and used containers will be decontaminated or discarded as appropriate.

A3.2.6 Sampling Equipment and Methodologies

A3.2.6.1 Grab Sampling

Surficial sediment grab samples will be collected at various locations and water depths in the Lake. Samples will be collected using a gravity corer or a clam shell type grab sampler (Van Veen, Ekman or equivalent).

The gravity corer will be used in SMU 8 to minimize the disturbance to the upper layer of sediment. The grab sampler will be used for geotechnical samples at the vane shear locations and will either be lowered by hand (for manual samplers) or using a winch from the sampling vessel. The sampler will be lowered slowly to minimize the shock wave, which may disturb the surficial fine-grained material. Upon contact with the sediment, the grab sampler automatically trips, the jaws close as the sampler is retrieved and the sediment is contained in the unit. Acceptable samples will show no evidence of sample "washout" or significant disruption of the surficial sediment. If an unlined sampler is used, sediments will be selected that were not in contact with the sides of the sampler.

A3.2.6.2 Vibracore

A Vibracore will collect sediment samples that are shallower than 20 ft below the sediment-water interface, except surficial samples. This scope of work has identified 105 Vibracore locations, including the porewater methods evaluation discussed below.

Generally, sampling of sediments for chemical analysis will be conducted using a 3-inch diameter cellulose acetate butyrate (CAB) core liner (or equivalent). If the 3-inch diameter tubes are not sufficient volume, 4-inch liners may be used. For CST and EET evaluation, sediments will be retained in a core of nominal 4-inch diameter.

After the Vibracore sample is brought to the boat deck, it will be cut into 1-2 meter lengths and sealed to minimize volatilization of chemical compounds. The cores will be stored vertically on the boat until they are delivered to the on-shore sample processing area. Cores will be stored in a refrigerated area no more than 1 day before sampling for chemical analysis.

In general, sorbent booms will be placed on the water surface around the drilling area at locations where cores will be advanced into the sediment. Based on field observations and agreement between Honeywell and NYSDEC, the booms will be removed if deemed unnecessary.

A3.2.6.3 Drilling

A barge-mounted drill rig will be required to collect sediment samples deeper than 20 ft below the sediment-water interface.

The standard drill rig will drill to approximately 140 ft (including water depth). Depths into the lake sediments will generally be less than 75 ft. Water depths will be 2-30 ft. Advancement of the borehole will be accomplished by flushing a 6-inch drill casing.

As noted in Section A3.2.1.2, the three locations in SMU 2 will penetrate the silt-clay layer. Therefore, these borings will be doubled-cased, (and grouted upon completion) to prevent the downward migration of contaminants.

In general, sorbent booms will be placed on the water surface around the drilling area at locations where borings will be advanced into the sediment. Based on field observations and agreement between Honeywell and NYSDEC, the booms will be removed if deemed unnecessary.

A3.2.6.4 Cone Penetrometer Testing

CPT uses a steel cone that is hydraulically pushed into the ground at up to 40,000 psi; sensors on the tip of the cone measure cone-tip pressure and sidewall friction. Additionally, porewater pressure measurements will be collected during testing. Twenty-nine CPT locations have been identified. SMU 1 CPT test locations were co-located with deep borings to provide adequate coverage of the SMU. SMU 2 CPT test locations were selected to provide strength data characteristics of the area of potential NAPL removal.

A3.2.6.5 Vane Shear

The vane shear is a tool designed to measure *in situ* undrained shear strength in soils. Both undisturbed (peak) and remolded (residual) strengths will be measured during this test. The tool consists of a spiral spring and vertical blades that are pushed into the soils or sediments. At the top is a handle that, when turned, deforms the spring causing displacement between the spring and the blades. The displacement is a function of the amount of torque required to turn the blades. A scale located on the instrument measures shear strength of the soils or sediments. Forty vane shear locations have been identified. Test locations were selected to provide initial adequate distribution within select capping areas specified in the ROD (NYSDEC, 2005).

A3.2.6.6 Membrane Interface Probe

A MIP will be used in SMU 2 to evaluate the potential for this technology to identify NAPL beneath the lakebed in SMU 2 (Section A3.2.2.2). Eight MIP locations have been identified for the Phase I PDI.

A3.3 SURFACE WATER AND POREWATER SAMPLING

Surface water samples will be collected in SMU 3 for chemical analysis. Porewater will be collected in various SMUs to support the groundwater model and sediment cap design.

The surface water and porewater sampling programs discussed in this section are relatively independent of the sediment sampling programs. (Water samples discussed elsewhere are those for CST and EET [Section A3.2.3], for odor and emissions [Section A3.2.5], and for seepage-induced consolidations tests [Sections A3.2.1.1 and A3.2.1.3].)

A3.3.1 Surface Water Sampling

Surface water samples will be collected from SMU 3 to support the onshore investigation of Wastebeds 1 through 8. All surface water samples will be collected in one round prior to any intrusive activities in this area. Surface water will be collected from approximately half way between the water surface and the top of the sediment surface using a peristaltic pump or equivalent. One sample will be collected from each of the thirty-two locations (Figure A3.5) and analyzed for compounds specified below.

Surface Water Sampling Analysis Compounds		
• Benzene • Toluene • Ethylbenzene • Xylene	• Chlorobenzene • Dichlorobenzenes (all) • Trichlorobenzenes (all)	• Naphthalene • Phenol • Mercury

A3.3.2 Porewater Sampling

Porewater samples will be collected to support the sediment cap evaluation and to support the groundwater model. Porewater sampling for a variety of compounds under varying geochemical and geophysical conditions is inherently complex; therefore, the Phase I effort will be used to determine the most appropriate method for sample collection and analysis. This effort will include a variety of techniques including *ex situ* sampling through centrifugation (with and without filtering), *in situ* installation of peepers (diffusion type samplers), and sampling the existing stations (which will be modified) from the 2001/2002 groundwater upwelling investigation (Parsons, 2003).

Porewater samples will be collected in SMU 1 and SMU 6 using diffusion type samplers called peepers (direct porewater collection), sediment collection (with push cores) followed by centrifuging (porewater generation in laboratory), and using previously installed double valve sampling pumps (direct porewater collection).

In SMU 1, samples will be placed with locations that are part of the sediment and chemical investigations discussed above (see Figure A3.3). Sample numbers and chemical analyses are summarized in Table A3.2, and individual sample locations are listed in Table A3.3.

Porewater samples will be collected from two depths at each of thirteen locations in SMU 1. They will be analyzed for mercury, VOCs (BTEX), specific SVOCs able to be detected on a VOC scan (chlorobenzene, dichlorobenzenes, trichlorobenzenes (1,2,3; 1,2,4; 1,3,5), and naphthalene), organic carbon, and pH. Sediment samples will be collected adjacent to the peepers and sent to the laboratory for porewater generation and analyses similar to the peepers (see *ex situ* sampling below).

Samples will be collected from the twelve existing upwelling locations in SMU 1 with the assistance of a dive crew. First, the existing pump lines will be cut at a distance just above the water level. The lines will be brought to a sampling vessel at the surface where a sample will be collected using the existing sampling pump to eliminate the possibility of stripping the VOCs as the water travels along the lake bottom to the former sampling stations. However, since the sample tubing is inside the same conduit as the piezometer cables, these may also have to be cut rendering the piezometers unusable in the future. The porewater collected for these locations will be analyzed for mercury, VOCs (BTEX), specific SVOCs able to be detected on a VOC scan (chlorobenzene, dichlorobenzenes, trichlorobenzenes (1,2,3; 1,2,4; 1,3,5), and naphthalene), organic carbon, and pH.

In SMU 6, twenty locations will be sampled as part of the porewater methods evaluation (see Figure A3.3). Sample analyses are summarized in Table A3.2 and sample locations are listed in Table A3.3.

Porewater samples will be collected at twenty locations in SMU 6 from surficial (0 to 1 ft) sediment peepers. Peepers will be analyzed for mercury, VOCs (BTEX), specific SVOCs able to be detected on a VOC scan (chlorobenzene, dichlorobenzenes, trichlorobenzenes (1,2,3; 1,2,4; 1,3,5), and napthalene), organic carbon, and pH. Sediment samples will be collected adjacent to the peepers and sent to the laboratory for porewater generation and analyses similar to the peepers (see *ex situ* sampling below).

Ex situ sediment samples will be collected with a Vibracore from two depths at the thirteen locations where peepers will be installed in SMU 1 and with a gravity corer (or similar method) from the twenty locations in SMU 6. These sediments will be handled as little as possible in the field and managed in a glove box at the lab to limit exposure to oxidizing conditions. Porewater from these sediment samples will be generated through centrifugation. A spiked sample will be analyzed in the lab to evaluate the potential for losses of VOC in the laboratory during the centrifugation process.

Porewater analyses are specified in Table A3.2 and include total and dissolved mercury, VOCs (BTEX), specific SVOCs able to be detected on a VOC scan (chlorobenzene, dichlorobenzenes, trichlorobenzenes (1,2,3; 1,2,4; 1,3,5), and napthalene), TOC, DOC, and pH.

A3.3.3 Porewater - General Chemistry for Groundwater Model

Porewater samples will be collected in SMUs 3, 4, 6 and 7 to support the groundwater model. Samples will be collected at two locations in SMU 3 and SMU 4 and in four locations in SMUs 6 and 7. At each location, three depth intervals will be sampled from the midpoint of the interval (1, 3, and 5 ft; Table A3.3).

Centrifugation of sediment samples in the laboratory will generate porewater. Porewater will be analyzed for salinity, chlorides and, if sample volume is sufficient, major cations and anions.

A3.4 GROUNDWATER DISCHARGE EVALUATION

Evaluating and quantifying the flux of groundwater discharge to Onondaga Lake is one of the components of the ongoing remedial evaluations for this site. The groundwater discharge evaluation will provide field measurements of groundwater discharge rates (Darcy flux) for use in both the cap model and the groundwater flow model. Darcy flux will be measured in specific areas followed by a calculated groundwater flux throughout the littoral zone.

A3.4.1 Use of Geophysical Data

Geophysical data will be screened for use in the groundwater discharge evaluation. Sub-bottom profiling data may indicate locations where groundwater seeps are altering the strata profile collected in an area. Side scan sonar data may show that the sediment surface in one location differs from surrounding locations. The data collected from the geophysical investigation alone will not provide definitive answers on potential upwelling locations but may be used as one line of evidence in screening for potential groundwater discharge locations during a subsequent phase.

A3.4.2 Seepage Meters

A technique to quantify groundwater discharge that will be evaluated during Phase I is a seepage flux meter. This is an open-ended cylinder that is pushed into the sediment. The cylinders are set at a fixed elevation and placed approximately 18 inches into the sediment and allowed to equilibrate. The seepage flux meters are equipped with thin-walled Tedlar bags and high quality valves of sufficient diameter for low flow conditions. The top of the chamber is funneled to direct flow to the bag. The flow is measured by recording the volume of water that enters the bag over a discrete time.

Very low seepage rates can be measured because the rate is a function of the collection area and the sampling duration. Therefore, measurement accuracy in low discharge areas can be increased by either lengthening the sampling duration or increasing the collection area of the meter. Each of the meters will be monitored on a weekly basis for the duration of the pre-design investigation activities, anticipated to be 2-3 months.

To develop the most appropriate procedure for future work, a transect of 3 flux meters will be installed in SMUs 4 and 6 (Figures A3.5 and A3.6).

Conductivity and temperature profiling will be conducted from a boat to attempt to identify areas of potential discharge. These screening results will guide the final placement of the seepage meters. The results of the screening and the seepage flux meters may provide some correlation between seepage rates and water chemistry.

A3.5 DATA MANAGEMENT

A3.5.1 Assignment of Sample Names

A sample nomenclature has been developed to ensure consistency in field sample ID assignment and compatibility with the Locus Focus electronic environmental information management system. A field data collection program has been created for use by the field teams. This program will automatically generate sample jar labels, and unique sample names, which will be assigned to each sample. Each unique sample name will have the following:

Location ID: consists of the Site ID – Location Type – Location #. For example, location ID OL-PW-10001 indicates that the sample came from Onondaga Lake; PW is the location type identification for porewater; and the remainder of the Location ID is the SMU number (in this case, SMU 1) and the sample within the SMU (0001, 0002, 0003, *etc.*). For locations where more than one sampling technique is required, STA should be used for the location type, indicating a sample station.

Field Sample ID: consists of the Site ID – COC # - Sample #. For example, field sample ID OL-12345-01 would indicate that the sample came from Onondaga Lake, chain of custody number 12345, line 1 on the COC.

A3.5.2 Quality Assurance/Quality Control

Field QA/QC samples will consist of the collection and analysis of rinse blanks, field duplicates, and matrix spike/matrix spike duplicate samples at a frequency of one for every twenty samples for each sample media (sediment, porewater, and soil borings). Since some of the sediment samples will be collected from dedicated tubes/liners, rinse blanks will not be needed at every location. Field QA/QC samples will be identified by using standard sample identifiers. (See QAPP.)

A3.5.3 Sample Holding

Samples will be collected and handled according to the procedures described in the QAPP for each field task.

A3.5.4 Sample Collection and Recordkeeping

Samples will be collected and managed by a detailed field program tracked on a laptop computer on each of the sampling vessels and in the sample processing trailer. The program will contain all of the sample stations and analyses with various dropdown menus to allow for tracking of all pertinent field information. Samples will be documented and tracked using the COC procedures described in the QAPP from the point of collection to final disposal. Analytical and geotechnical testing records will be kept as specified in the QAPP.

A3.5.5 Data Entry into Database

Data will be added to Locus Focus through an input module of the system by the Data Manager. Access to the input module will be restricted to the Syracuse Portfolio Data Managers or delegates. Chemical analytical data will be loaded/entered into a database as discussed in the QAPP. The QAPP specifies minimum requirements for sample information that will be entered into the database. Data collected in the field will be recorded electronically, transferred to, and stored in the database. Additionally, field, geotechnical, and other data will be stored in the project files in hard copy.

A3.5.6 Data Validation

Analytical data generated during the investigation activities will be reviewed and validated in accordance with the approved work plan. Data validation of Level II through Level IV analytical deliverables will be performed (task dependent) in accordance with guidance provided by the USEPA, adapted to the QA/QC criteria in the USEPA CLP, USEPA SW-846, and the QAPP. Following validation, the results will be incorporated into the database. Data incorporation will be consistent with procedures utilized to incorporate data from other Onondaga Lake projects.

A3.5.7 Usability of Estimated Data

All chemical data will be evaluated for usability in accordance with the USEPA validation protocols specified in the QAPP.

Insert Table A3.1 Summary of Chemical and Geotechnical Sampling

Table A3.1-Continued Summary of Chemical and Geotechnical Sampling

Table A3.1-Continued Summary of Chemical and Geotechnical Sampling

Table A3.1-Continued Summary of Chemical and Geotechnical Sampling

Table A3.1-Continued Summary of Chemical and Geotechnical Sampling

Insert Table A3.2 Porewater Sample Location and Analysis Summary Table

Insert Table A3.3 Sample Location and Analysis Table

Table A3.3 - Continued   Sample Location and Analysis Table

Table A3.3 - Continued   Sample Location and Analysis Table

Table A3.3 - Continued   Sample Location and Analysis Table

Table A3.3 - Continued Sample Location and Analysis Table

Table A3.3 - Continued Sample Location and Analysis Table

Table A3.3 - Continued   Sample Location and Analysis Table

Table A3.3 - Continued   Sample Location and Analysis Table

Insert Table A3.4 Chemical Analysis for Effluent Elutriate and Supernatant Water Treatability Testing

Insert Figure A3.1 Track Line Spacing

Insert Figure A3.2 Historical Resources Location Map

Insert Figure A3.3 Sample Location Map: SMU 1

Insert Figure A3.4 Sample Location Map: SMU 2

Insert Figure A3.5 Sample Location Map: SMU 3

Insert Figure A3.6 Sample Location Map: SMU 4

Insert Figure A3.7 Sample Location Map: SMU 6

Insert Figure A3.8 Sample Location Map: SMU 7

Insert Figure A3.9 Sample Location Map: SMU 8

SECTION A4

REFERENCES

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