ONONDAGA LAKE PRE-DESIGN INVESTIGATION: PHASE IV WORK PLAN - ADDENDUM 3 CAP DESIGN BENCH-SCALE TESTING: ADDITIONAL COLUMN STUDIES AND ISOTOPE DEGRADATION EVALUATION

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1.0 INTRODUCTION

Column experiments were conducted as part of the Phase III Pre-Design Investigation (PDI) Addendum 3 (Parsons, 2007) to build on slurry experiments evaluated as part of the Onondaga Lake Phase II PDI Addendum 6 (Parsons, 2006a). The Phase III column experiments were designed to provide a representation of conditions within a sediment cap including redox potential, sorption to cap materials, buffering capacity of cap material (for SMU 1) and nutrient and microbial activity. These studies were focused on the more mobile volatile organic compounds benzene, toluene, ethylbenzene, xylene, dichlorobenzene, chlorobenzene, and naphthalene as these compounds will dictate the design of the isolation cap.

This Work Plan includes three tasks which expand upon the data set collected during Phase II and Phase III for cap design:

1) Additional column studies in SMU 6 and 7 using improved column equipment which allows sampling of the cap influent as well as effluent to directly measure initial porewater concentrations.

2) Columns will be run specifically to evaluate the fate and transport of Hg through a sand cap. Phase III columns were designed to evaluate VOC compounds anticipated to drive the cap design. Sample volumes were limited in these columns and the analysis focused on the VOCs. Additionally the flow rate was set such that breakthrough of Hg was not predicted.

3) Biological degradation will be further assessed using carbon isotopes to measure biological degradation rates and confirm the results from the Phase III columns, which showed no measurable concentration of contaminants in the column effluent (indicating complete degradation).

Additional columns will be run during the Phase IV PDI to further assess conditions in SMU 6 and 7, where relatively low initial porewater concentrations exist, to analyze the reproducibility of results from the Phase III tests and to determine the effectiveness of a sand cap in SMU 6 and 7. Mercury-specific column studies will also be run on each SMU 1, 4, and 7 sediment to validate assumptions of mercury partitioning to sand cap material in locations where high concentrations of mercury exist. These studies will be performed at the University of Texas in the same laboratory as the Phase III studies. Column studies, based on the results of the cap

amendment isotherm evaluation Phase IV PDI Addendum 2 (Parsons, 2008), are not included in this Work Plan and will be considered following completion of the work specified in Addendum 2 (Parsons, 2008).

Results from both the Phase II and Phase III bench-scale studies indicate that biological degradation is not occurring at significant rates over the duration of the laboratory experiments in SMU 1. Degradation in SMU 6 and 7 has been observed; however, compounds of interest have long anaerobic half lives that can be difficult to measure in a laboratory setting and results could be strengthened by a further line of evidence. The analysis of isotope fractionation is useful for characterizing and quantifying degradation of contaminants sediment and can be employed to estimate the rate and extent of degradation of refractory compounds. Therefore, during Phase IV, carbon isotope experiments will be initiated to provide insight on long-term biological activity and to provide an additional line of evidence to support the results from Phase II and III.

These studies will be focused on samples from areas of known high contaminant concentration. The sample locations, data-gathering methods, and details of the analyses and testing to be performed at each location are described in this document. The core samples will be collected in accordance with the procedures outlined in the Phase I PDI Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), Project Safety Plan (PSP), and Standard Operating Procedures (SOPs) (Parsons, 2005).

2.0 PROJECT OBJECTIVES

The purpose of the Phase IV PDI is to collect information required to conduct remedial design activities. The design of the isolation cap component of the remedy will be based on a mathematical model of contaminant fate and transport, as well as calculations to ensure the physical integrity of the cap. The studies proposed in this Work Plan are designed to support development of cap model input parameters and to examine the potential for processes such as advection associated migration and biodegradation to impact the performance of the cap. This information will be combined with the existing data set for use during design.

3.0 MOBILIZATION AND LOGISTICS

This section covers the mobilization and logistics to support the field tasks outlined in this addendum.

3.1 Health and Safety

Parsons ranks health and safety as the highest priority. Parsons Project Safety Plan (PSP) and our Subcontractor's Safety Plans (SSP) prepared for previous PDI activities will be used for this investigation and will be strictly followed by all personnel. Any task outside of the current scope defined in the PSP will have a new Job Safety Analysis (JSA) completed before the task begins. Copies of the PSP and SSPs will be maintained at the support zone and on each vessel.

3.2 Site Facilities

The support zone and facilities utilized for the previous phases of the PDI work will be relocated to the clearing off the upper road to Harbor Brook. The dock will be located west of the causeway, closer to the entry gate to the Onondaga Lake site. The support zone will be relocated due to field work for the installation of the Willis portion of the Willis/Semet IRM barrier wall. All decontamination and waste management activities will be conducted in accordance with the Phase I PDI Work Plan (Parsons, 2005).

4.0 SAMPLING LOGISTICS

Samples will be collected from a barge or a pontoon boat using a vibracore or push core in accordance with the procedures outlined in the Phase I PDI SAP (Parsons, 2005). Cores will be located in areas that are representative of the sediment that will be capped.

4.1 Column Studies

4.1.1 Additional SMU 6/7 Columns

Sample locations are depicted on Figure 1. Table 1 lists each sample location and provided the number of cores to be collected and sample selection information. Three cores will be collected at each location. Sample locations were selected based on concentrations of COCs in porewater measured during the PDI. Sample locations and depth intervals were selected where maximum or elevated levels (in the event the maximum concentrations of certain COCs were located in different samples) of COCs were measured in previous samples. Sample locations and depth intervals are provided in Table 1. A 14-inch segment (maximum length that can be shipped vertically in cooler) of each core will be selected for shipment to the laboratory for bench testing. Criteria for selecting the appropriate segment from each core will include:

- representative of materials within the core;
- biased toward the top of the core, but excluding the top 3 to 6 inch nepheloid layer, which may be aerobic and not representative; and
- excludes “crusty” layers that will be hard to handle in the laboratory.

Initially, three columns will be set up for each SMU 6 and 7, additional cores will remain in storage for use as replicates, in the event that concentrations are non-detected in the initial cores, or in the event that any cores are damaged. Columns will be run at a base level flow of 0.25 cm/day. Each column will contain a 30 cm sediment layer and be connected to a separate column containing a 15 cm sand cap layer. The use of separate columns for sediment and cap allows the influent porewater into the cap to be sampled, overcoming the difficulty of sampling influent porewater in previous studies (see Figure 2).

The sediment column will be prepared by extruding the bottom segment directly into a 30 cm tall column in an oxygen-free chamber. Columns will remain in the oxygen free chamber throughout the testing. The remaining core segment (approximately 2 inches) will be submitted for chemical analysis for contaminants of concern (DCBs, MCB, naphthalene, BTEX compounds, and fraction organic carbon).

In addition to the sediment cores, lake water will be collected for the column tests. Approximately 5 gallons of water will be collected from the dock area in SMU 1 and shipped to the University of Texas.

Core segments will be capped and sealed immediately after collection and an effort will be made to minimize exposure to ambient air. A written description of each core will also be documented in the field. Photographs will be collected in the field of each core prior to shipment. The cores will be shipped vertically and will be maintained at 4°C and sealed with no headspace until tests are conducted.

4.1.2 Mercury-Specific Columns

Column studies specific to the evaluation of mercury partitioning will be conducted with samples from SMU 1, 4, and 7 where the highest levels of mercury in lake porewater have been observed. These studies will be similar to the additional column studies in SMU 6/7; however, the flow rate will be set at 100 cm/day and the thickness of the sand cap layer will be set at 1 cm as opposed to the 15 cm used in the traditional columns. These modifications have been made to address the anticipated partitioning of mercury, which is expected to be much higher than VOCs. Three samples will be collected at one location in each SMU 1, 4, and 7, as shown on Table 1. Locations and sample intervals were selected based on maximum mercury concentration measurement in prior PDI porewater sampling events. Initially, one column will be run for each location. If the retardation factors from the initial SMU 1, 4, and 7 columns vary by greater than one order of magnitude then additional columns will be run to verify the results. Following completion of the initial columns (approximately 4 months from initiation), results will be summarized and discussed with NYSDEC. The need for additional columns will be determined in consultation with NYSDEC.

4.1.3 Carbon Isotope Experiments

The carbon isotope experiments will be run on cores collected as part of the SMU 6/7 additional column studies as described in Section 4.1.1. The purpose of the additional carbon isotope studies is to provide specific evidence for contaminant degradation and provide compound specific degradation rates. Column effluent concentrations can provide net degradation rates but the presence of monochlorobenzene, for example, will not differentiate between monochlorobenzene originally in the sediment cores and monochlorobenzene formed from the dechlorination of dichlorobenzene. The introduction of isotopic tracers, however, will allow differentiation between introduced compounds and their breakdown products and

compounds already present in the cores. The introduction of radiolabeled carbon 14 compound will allow identification of the extent of mineralization of the compound by trapping and monitoring of the carbon dioxide produced. The introduction of stable isotopic tracer, carbon 13, allows the fate of the compound to be traced through partial decomposition products.

5.0 SMU 6/7 AND MERCURY-SPECIFIC COLUMN STUDIES

5.1 Objective

The column studies will be used to estimate contaminant mobility through the sediment cap in minimally disturbed cores, spatial variability of redox and pH throughout the column, sorption to cap materials, and contaminant fate processes in the cap material. A set of columns will be run to specifically assess mercury fate and transport. These columns will only be sampled for mercury due to sample volume and handling requirements.

5.2 Procedures

Initial Porewater Concentration Measurement

During the Phase III Addendum 3 studies, initial porewater concentrations were measured in porewater generated via centrifugation of sediment collected from a section of the sample tube. A separate section was then extruded for use in the actual column. Vertical heterogeneity was acknowledged as a concern using this method. Additionally, the nature of the sediment and the availability of porewater volume for analysis was also limited using this method. For both the additional column studies in SMU 6 and 7 and the mercury-specific columns, porewater will be collected directly from the effluent of the separate sediment column. For the additional column studies from SMU 6 and 7, approximately 1.5 mL of porewater will be collected at the initiation of the column experiment following procedures previously employed to sample the effluent from the cap column. For the mercury-specific columns, approximately 40 mL of sediment column effluent (porewater) will be collected.

Use of a separate sediment porewater "generator" column and a sand cap column also allows introduction of radiolabeled compounds into the sand capping column influent (discussed in Section 6)

Column Experiments

A 30 cm section of sediment from the sample core will be extruded with minimal disturbance into a 2" x 30 cm glass column. A sand cap, approximately 15 cm thick, will be placed in a separate glass column connected to the sediment "generator" column by a short length of Teflon tubing. A 1 cm thick sand column will be employed for the mercury-specific columns due to the high sorption and, therefore, low migration rates of mercury expected in the sand column. The remainder of the cap column will be filled with glass beads for the mercury-specific column experiments. The filled column will be saturated with lake water. The column

will be maintained in a nitrogen atmosphere glove box at 12˚C for the duration of the experiment. The glove box has a meter that provides real time readings of O2 and H2. During sampling, the glove box O2 readings will be recorded and the deaerated artificial porewater reservoir that enters the column will be sampled to confirm the absence of oxygen. The experimental set-up is shown in Figure 2.

Water will be injected into the sediment column at a baseline superficial (Darcy) velocity of 0.25 cm/day for the studies in SMU 6 and 7 similar to the Phase III columns. This rate was selected such that breakthrough would likely occur in the columns within approximately two months. The mercury-specific columns will be run at a 100 cm/day flow rate due to the typically large sorption coefficient of mercury in natural media. The water will be recirculated in a closed loop to minimize the introduction of any makeup water. It is anticipated that this will more closely resemble groundwater moving through the cap than would introducing fresh water in an open loop system. The sediment and cap materials have approximately equal pore volumes, which will also minimize the introduction of outside makeup water into the cap prior to contaminant breakthrough.

One replicate sediment core from each of SMU 6 and 7, and a sand cap layer for each, will be irradiated and used as a control to evaluate abiotic losses in the columns. Flow rates and column preparation for these experiments will be identical to the corresponding baseline core.

Contaminants can be released from the sediment by partitioning to the mobile water phase. Mobilized contaminants will be sampled by monitoring of effluent water via collection in vials containing methanol to insure VOC retention in the sample. Sampling will be initiated at 1/10 the modeled steady-state time for each set-up, and as needed thereafter, to collect three to four samples along the breakthrough curve such that this portion of the curve is adequately characterized, this schedule will be followed for both the SMU 6/7 columns and the Hg Specific Columns. An additional three to four samples will be collected along the steady state portion of the breakthrough curve such that the steady state portion of the curve is adequately defined. Sampling frequency will be adjusted depending on the preliminary analyses. The location of the sample extraction point will be as close as practical to the column exit. There will be a reservoir of makeup artificial porewater consistent in composition with the APW used during the Phase III PDI. The APW reservoir will be attached to the inlet side of the column (i.e. not to the measured effluent, but to the bottom of the sediment column) during sampling. The pump will pull new fluid from this reservoir while simultaneously filling a sample reservoir. The volume of makeup water added will be equal to the volume of sample. The makeup water will not dilute the sample collected, and will not migrate into the cap layer without passing through and becoming equilibrated with sediment porewaters.

Samples collected from the SMU 6 and 7 columns will be analyzed for BTEX, dichlorobenzene (DCB), chlorobenzene (CB), and naphthalene. Separate samples will be collected for pH, redox, DO, and a hydraulic tracer in the effluents from the columns. Typically,

chloride or bromide are used as hydraulic tracers but these compounds are present in SMU 1 porewaters or cannot be distinguished in SMU 1 porewaters. They may still be useful in SMU 6 and 7 porewaters. An alternative tracer is tritium which may be introduced into the flow stream between the sediment and sand cap columns and measured in the sand cap effluent. The decision as to which tracer depends upon which has the most conflicts within the sediment. Initially, tritium will be used, assuming approvals from radiation safety office and sufficient access to the analytical equipment. If it is not possible to use tritium then bromide will be used. Chloride will be used as a last resort given the need to overcome background. These measurements will be used to confirm consistency of these values and to indicate any changes in biogeochemical state of the sediment core. Sampling will be limited as much as possible due to volume requirements. If problems are observed, sampling frequency will be increased as necessary to monitor the biogeochemical changes. The mercury-specific column sample will be analyzed only for mercury to ensure sufficient sample volume.

Effluent samples will be analyzed for CPOIs by DHL Laboratories by purge-and-trap using SW-846 Method 8260. Mercury will be analyzed by Test America using Method 1631. Any deviations from these methods due to sample volumes or other requirements associated with the sample experimental procedures will be documented in the final report.

The purpose of the effluent sampling is to define migration rate and breakthrough of the cap layer. Upon breakthrough and apparent achievement of steady state conditions, the experiment will be stopped. Some of the more hydrophobic compounds may not achieve steady state or may require much longer periods of experimentation. The flow and dimensions have been selected, however, such that all CPOIs (BTEX, naphthalene, and chlorobenzenes), with the exception of mercury, are expected to achieve steady conditions within six months

The cap media and sediment will then be extruded and sectioned for analysis of contaminants of concern. Due to sample volume requirements, it is expected that sectioning will be in 5 cm intervals. For the SMU 6/7 columns three, 5-cm cap material samples and six, 5-cm sediment samples will be sent to Test America for VOC analysis by SW-846 Method 8260. For the mercury specific columns the columns will be segmented in the same intervals and analyzed for mercury by SW846 Method 7471A. This procedure may be modified following shut-down of the Phase III cores to incorporate lessons learned from that effort. Changes will be discussed with NYSDEC.

5.3 Results

The results from the column experiments will be a steady state contaminant flux and chemical concentration profile within the cap. The effluent contaminant concentrations and solid phase concentrations will be compared to predictions of the transient and steady state cap models (Lampert and Reible, 2007) for assessment of contaminant fate processes and rates. Specifically, chemical reactivity in the chemical isolation layer will be estimated by fitting the model to observations. Breakthrough time of a particular CPOI will provide an indication of sorption-

related retardation and steady state concentration will provide an indication of average compound degradation rate. Comparison of biotic to abiotic control column effluent concentrations will indicate whether the observed degradation or loss was due to biotic or abiotic processes. The methods and results of this modeling analysis, including a comparison of fitted and observed concentration measurements, will be reported.

6.0 CARBON ISOTOPE EXPERIMENTS

6.1 Background

The analysis of isotope fractionation is increasingly being used for characterizing and quantifying degradation of contaminants in aquifers and sediment. Carbon isotope tracers can be employed to estimate the rate and extent of degradation of refractory compounds. Isotopes of an element contain different number of neutrons, but the same number of protons and electrons. Unstable isotopes are radioactive (e.g., ^{14}C), and they spontaneously decay to form other isotopes. Stable isotopes (e.g., ^{13}C) are those that do not spontaneously decay. Both types of isotopes can be used to probe the transformation of environmental contaminants.

Because of the recalcitrance of certain compounds under anoxic conditions, transformation is slow and difficult to verify by chromatography over periods of approximately one year. Isotope tracers offer increased sensitivity and allow detection of transformation of only a few percent of the starting mass of contaminant.

Radioactive isotopes are generally measured after mineralization of the contaminant to carbon dioxide. The effluent from the column can be acidified, driving the CO_2 off as a gas and the gas phase can be trapped in a strong basic solution. The basic solution can then be subjected to liquid scintillation counting to evaluate radioactivity and therefore the fraction of the original compound converted to carbon dioxide. These measurements can only be used to evaluate mineralization of the initial introduced radiolabeled compound and do not provide information on the rate of partial degradation of the parent compound (i.e. degradation that does not depend upon mineralization). For estimates of the rate of partial degradation processes, stable isotopes will be used.

Stable isotope (^{13}C) compounds will be separated by chromatography before combustion and detection of isotope enrichment of the resulting carbon dioxide. As a result of the chromatographic separation, DCB can be separated from MCB which can be separated from other reaction intermediate species. By measuring isotope enrichment of each of these compounds separately, an indication of how much of the original stable isotope has distributed (by degradation processes) to the other species can be determined. Thus, the introduction of isotopically enriched DCB can be used to estimate the net rate of formation of isotopically enriched MCB and other intermediates.

6.2 Objective

The primary objective of the Phase IV carbon isotope studies is to determine the extent of degradation expected in a conventional sand cap in SMUs 6 and 7 of Onondaga Lake. Studies conducted during Phase II and Phase III (batch and column biodegradation experiments) indicate that most compounds degrade sufficiently quickly in SMUs 6 and 7 such that a conventional sand cap will be adequate; however, limitations on detectable levels of compounds in SMU 6 and 7 sediment, as well as recalcitrant compounds with degradation half lives on the order of a year or more, warrant further evaluation prior to cap design. The proposed experiments are designed to provide additional confidence in this conclusion and to examine specifically the most refractory of the SMU 6 and 7 contaminants, 1,4-dichlorobenzene (DCB). This compound degrades slowly to monochlorobenzene (MCB), primarily under anaerobic conditions; MCB degrades slowly under anaerobic conditions and more rapidly under aerobic conditions. 1,2-DCB is generally present in lower concentrations than the 1,4 isomer in Onondaga Lake sediments, and it degrades more rapidly. 1,3-DCB is generally not present in Onondaga Lake sediment samples and, if present, would also be expected to degrade more rapidly than 1,4-DCB. Thus, only 1,4-DCB and its decomposition to MCB will be examined in the Phase IV proposed experiments.

Column effluents will be analyzed with a high resolution gas chromatograph-combustion-isotope ratio mass spectrometer (GC-C-IRMS), which is housed in the Stable Isotope Laboratory at the Jackson School of Geosciences at the University of Texas at Austin. With this system, it should be possible to monitor and estimate degradation rates for 1,4-DCB and relatively stable decomposition products such as MCB. The influent to the cap column will be spiked with isotopically enriched 1,4 DCB and the effluent samples will be analyzed for isotopically enriched parent compound as well as intermediates. The effluent concentration of ^{13}C labeled 1,4 DCB indicates the reaction of DCB, if any, while the presence of other 13C compounds indicates their net formation rate. To illustrate if 50% of the DCB degraded to MCB and the MCB was stable, 50% of the original mass of isotopically enriched DCB would be found in DCB while 50% would be found in MCB. If half of the MCB were likewise degraded in the cap, then only 25% of the original mass would be found in MCB and 25% of the original isotope enrichment would be found in other species.

In order to maximize the potential data that can be collected in the experiments, ^{14}C labeled 1,4 DCB or MCB will also be introduced between source and cap column. These will likely be introduced after stable isotopes have indicated the reactivity of the compound as a confirmation step. The^{14}C enriched species will not interfere with the stable isotope evaluation because the mass spectrometric analysis separates the compounds on the basis of molecular mass. But the need for essentially complete capture of the radiolabeled compound likely precludes both compounds from being introduced at the same time (See Section 6.3).

6.3 Procedures

Experiments will be conducted in an oxygen-free chamber kept at 12°C. Each sample set-up (Figure 2) will consist of two columns in series; in the direction of flow, the first column will contain lake sediment and the second column will contain the sand cap. Artificial porewater (APW) or extracted porewater will be pumped from a reservoir through the sediment column by a peristaltic pump. The effluent from the sediment column will be representative of *in situ* conditions in terms of water chemistry and microbial community. A syringe pump will introduce isotope-enriched 1,4-DCB into the column tubing prior to entry into the cap column. Cap column effluent will be analyzed for 1) concentration of parent DCB; 2) concentrations of organic metabolic products, including MCB, benzene, and chlorocatechol; and 3) isotopic enrichment of inorganic carbon, indicative of complete mineralization of DCB. Column effluent will be trapped on a sorbent column (Tenax will be used as VOC sorbent), then desorbed/extracted into the GC-C-IRMS instrument to increase sensitivity. The specific amount of carbon isotopic tracer to be added in these experiments will be defined in preliminary experiments to be conducted while the columns are operated in a conventional manner and the hydraulic tracer experiments are conducted. The amount of isotope tracer and detection limits will be provided to NYSDEC following the methods development work.

As discussed above, the isotopes can not be injected simultaneously. The preference is to begin the first injection with stable isotopes and then use mineralization of the radioisotopes to confirm the results. Based on transport rates observed through the Phase III columns, the time for a pulse to move through the system will be on the order of 1-3 months. The injection of isotopes will be spaced such that the alternate isotope will be injected immediately after analysis is complete or when there is enough separation between the two that the other can be injected with a comfortable separation distance.

6.4 Results

The results from the isotope studies will be mass of parent compound DCB, organic metabolic products, and inorganic carbon as captured on the sorbents. Results will include degradation rates of DCB and potentially MCB (if degradation is observed).

7.0 SCHEDULE

It is anticipated that sediment samples will be collected the last week of September. The additional columns in SMU 6 and 7 and the mercury-specific partitioning studies will be initiated upon receipt at the University of Texas. After the SMU 6 and 7 columns are up and running, the isotope work will begin. It is estimated that the first pulse of isotope will be injected in early January and initial results on the sorbent will be analyzed by late March. Results from this work will be used as an additional line of evidence to evaluate the degree to which the isotopic tracer results are confirming degradation of the most recalcitrant compounds in SMU 6 and 7 and ultimately the need for an amended cap in SMU 6 and 7 for the conceptual design. The experiments will continue to run for approximately one year with periodic analysis of the

sorbent. After each round of isotope analysis, a decision will be made as to the utility of continuing the experiments. Column shut down will be conducted in consultation with NYSDEC.

An interim report or presentation of results will be provided to NYSDEC in early April 2009.

8.0 QUALITY ASSURANCE/QUALITY CONTROL

The sample names, QA/QC procedures, sample collection, data entry, and data validation for this portion of the work will be conducted in accordance with the Phase I PDI Work Plan (Parsons, 2005). Any deviations from these procedures will be discussed with NYSDEC prior to execution of the work or qualified in the final report if dictated by experimental process limitations during bench studies.

9.0 REFERENCES

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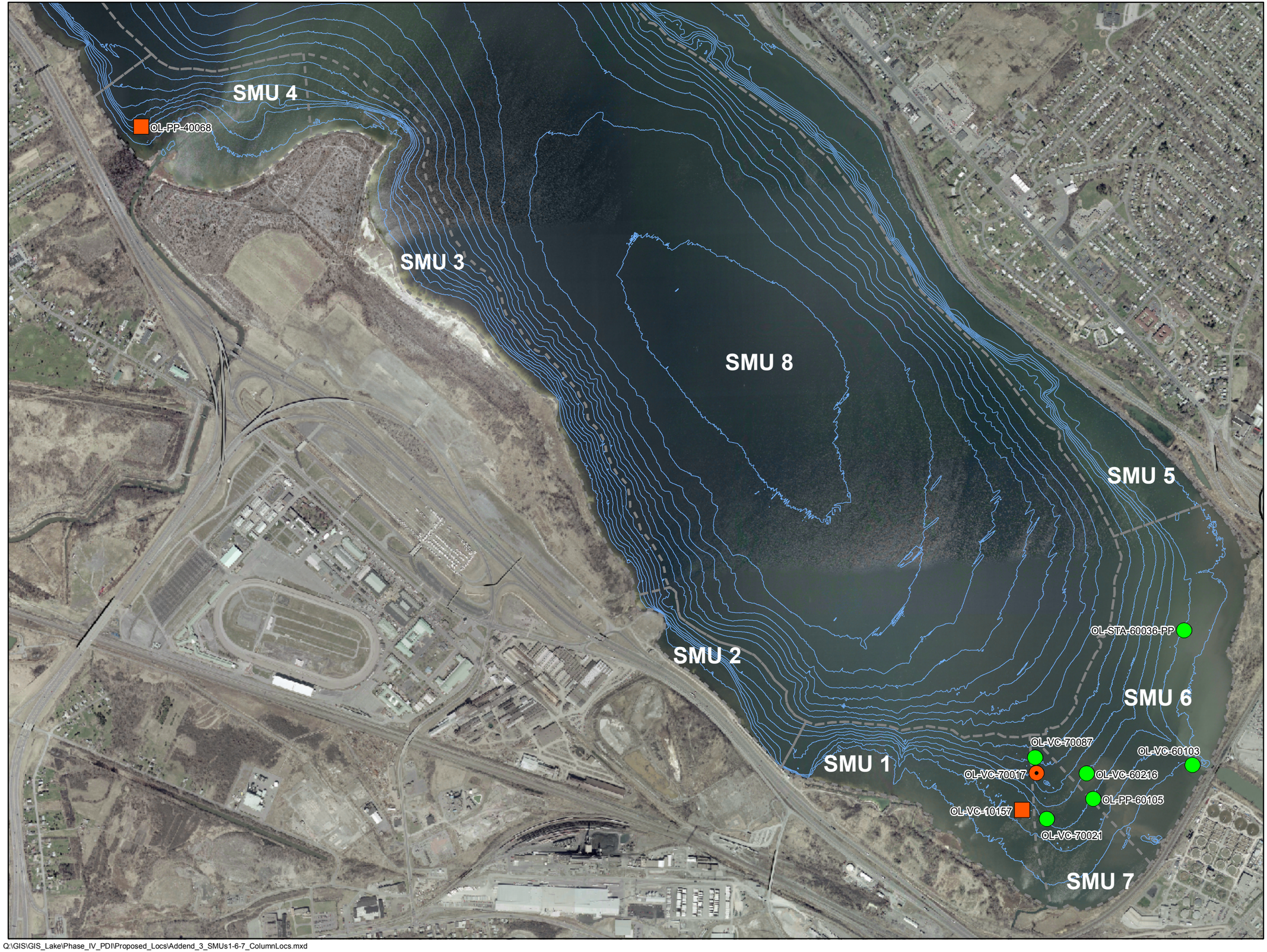
FIGURES



Proposed Additional Column Study Location

Proposed Mercury Specific Column Study Location

Proposed Additional and Mercury Specific Column Study Location

NOTES

1. Bathymetry contours are in 4 foot intervals.
2. Water depth based on average lake elevation of 362.82 feet.

0 250 500 1,000 1,500 2,000
Feet

FIGURE 1

Honeywell

Onondaga Lake
Syracuse, New York

Phase IV PDI Addendum 3
SMUs 1-4-6-7
Proposed Sample Locations
for Column Studies

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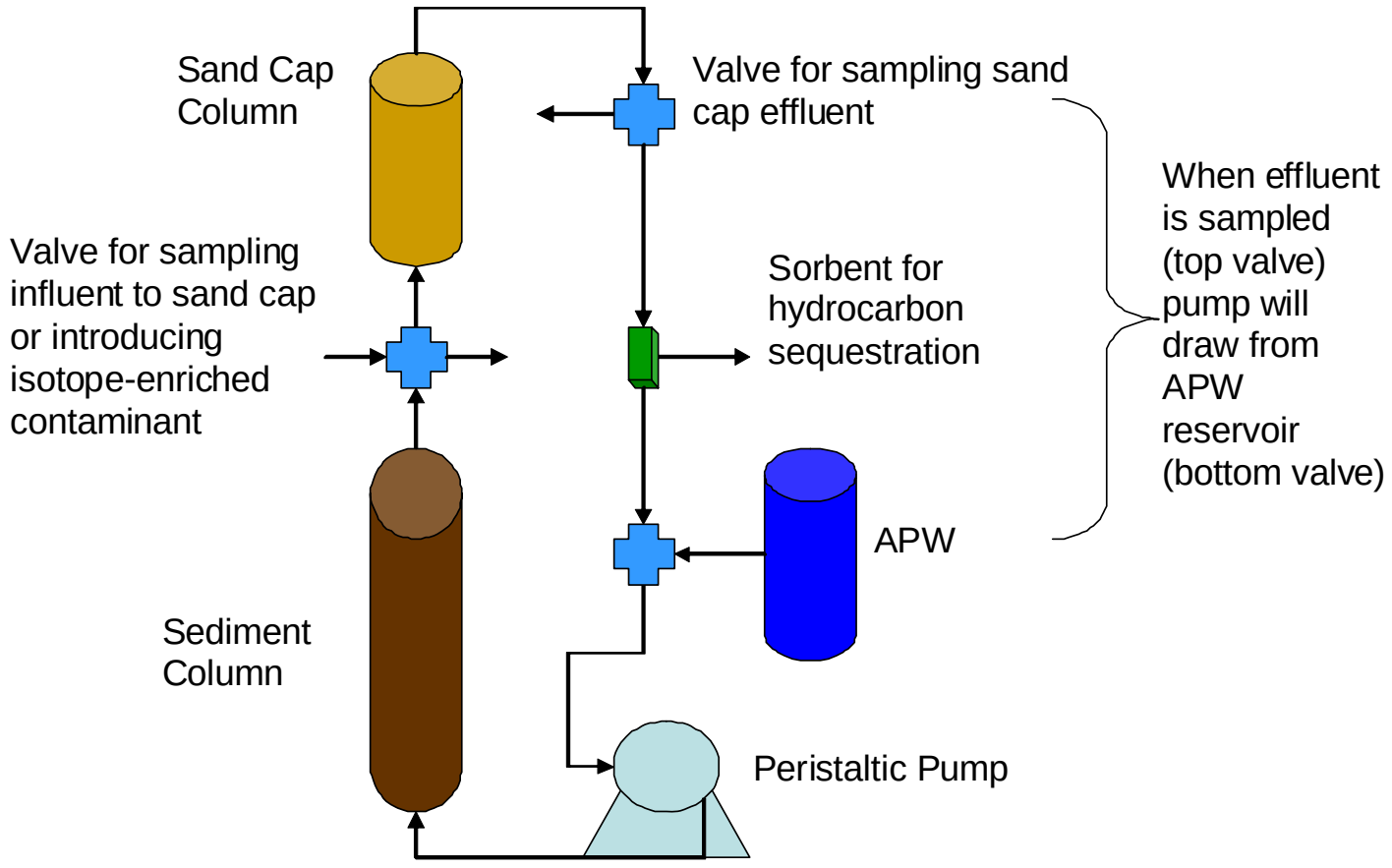
Q:\GIS\GIS_Lake\Phase_IV_PDI\Proposed_Locs\Addend_3_SMUs1-6-7_ColumnLocs.mxd

FIGURE 2

PHASE IV COLUMN TEST SCHEMATIC



TABLES

TABLE 1
SAMPLE LOCATION INFORMATION

SMU	Sample Location	Target Sample Depth Interval*	Number of Cores	Reason for Selection
Cores for Additional Column Studies in SMU 6 and 7				
6	OL-VC-60103	2-4	3	Sufficient** concentrations of dichlorobenzene, chlorobenzene, toluene, benzene. Maximum toluene concentration measured in SMU 6.
6	OL-PP-60105	2-4	3	Sufficient concentrations of chlorobenzene, dichlorobenzene, benzene, naphthalene. Benzene concentration (16 ug/L) very close to maximum measured in SMU 6 (19 ug/L).
6	OL-STA-60036-PP	0-1	3	Sufficient concentrations of di-chlorobenzene, chlorobenzene, xylene, toluene, naphthalene. Maximum ethylbenzene concentration measured in SMU 6. Naphthalene concentration at this location close to the maximum concentration in the SMU.
6	OL-VC-60216	2-4	3	Sufficient concentrations of di-chlorobenzene, chlorobenzene, xylene, benzene, naphthalene. Maximum CB, DCB and Xylene measured in SMU 6 (based on unvalidated Phase 4 data).
7	OL-VC-70017	7-9	3	Sufficient concentrations of BTEX, chlorobenzene, dichlorobenzene and naphthalene. Maximum chlorobenzene concentration measured very close to this location 70021A.
7	OL-PP-70021	9-10	3	Sufficient concentrations of BTEX, chlorobenzene, di-chlorobenzene and naphthalene. Benzene 600 ug/L concentration is the maximum in SMU 7. Maximum toluene, dichlorobenzene concentration in SMU.

TABLE 1 (CONTINUED)
SAMPLE LOCATION INFORMATION

SMU	Sample Location	Target Sample Depth Interval*	Number of Cores	Reason for Selection
Cores for Additional Column Studies in SMU 6 and 7 (Cont.)				
7	OL-VC-70087	8-10	3	Sufficient concentrations of BTEX, chlorobenzene, dichlorobenzene and naphthalene.
Mercury Specific Column Studies				
1	OL-VC-10157	0-2	3	High levels of Hg observed in porewater.
4	OL-PP-40068	2-4	3	High levels of Hg observed in porewater.
7	OL-PP-70017	9-10	3	High levels of Hg observed in porewater.

** 14" core segment will include this target sample interval.*

*** "Sufficient" defined as approximately 10 ug/L based on typical detection limits and a level of confidence that the results are outside the noise of the analytical method.*