DRAFT ONONDAGA LAKE CAPPING AND DREDGE AREA AND DEPTH INITIAL DESIGN SUBMITTAL

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LIST OF ACRONYMS

AC	Activated carbon
ARARs	Applicable or Relevant and Appropriate Requirements
BMPs	best management practices
BSQV	bioaccumulation-based sediment quality value
CPP	Citizen Participation Plan
CPOIs	Chemical parameters of interest
CPP	Onondaga Lake Citizen Participation Plan
CY	cubic yards
ESD	Explanation of Significant Differences
foc	fraction of organic carbon
FS	Feasibility Study
GPS	global positioning system
Honeywell	Honeywell International Inc.
IDS	Initial Design Submittal
ILWD	in-lake waste deposit
IRM	Interim Remedial Measure
Koc	organic carbon partitioning coefficient
LCP	Linden Chemical and Plastics
MNR	monitored natural recovery
NAPL	Non-aqueous-phase liquid
NAVD	North American Vertical Datum
NPL	National Priorities List
NYSCC	New York State Canal Corporation
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
OM&M	operation, maintenance and monitoring
OU	Operable Unit
PEC	Probable effects concentration
PECQ	PEC quotient

LIST OF ACRONYMS (CONT.)

PRGs	preliminary remedial goals
PSA	Preliminary Site Assessment
RAOs	remedial action objectives
RD/RA	remedial design/remedial action
RDWP	Remedial Design Work Plan
RI	Remedial Investigation
ROD	Record of Decision
SCA	Sediment Consolidation Area
SECs	Sediment effects concentrations
SMUs	Sediment Management Units
SOW	Statement of Work
SVOCs	semi-volatile organic compounds
VOCs	volatile organic compounds
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

Honeywell continues the progress toward achieving the goals of the Record of Decision (ROD) and the community's vision for a restored Onondaga Lake with the development of this draft Capping and Dredge Area and Depth Initial Design Submittal (IDS). The lake remediation plan, which was selected by the New York State Department of Environmental Conservation (NYSDEC) and the U.S. Environmental Protection Agency (USEPA), calls for a combination of dredging and capping – environmental cleanup standard methods that will address the contamination in lake sediments and water. This IDS presents the conceptual design relating to the delineation of remedial areas, the design of the sediment cap, and the establishment of the areas and depths of sediment to be dredged as part of the remedy.

The Honeywell design team is developing a remedial design that is effective and meets the objectives outlined in the ROD, restoring Onondaga Lake while ensuring long lasting protection of health and the environment. This design has been developed by a design team consisting of more than 100 local engineers and scientists working with nationally recognized experts from various universities, research institutions, and specialty engineering firms, and with input from community stakeholders.

Restoring diverse, functioning and sustainable habitats to the remediated areas of Onondaga Lake is one of the top priorities of this remedial program. Therefore, habitat considerations are at the forefront of the various design evaluations for the lake and have been fully integrated into this document. Habitat considerations are a major factor in developing cap thicknesses. Dredging areas and depths are also significantly influenced by habitat considerations because post-remediation water depths were developed in order to achieve specific habitat-based goals. The revised draft Remedial Design Elements for Habitat Restoration (Parsons, 2009a) presents a comprehensive framework for habitat restoration and enhancement within and adjacent to the lake for those areas impacted by remedial activities. The cap will provide long-term chemical isolation of underlying impacted sediments. It will be resistant to erosive forces such as wind/wave-generated currents, tributary and other inflows, and ice. It will also provide a suitable habitat substrate that plants, animals, and fish can use without impacting the chemical isolation layer.

Honeywell recognizes the importance of controlling upland sources of contamination to the lake system, and has made significant progress with the remediation of upland sites. Honeywell has already completed construction of the remedy at the LCP OU-1 site, a former Allied Chemical property that was one of the primary sources of mercury contamination to Onondaga Lake. Honeywell has also made significant progress with the installation of a hydraulic barrier wall and groundwater treatment plant, as part of the Willis/Semet Interim Remedial Measure (IRM) Barrier Wall, to prevent contaminated groundwater from entering the lake. Approximately 1,200 ft of an underground barrier wall (the Semet portion), constructed of interlocking steel panels, was installed along the southwest shoreline of Onondaga Lake in 2006 as part of the IRM. Additionally, Honeywell completed construction of a groundwater treatment plant in 2006 to collect, process, and treat contaminated groundwater that will accumulate behind the underground barrier wall. Installation of an additional 1,600 ft of nearshore underground barrier wall (the Willis portion of the IRM) was completed in 2008.

Community input remains a vital component of Honeywell's design for the restoration of Onondaga Lake. Honeywell is committed to working with community leaders, interested stakeholders, and citizens to include input, recommendations, comments and perspectives into the design process. Community members have the opportunity to participate in the design, construction, and post-construction periods as detailed in the NYSDEC's Citizens Participation Plan (CPP) (NYSDEC 2009). Feedback received through the community participation process has already had a considerable influence on design-level decisions in several areas of the remedial design.

Onondaga Lake Design Process

The selected remedy outlined in the ROD issued by USEPA and NYSDEC calls for the dredging and disposal of up to an estimated 2.65 million cubic yards (CY) of contaminated sediments, construction of an isolation cap over an estimated 425 acres in the shallower areas of the lake, construction of a thin-layer cap over an estimated 154 acres in the lake's deeper areas, construction and operation of a hydraulic control system along part of the shoreline, completion of a pilot study to evaluate methods to prevent formation of methyl mercury, wetland and habitat restoration, monitored natural recovery, as well as long-term maintenance and monitoring.

Detailed technical evaluations completed during the Feasibility Study (FS) demonstrated that capping in conjunction with dredging would be effective and would be the best approach to meet the remedial goals. Following completion of the FS and issuance of the ROD, extensive design-related investigation activities were initiated to supplement the data collected during the Remedial Investigation (RI) and provide the data necessary to allow design of the remedy. Design–related investigations related to cap design and determination of dredge areas and depths have included:

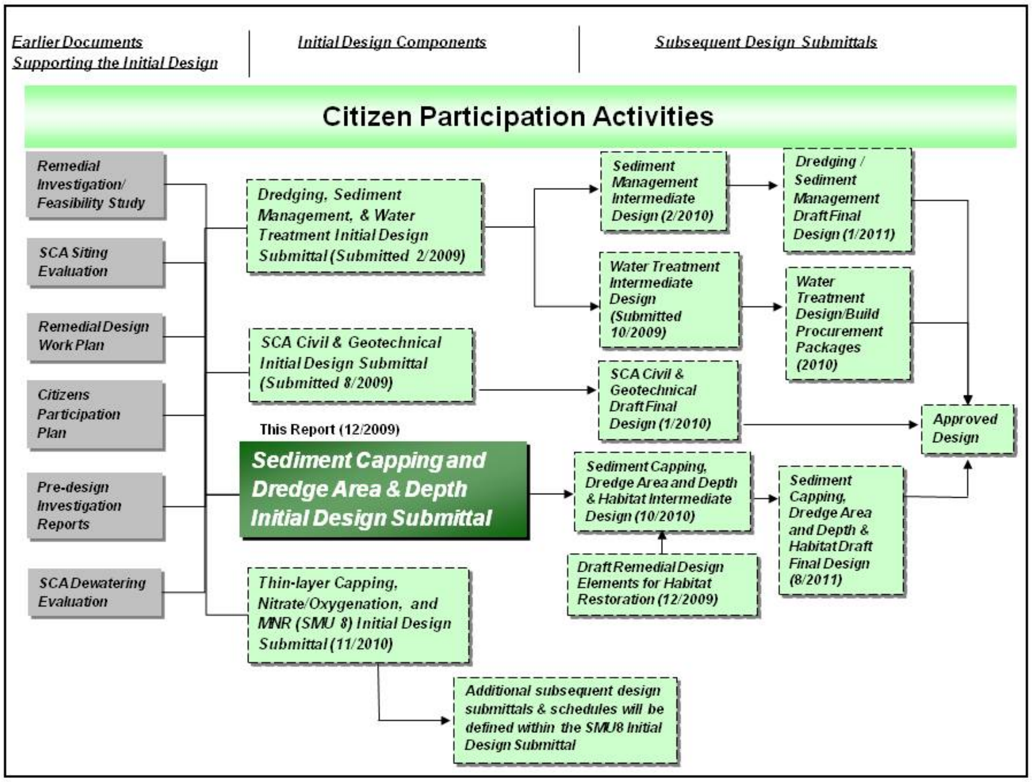
- bench-scale tests to evaluate cap performance and generate data pertaining to design of the chemical isolation layer;
- geophysical surveys to map the lake bottom and identify debris and in-lake utilities that will be addressed as part of the remediation;
- sediment sampling for chemical and geotechnical analyses to determine the remediation areas and dredge depth;
- *in situ* geotechnical testing of sediments to provide data related to design of the cap; and
- porewater sampling and analysis to generate data pertaining to design of the chemical isolation layer.

These activities to date have provided more than 800 sediment sampling locations, almost 10,000 environmental samples, and more than 200,000 chemical and geotechnical analyses to support design of the selected remedy. Honeywell presented the results of these investigations in data summary reports and submitted them to the NYSDEC. These reports are available in the public document repositories listed in the CPP.

Honeywell's design team prepared this IDS in accordance with the Draft Remedial Design Work Plan for the Onondaga Lake Bottom Subsite (RDWP) (Parsons, 2009b), the ROD and associated Consent Decree Scope of Work (SOW). As detailed in the RDWP, the remedial design will include the preparation of four IDSs, each of which will be submitted separately, and will address various elements of the remedy. Separating the design into four submittals allows for a streamlined schedule associated with critical path activities (e.g., sediment consolidation area [SCA] and water treatment) to facilitate achievement of the timeline associated with initiating dredging in 2012, which is a requirement of the Consent Decree. The four design submittals include the following:

- Dredging, Sediment Management, and Water Treatment (Parsons, May 2009c);
- Sediment Consolidation Area Civil and Geotechnical IDS (Parsons, December 2009d);
- Capping and Dredge Area and Depth IDS (this report); and
- Thin-Layer Capping, Nitrate Addition/Oxygenation, and MNR IDS (scheduled for submittal 11/25/2010).

The following graphic illustrates how these four IDS documents fit in with the overall Onondaga Lake design process and highlights how citizen participation is an important component in the overall process. Several earlier supporting documents (e.g., remedial investigation/feasibility study reports etc.) provide the basis for the preparation of the four IDS documents. Combined, these four documents will provide the initial design level details for all components of the Onondaga Lake remedy. Additional design details will be provided in subsequent submittals, as shown below.



General Schematic of Onondaga Lake Design Process

This IDS presents the design team's process and evaluation results relating to three main technical areas: (1) delineation of remediation areas, (2) design of an effective sediment cap, and (3) establishment of the areas and depths of sediment to be dredged as part of the remedy. Each of these technical areas is discussed below. Dredging areas and depths are developed in the same document as the cap design because the dredging and capping components of the design are inter-related. For example, in many cases, the dredging areas and depths are determined based on desired post-capping water depths based on habitat considerations.

Delineation of Remediation Areas

To ensure that all of the contaminated sediments are addressed, Remediation Areas A through F have been defined for the littoral zone based on in-lake conditions determined through extensive design-related sampling investigations. These remediation area designations are a refinement to the sediment management unit (SMU) designations utilized in the FS and ROD and do not change the scope of the remedy. Remediation boundaries were conservatively developed to encompass all areas of contamination, and some clean areas beyond them as a conservative safety buffer.

Capping and Habitat Restoration

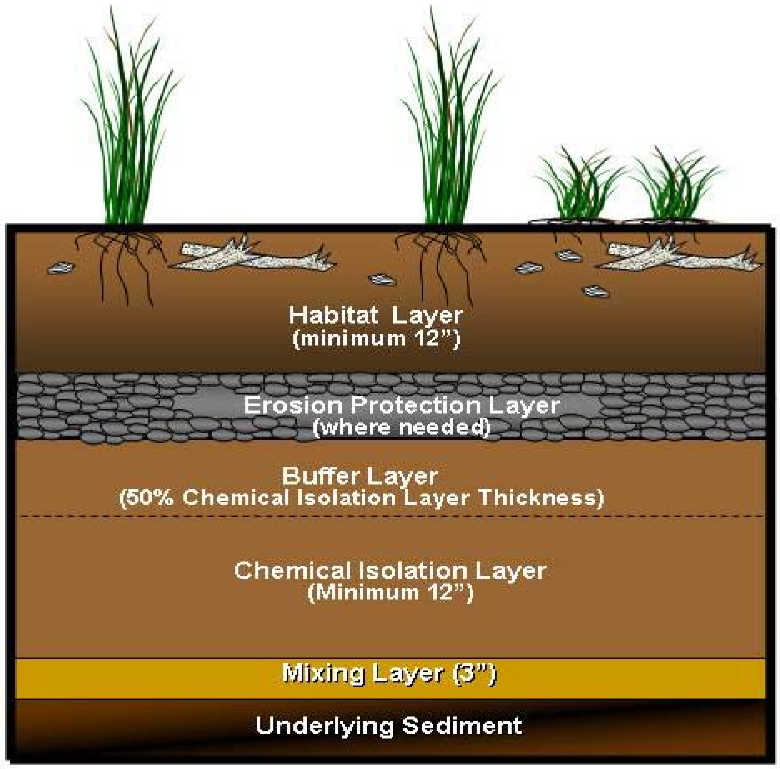
As detailed in this IDS, detailed technical evaluations demonstrate that capping will be effective in Onondaga Lake. Capping of subaqueous contaminated sediments is an accepted and proven long-term engineering option for managing dredged materials and for *in situ* remediation of contaminated sediments (USEPA, 1994, 2005; NRC, 1997, 2001; Palermo, Clausner, *et al*., 1998; Palermo, Maynord, *et al*., 1998), and is a significant component of the Onondaga Lake remedy. Sediment caps are a proven technology and have been implemented at numerous sediment remediation sites, including the Fox River in Wisconsin, the St. Louis River Interlake Duluth Tar site in Minnesota, and Port Hueneme in California. Based on the cleanup objectives established for the lake, the functions for the cap include the following:

- restoration and enhancement of aquatic habitat in the lake;
- physical isolation of the contaminated sediment from the aquatic environment;
- reduction or elimination of the flux of dissolved contamination into the upper layers of the cap such that cap performance criteria are not exceeded; and
- stabilization of contaminated sediment, preventing resuspension and transport of contaminants to the profundal area and other areas of the lake.

Habitat restoration goals are established within the Habitat Plan. The capping and habitat restoration design presented in this IDS achieve the established habitat restoration goals for the lake. These habitat restoration goals are to

- maintain or improve the quality and diversity of habitat in the lake;
- discourage the establishment of invasive species; and
- promote public access and use and minimize future maintenance.

To ensure that habitat restoration, erosion protection and chemical isolation goals are met and that the cap provides long-term protection of human health and the environment, the cap will include specific layers dedicated to various purposes. These layers will include a habitat layer, an erosion protection layer, a buffer layer, and a chemical isolation layer, as well as an allowance for mixing of the bottom of the chemical isolation layer with the underlying lake sediment, as shown in the schematic below. The minimum thicknesses shown in this figure are based on minimum ROD requirements and are discussed in detail in this IDS.



General Schematic of Sediment Cap

The design team performed detailed evaluations for each of the sediment cap layers depicted in the figure above. These evaluations included extensive laboratory bench-scale analysis, state-of-the-science numerical and computer modeling designed to conservatively predict long-term effectiveness, assessment of capping successes and lessons learned at precedent sites, evaluation of post-remediation habitat considerations, and continuous consultation with national and local experts. These analyses were performed to ensure that the design of each individual layer is sufficient to withstand the various conditions expected in the lake, and will function as necessary to ensure compliance with the remedial goals.

The depth of sediments requiring dredging in many parts of the lake is determined by the depth of water desired and the thickness of the cap. Water depths following dredging were developed in the Lake Wide Habitat Plan to achieve optimum habitat conditions. The cap thickness is a combination of the habitat layer, erosion layer, and chemical isolation layer as explained in Section 4. The dredging depths are then discussed in Section 5. For example, in areas near the mouth of Ninemile Creek, the habitat restoration goal includes development of areas where floating aquatic plants such as lilly-pads will thrive. This type of habitat is currently absent from Onondaga Lake. The required water depth for floating aquatic plants is 1 to 3 ft. Dredging to achieve a water depth of 7 ft prior to placement of a 5 ft thick cap (including a 2 ft habitat layer) would result in a post-remediation water depth of 2 ft, which is ideal for floating aquatic plants. Because dredge depth are developed based on these types of considerations in many areas, the cap and habitat restoration goals and design are developed prior to presentation of the dredging design even though dredging will be completed prior to capping as part of the construction sequence.

Dredge Areas, Depths, and Volumes

Dredging is a major component of the remedy. Remedy effectiveness will be achieved by implementing dredging to achieve two primary goals. Elevation-based dredging will achieve specific water depths which will allow the placement of the sediment cap to result in targeted water depths, which have been selected based on habitat considerations. Dredging to a specified elevation will also be implemented in an area of the lake known as the in-lake waste deposit (ILWD) to achieve specific removal goals, followed by capping. Dredging to achieve cleanup criteria will be used in specific nearshore areas, which will remove all of the sediments in that area which exceed the specified cleanup criteria for the lake.

The overall lake remedy as specified in the ROD included dredging of as much as an estimated 2,653,000 CY of sediment based on 2004 estimates. Subsequent data collection and more detailed design evaluations from 2004 to 2009 have allowed for a more accurate estimate of the dredge volume required to meet the ROD-specified remedial goals, resulting in a design dredge volume of approximately 2,172,000 CY. A majority of the volume difference is attributed to the Explanation of Significant Differences (ESD) associated with SMU 2. Based on investigation data and a stability evaluation, there was significantly less non-aqueous phase liquid (NAPL)-impacted material beneath the lake in SMU 2 than was assumed during the FS and ROD, and removing this material could result in instability of the adjacent shoreline. Therefore, as part of the ESD, the alignment of the Willis-Semet IRM Barrier Wall (Willis portion) was moved offshore immediately beyond the farthest extent of pooled NAPLs within the lake in lieu of dredging of this material.

As part of the remedial design process, the design team will continue to work with the community to develop various performance criteria and work plans specifically designed to ensure that the health and safety of the surrounding community and environment is maintained throughout the execution of the remedy. The community health and safety plans relevant to capping activities that will be developed and presented in the Final Design will include:

- Site Security & Community Health and Safety Plan;
- Traffic Management Plan;
- Navigational Protection; and
- Noise Abatement Plan.

A Spill Contingency Plan and Volatile and Odor Emissions Monitoring and Mitigation Plan will also be prepared, as detailed in the Operations IDS.

In addition, Honeywell is committed to minimizing the carbon footprint of remedial construction activities. During the design phase, evaluations are being conducted to identify opportunities to incorporate sustainability concepts, including those presented in the *Clean and Green Policy* (USEPA, 2009) into all aspects of the remediation. To the extent practicable, use of renewable energy sources, utilization of locally produced/sourced materials and supplies, reduction/elimination of waste, efficient use of resources and energy, and other practices will be specified in the remedial design, and implemented during remedial construction.

Long-Term Effectiveness and Protectiveness of the Cap

Based on sound science and detailed engineering evaluations completed by a design team consisting of numerous local and nationally recognized technical experts, the conceptual design included herein provides long term protection to human health of the surrounding community members and the public, and satisfies the requirements of the NYSDEC's ROD, and the RDWP. The cap will provide long-term chemical isolation of underlying impacted sediments. It will be resistant to erosive forces such as wind/wave-generated currents, tributary and other inflows, and ice. It will also provide a suitable habitat substrate that plants, animals, and fish can use without impacting the chemical isolation layer. A long-term cap monitoring and maintenance plan will be developed and implemented to ensure that the cap performs as intended. Ongoing input from community groups and the integration of the habitat considerations will help ensure that the vision for the post-remediation Onondaga Lake is in line with the desires of the community, and maximizes the value of this important asset.

SECTION 1

BACKGROUND AND DESIGN PROCESS OVERVIEW

This Onondaga Lake Capping and Dredge Area and Depth IDS Report has been prepared on behalf of Honeywell. The purpose of this IDS Report is to provide conceptual-design level evaluation of components of the Onondaga Lake remediation pertaining to the sediment cap, the definition of the areas, depths, and volumes of sediment to be dredged, and integration with habitat considerations. Restoring diverse, functioning and sustainable habitats to the remediated areas of Onondaga Lake is one of the top priorities of this remedial program. Therefore, habitat considerations are at the forefront of the various design evaluations for the lake and have been fully integrated into this document. Regulatory and community input and review will continue through the design process, and public feedback will be obtained on this design and addressed during further development and finalization of the remedial design.

The lake bottom is on the New York State Registry of Inactive Hazardous Waste Sites and is part of the Onondaga Lake National Priorities List (NPL) Site. Honeywell entered into a Consent Decree (United States District Court, Northern District of New York, 2007) (89-CV-815) with the NYSDEC to implement the selected remedy for Onondaga Lake as outlined in the ROD issued on July 1, 2005. The following documents are appended to the Consent Decree: ROD, Explanation of Significant Differences (ESD), SOW, and Environmental Easement.

This IDS was prepared in accordance with the Remedial Design Work Plan (RDWP) for the Onondaga Lake Bottom Subsite (Parsons, 2009b). This IDS is based on extensive information and data gathered during five years of design-related investigations, as well as data collected as part of the Remedial Investigation (RI) (TAMS, 2002). In addition to the thousands of samples collected and analyzed, numerous bench studies executed, and completion of many field evaluations and data collection activities, additional investigation activities are anticipated to address data gaps subsequent to the submittal of this IDS. Data gathered during these upcoming investigations will be incorporated into future design submittals.

1.1 ONONDAGA LAKE DESCRIPTION

Onondaga Lake is a 4.6 square mile (3,000 acre) lake located in Central New York State immediately northwest of the City of Syracuse (Figure 1.1). The lake is approximately 4.5 miles long and 1 mile wide, with an average water depth of 36 ft.

Ninemile Creek and Onondaga Creek are the two largest tributaries to Onondaga Lake (Figure 1.1). Other tributaries in a clockwise direction from the southeast section of the lake include Ley Creek, Harbor Brook, the East Flume, Tributary 5A, Sawmill Creek, and Bloody Brook (Figure 1.1). In addition to the tributary streams, the treated effluent from the Onondaga County Metropolitan Wastewater Treatment Plant (Metro), located between Onondaga Creek and Harbor Brook, contributes a significant portion of the water entering the lake.

As part of the remedial alternative development and evaluation process during the FS (Parsons, 2004), the lake bottom was divided into eight sediment management units (SMUs) based on water depth, source of water entering the lake, and physical, ecological, and chemical characteristics (NYSDEC and United States Environmental Protection Agency [USEPA], 2005). SMUs 1 through 7 are located in the littoral zone (less than 30 ft) of the lake where most aquatic vegetation and aquatic life reside, while SMU 8 consists of sediment in the profundal zone (deeper than 30 ft) (Figure 1.2).

1.2 REMEDIATION OBJECTIVES AND GOALS

A key objective of all remedial activities is to ensure protection of onsite workers, the surrounding community, and the environment from potential risks associated with the completion of the remedy. The ROD also provides more specific objectives, called Remedial Action Objectives (RAOs), as listed below.

- "ROA 1: To eliminate or reduce, to the extent practicable, methylation of mercury in the hypolimnion."
- "RAO 2: To eliminate or reduce, to the extent practicable, releases of contaminants from the in-lake waste deposit (ILWD) and other littoral areas around the lake."
- "ROA 3: To eliminate or reduce, to the extent practicable, releases of mercury from profundal (SMU 8) sediments."
- "RAO 4: To be protective of fish and wildlife by eliminating or reducing, to the extent practicable, existing and potential future adverse ecological effects on fish and wildlife resources, and to be protective of human health by eliminating or reducing, to the extent practicable, potential risks to humans."
- "RAO 5: To achieve surface water quality standards, to the extent practicable, associated with chemical parameters of interest (CPOIs)".

Of these, RAOs 2, 4, and 5 pertain to the dredging and capping activities described in this IDS.

As part of the FS process, USEPA guidance requires the establishment of preliminary remedial goals (PRGs) that can be used to select appropriate remediation technologies and to develop remedial alternatives within the FS. The PRGs represent the primary goals of the remedial efforts. To achieve the RAOs stated above, three PRGs were developed to address the three primary affected media within the lake: sediment, biological tissue, and surface water. PRGs for Onondaga Lake, as per the ROD (NYSDEC and USEPA, 2005, p. 35), are listed below.

- "PRG 1: Achieve applicable and appropriate sediment effects concentrations (SECs) for CPOIs and the bioaccumulation-based sediment quality value (BSQV) of 0.8 mg/kg for mercury, to the extent practicable, by reducing, containing, or controlling CPOIs in profundal and littoral sediments."
- "PRG 2: Achieve CPOI concentrations in fish tissue that are protective of humans and wildlife that consume fish. This includes a mercury concentration of 0.2 mg/kg in fish

tissue (fillets) for protection of human health based on the reasonable maximum exposure scenario and USEPA's methylmercury National Recommended Water Quality criterion for the protection of human health for the consumption of organisms of 0.3 mg/kg in fish tissue. This also includes a mercury concentration of 0.14 mg/kg in fish (whole body) for protection of ecological receptors. These values represent the range of fish tissue PRGs.

- "PRG 3: Achieve surface water quality standards, to the extent practicable, associated with CPOIs".

PRG 1 addresses RAOs 2 and 4. PRG 2 addresses RAO 4. PRG 3 addresses RAO 5.

1.3 REMEDY OF RECORD

The ROD for the lake bottom presents the remedy selected by NYSDEC and USEPA for addressing the RAOs and PRGs presented in Section 1.2 above. The SOW, presented as Appendix C of the Consent Decree, further describes design-related elements for the implementation of the remedy, such as the development of dredging areas and volume; isolation cap areas, models and components; approach for addressing the profundal zone (SMU 8); management of dredged sediments; water treatment system; and the design and construction schedule.

Major components of the selected remedy relevant to the dredging and capping activities in the littoral zone, which is the focus of this IDS Report, are set forth in the ROD and SOW and are summarized as follows (United States District Court, 2007 – appendices to the Consent Decree):

- "Dredging of as much as an estimated 2,653,000 CY of contaminated sediment/waste from the littoral zone in Sediment Management Units (SMUs) 1 through 7 to a depth that will prevent the loss of lake surface area, ensure cap effectiveness, remove non-aqueous-phase liquids (NAPLs), reduce contaminant mass, allow for erosion protection, and re-establish the littoral zone habitat. Most of the dredging will be performed in the ILWD (which largely exists in SMU 1) and in SMU 2."
- "Dredging, as needed, of an additional 3.3 ft in the ILWD to remove materials within areas of hot spots (to improve cap effectiveness) and additional dredging, as needed, to ensure stability of the cap."
- "Placement of an isolation cap over an estimated 425 acres of SMUs 1 through 7."
- "Completion of a comprehensive lakewide habitat restoration plan."
- "Habitat reestablishment will be performed consistent with the lakewide habitat restoration plan in areas of dredging/capping."
- "Implementation of institutional controls including the notification of appropriate governmental agencies with authority for permitting potential future activities which could impact the implementation and effectiveness of the remedy."
- "Implementation of a long-term operation, maintenance, and monitoring (OM&M) program to monitor and maintain the effectiveness of the remedy".

NYSDEC will certify that the institutional controls are in place and that Honeywell is performing remedy-related OM&M.

The NYSDEC and USEPA issued an ESD as Appendix B of the Consent Decree to specify a modification to the selected remedy documented in the ROD. Based on investigation data and a stability evaluation, there was significantly less NAPL-impacted material beneath the lake in SMU 2 than was assumed during the FS and ROD, and removing this material could result in instability of the adjacent shoreline. Therefore, the alignment of the Willis-Semet IRM Barrier Wall (Willis portion) was moved offshore immediately beyond the farthest extent of pooled NAPLs within the lake in lieu of dredging of this material. In addition, NAPL recovery wells will be installed on the landward side of the new barrier wall. Existing upland areas along WB 1-8 will be converted to new aquatic habitat to mitigate the loss of lake surface area resulting from placement of the barrier wall offshore.

1.4 DESIGN PROCESS OVERVIEW

Detailed technical evaluations completed during the FS demonstrated that capping in conjunction with dredging would be effective and would be the best approach to meet the remedial goals. Following completion of the FS and issuance of the ROD, extensive design-related investigation activities were initiated to supplement the data collected during the RI and provide the data necessary to allow design of the remedy. Design–related investigations related to cap design and determination of dredge areas and depths have included:

- bench-scale tests to evaluate cap performance and generate data pertaining to design of the chemical isolation layer;
- geophysical surveys to map the lake bottom and identify debris and in-lake utilities that will be addressed as part of the remediation;
- sediment sampling for chemical and geotechnical analyses to determine the remediation areas and dredge depth;
- *in situ* geotechnical testing of sediments to provide data related to design of the cap; and
- porewater sampling and analysis to generate data pertaining to design of the chemical isolation layer.

These activities to date have provided more than 800 sediment sampling locations, almost 10,000 environmental samples, and more than 200,000 chemical and geotechnical analyses to support design of the selected remedy. Honeywell presented the results of these investigations in data summary reports and submitted them to the NYSDEC. These reports are available in the public document repositories listed in the CPP.

This document focuses on the conceptual design of the sediment cap, and defining the dredge areas, depths, and volumes for the remedy. This conceptual design was developed using the design-related investigation summarized above. A schedule for subsequent design submittals pertaining to capping and dredge areas and depths is provided in Section 10. The design overview that follows is provided to put the capping and dredge area and depth components of the project into context with the rest of the remedy.

The primary elements of the selected remedy as documented in the ROD, and as described above, include:

- sediment removal (dredging) and transport to the sediment consolidation area (SCA);
- onsite management of dredged material at the SCA;
- sediment capping (isolation and thin-layer) including remediation area determination and definition of dredge areas, depths, and volumes;
- water treatment system;
- nitrate addition or oxygenation of the hypolimnion;
- monitored natural recovery (MNR);
- habitat restoration and enhancement;
- institutional controls; and
- long-term operation, maintenance, and monitoring.

For most of the remedial elements described above, design-related investigations, engineering assessments, and evaluation reports were completed in advance of the preparation of this IDS Report to assess specific elements of the remedy, advance design decisions, and to obtain concurrence with NYSDEC and USEPA on critical path components. A summary of the documents pertinent to this IDS Report is included as Table 1.1. All of these documents are available in the document repositories, or will be following final NYSDEC approval.

Due to interaction between the various remedial elements, and varying design schedule considerations with specific design components, it was necessary to separate the design into four distinct submittals. Separating the design into four submittals allows for accelerated design submittals for critical path activities (e.g., SCA and water treatment), helps the agency review process by staggering the submission of large documents, and facilitates the schedule for starting and completing the remedial action consistent with the Consent Decree. Future design submittals and their associated submittal schedules have been developed and presented in each of the IDS reports.

The content of the four IDS Reports is as follows:

- The *Dredging, Sediment Management, and Water Treatment IDS* was intended to provide conceptual design-level information pertaining to operational components of the remedy including the dredging, transportation, and dewatering of impacted lake sediments, and treatment of construction water generated during the process. This IDS was submitted to the NYSDEC in February 2009 and is available in the public repositories.

- The *SCA Civil & Geotechnical IDS* includes the civil and geotechnical design elements (*e.g.*, liner system) required for construction of the SCA. This IDS was submitted to the NYSDEC in August 2009 and is available in the public repositories.
- The *Sediment Cap and Dredge Volume IDS* (this report) includes the conceptual level, design detail for the sediment cap components of the remedy. This submittal also includes the integration of conceptual level design details pertaining to habitat restoration and also provides dredging volumes and removal areas and depths.
- The *Thin-Layer Capping, Nitrate Addition/Oxygenation, and MNR (SMU 8) IDS* focuses on the deep water areas of the lake, and will provide conceptual design-level details pertaining to thin-layer capping (including locations, extent, materials, and sequencing), nitrate addition and/or oxygenation for the purposes of inhibiting the formation of methylmercury within the lake, and the approach to MNR in specific areas of the lake.

Figure 1.3 illustrates the relationships between the various Remedial Design components for the Onondaga Lake project, and illustrates the important of citizen participation throughout the entire design process.

1.5 INITIAL DESIGN SUBMITTAL ORGANIZATION

This IDS Report is organized into eleven sections and multiple appendices. A summary of each section is provided below.

- Section 1: Site Description and Design Process Overview – Presents background information, site description, remedial goals for the site, and a summary of the Remedial Action.
- Section 2: Community Protection and General Project Requirements – Highlights Honeywell's community participation efforts and presents general requirements applicable to many aspects of the project, including various Federal, State, and Local requirements, ordinances and regulations applicable to the design.
- Section 3: Remediation Areas – Provides an updated basis for the division of the littoral zone into distinct Remediation Areas, which include capping and/or dredging. These areas were previously summarized in the Dredging, Sediment Management, and Water Treatment IDS. The outer boundary of these remediation areas is based on the data collected during the Pre-Design Investigation.
- Section 4: Capping Design – Presents the technical evaluations and design for the sediment cap.
- Section 5: Dredging Area, Depth, and Volumes – Presents the design plans for the dredging areas, depths and volumes for each Remediation Area.
- Section 6: In-Lake Debris and Utility Management – Presents characterization of debris and utilities within cap areas and preliminary management strategies.

- Section 7: Construction Sequencing and Schedule – Presents a preliminary analysis on the sequencing of dredging and capping operations in various Remediation Areas of the lake.
- Section 8: Post Cap Maintenance and Monitoring Strategy – Presents preliminary plans for post-construction maintenance and monitoring of the sediment cap.
- Section 9: Subcontracting Strategy – Summarizes the anticipated subcontracting strategy for the sediment cap construction.
- Section 10: Design Submittal and Construction Schedule – Presents the schedule for additional design submittals associated with the sediment cap, and presents the anticipated bidding, procurement, and construction schedule.
- Section 11: References – Lists the references used to prepare this IDS Report.

SECTION 2

COMMUNITY PARTICIPATION, COMMUNITY HEALTH AND SAFETY, AND GENERAL PROJECT REQUIREMENTS

The health and safety of members of the community and consideration of community input are of paramount importance in designing the lake remedy. Section 2.1 of the *Dredging, Sediment Management, and Water Treatment IDS (*Parsons, 2009c) and the *Sediment Consolidation Area Civil and Geotechnical IDS* (Parsons, 2009d) provide detailed discussions of community considerations and project requirements relevant to those aspects of the Onondaga Lake remedy. The *Onondaga Lake Citizen Participation Plan* (CPP) (NYSDEC, 2009) provides details regarding community involvement for the entire Onondaga Lake Bottom Subsite remedial program. Community considerations and project requirements that pertain specifically to the sediment capping aspects of the remedy are discussed in the subsections below.

2.1 COMMUNITY PARTICIPATION AND HEALTH AND SAFETY

Honeywell is continuing a Community Outreach Program designed to ensure transparency of the design process, incorporate community ideas and feedback, and to maintain awareness of remedial progress and milestones. This outreach was designed in recognition of the importance of the lake as a natural resource to the surrounding area, and the level of community interest in the progress of the Onondaga Lake remediation. This section discusses the importance of community feedback and some of the design aspects that have been modified based on feedback received to date, and outlines future plans and design components which will help ensure the health and safety of the surrounding community while remedial activities are ongoing.

2.1.1 Community Participation

The NYSDEC and Honeywell are required and committed to informing and involving the public during the remedial design and construction phases of the Onondaga Lake project. Public interest in the cleanup and restoration remains high. The CPP provides a formal, yet flexible plan for communication with the public during the remediation of the Onondaga Lake bottom.

Feedback received through the community participation process has already had a considerable influence on design-level decisions in several areas of the remedial design. Pertaining to the activities described in this IDS Report, community interest and feedback have primarily focused on the restoration and end-use components of the remedial design. Significant effort has been spent to develop a lakewide plan for the incorporation of habitat restoration. These plans are presented in the *Onondaga Lake Remedial Design Elements for Habitat Restoration* (Parsons, 2009a). Community members and interest groups such as the Audubon Society, Ducks Unlimited, Citizens Campaign for the Environment, Salt City Bassmasters, New York Wildfowlers, Onondaga County Federation of Sportsmen, Sierra Club, Izaak Walton League of America, and NYSDEC have provided critical input to ensure that the vision for post-remediation Onondaga Lake fits with the goals of the community, and that the recreational opportunities facilitated by the remedial design are aligned to maximize the benefit to the surrounding community.

Continued involvement of the community is a critical component to the successful restoration of Onondaga Lake. Opportunities for further community participation have been summarized in the CPP and are incorporated into the design process.

2.1.2 Community Health and Safety

As part of the remedial design process, the design team will continue to work with the community to develop various performance criteria and work plans specifically designed to ensure that the health and safety of the surrounding community and environment is maintained throughout the execution of the remedy. The community health and safety plans relevant to capping activities that will be developed and presented in the Final Design will include:

- Site Security & Community Health and Safety Plan – This plan will outline health and safety considerations including provisions for physical security for the site and physical security for off-site support areas to minimize risks to persons, property, and the environment. Physical security planning will include remedial activities on the lake and at the lakeshore (e.g., support facilities). A vulnerability assessment will be included to identify potential security challenges, prioritize those challenges, and describe appropriate control measures. Security measures to be implemented will be specified, and may include fences, gates, signs, remote cameras, security patrols, and lighting. Additionally, posting requirements for appropriate warning signs, barricades, and fences to protect members of the public from accidentally accessing the site will be outlined.
- Traffic Management Plan – Depending on the method of delivery and placement of the material associated with the sediment cap, traffic associated with the delivery of material, equipment, and supplies may be necessary. To ensure construction vehicles are routed to appropriate roads, a Traffic Management Plan will be created to specify traffic patterns for the construction areas utilized for material storage and/or handling.
- Navigational Protection Plan – To protect recreational boaters in Onondaga Lake from work zones, navigational hazards, and construction equipment, a Navigational Protection Plan will be created to outline communication procedures for conveying important project information pertinent to boaters, posting and delineation of sensitive/restricted project areas, and procedures associated with the siting and illumination of on-water equipment.
- Noise Abatement Plan – To ensure noise levels from remedial construction activities are controlled to the extent practicable, a Noise Abatement Plan will be established to outline equipment requirements and hours and areas of required noise reduction.

In addition, a Spill Contingency Plan and Volatile and Odor Emissions Monitoring and Mitigation Plan will be prepared, as detailed in the Operations IDS.

2.2 GENERAL PROJECT DESIGN AND PERFORMANCE CRITERIA

General requirements applicable to the dredging and capping components of the Remedial Design are described below. Additional details on requirements pertaining to specific aspects of the remedy are provided in Sections 3 through 5.

2.2.1 Sustainability

Honeywell is committed to minimizing the carbon footprint of construction activities anticipated as part of the execution of the remedy. During the design phase, evaluations are being conducted to identify opportunities to incorporate sustainability concepts, including those presented in the *Clean and Green Policy* (USEPA, 2009) into all aspects of the Onondaga Lake remediation. To the extent practicable, use of renewable energy sources, utilization of locally produced/sourced materials and supplies, reduction/elimination of waste, efficient use of resources and energy, and other practices will be specified in the Remedial Design, and implemented during remedial construction. Further details pertaining to the incorporation of sustainable practices will be included in the Final Design.

2.2.2 Federal and State ARARs

Compliance with federal and state Applicable or Relevant and Appropriate Requirements (ARARs) will ensure that the existing resources are protected during operations and provide for overall protection of human health and the environment. A comprehensive list of chemical-specific, action-specific and location-specific ARARs are included in the ROD. Regulatory requirements, including ARARs, applicable to the sediment capping and other components of the remedy are summarized in Table 2.1. Compliance with federal and state ARARs frequently involve formal permit application and approval processes. Details pertaining to these processes applicable to Onondaga Lake are outlined in the Consent Decree (United States District Court, 2007).

2.2.3 Local Ordinances and Regulations

Table 2.1 also includes local ordinances and regulations. The ordinances and regulations that apply to the sediment capping activities include Town of Geddes requirements pertaining to noise, traffic, vibration, dust or odors, building permits, site development permits, and site plan approval and flood plain development permits for temporary shore support facilities, and in-lake utility work.

2.2.4 Health and Safety Requirements

The health and safety of site personnel, visitors and members of the public are considered the top priority on this project. Written safety plans will be developed for each phase of the remediation project. Project Safety Plans will be developed and updated as needed to address changing activities and site conditions. The health and safety record of all bidding contractors will be evaluated as part of the bidding process. At a minimum, selected remedial contractors will be required to prepare Project Safety Plans, which will address potential safety issues associated with the specific tasks the contractor will be performing. Specific requirements, including audit procedures, employee drug and alcohol screening programs, and near-miss reporting protocols will also be specified within the Final Design.

2.2.5 Property and Site Access and Right-of-Way Entry

Several components of the remedy may require the use of non-Honeywell owned property. These activities could include: construction laydown and cap material storage areas, debris management, or placement processing areas. To ensure access to the properties owned/managed by these entities, access agreements and necessary permits will be obtained in advance of the execution of the remedial activities. All Remedial Contractors whose scope requires use of these properties will be required to abide by the terms and conditions of the negotiated access agreements and permits.

SECTION 3

REMEDIATION AREAS

The littoral remediation area has been delineated based on extensive design-related investigations and covers an estimated 408 acres. Design and performance criteria pertaining to establishment of remediation areas are discussed below, followed by a discussion of the design evaluation methods and results.

3.1 REMEDIATION AREA DESIGN AND PERFORMANCE CRITERIA

To facilitate achievement of the RAOs and PRGs detailed in Section 1.2 and ensure protection of human health and the environment, numeric sediment cleanup criteria were developed in the ROD. The cleanup criteria that must be met within the littoral area are the probable effects concentration (PEC) of 2.2 mg/kg for mercury and a mean PEC quotient (PECQ) of 1 for the 23 contaminants that showed significant contributions to toxicity on a lakewide basis. These 23 contaminants and the method for calculating the Mean PECQ are provided in Table 3.1.

3.2 REMEDIATION AREA EVALUATION AND PRELIMINARY DESIGN

As discussed in Section 1.1, Onondaga Lake was divided into eight different SMUs during the FS and ROD process, based on water depth, sources of water entering the lake, and ecological and chemical risk drivers. SMUs 1 through 7 are located in the shallow (littoral) zone (less than 30 ft) of the lake where most aquatic vegetation and aquatic life reside, while SMU 8 consists of sediment in the deeper (profundal) zone (deeper than 30 ft). These SMUs were developed for remedial alternative development and evaluation purposes. Also, the ROD-specified remedy presented the required in-lake portions of the remedy on a SMU-specific basis. These SMU-specific ROD requirements will be met during remedy design. However, analysis of the data collected following the FS and ROD as part of four years of design-related investigation indicated that the SMU boundaries did not always accurately define the limits of the individual sub-areas of the lake. Therefore, the concept of Remediation Areas has been developed to facilitate the design process.

To more accurately reflect the current understanding of in-lake conditions, the littoral area remediation has been redefined into Remediation Areas A through F. Remediation Areas and their relationship to SMU boundaries are shown in Figure 3.1. A summary description of these Remediation Areas is provided below.

- Remediation Area A - Mouth of Ninemile Creek. SMU 4 was originally delineated based on the sediment impacts resulting from the discharge of Ninemile Creek. Subsequent data indicated these impacts extended into adjacent SMUs 3 and 5. Therefore, Remediation Area A includes SMU 4 and adjacent impacted areas in SMU 3 and SMU 5.

- Remediation Area B – SMU 3 was originally delineated based on the area impacted offshore of Wastebeds 1 through 8. This is consistent with the Remediation Area B designation. However, it excludes the portions of SMU 3 that are now included in Remediation Areas A and C.
- Remediation Area C – This area is offshore of the New York State Department of Transportation (NYSDOT) Turn-around Area and the Willis/Semet IRM barrier wall, consistent with SMU 2. However, based on design-related investigation data, the area of contamination extends into adjacent SMU 3, which is included in Remediation Area C. Also, the ILWD was found to extend into SMU 2. The SMU 2 ILWD area is excluded from Remediation Area C.
- Remediation Area D – SMU 1 was originally delineated as the extent of ILWD in the littoral area. Based on design-related investigation data, the ILWD extends into SMU 2 and SMU 7. Remediation Area D includes the ILWD in SMUs 1, 2, and 7.
- Remediation Area E – This includes the southwestern end of the lake, inclusive of SMU 6 and SMU 7, except for the portion of the ILWD that extends into SMU 7. It also includes the contiguous remedial area that extends into adjacent SMU 5.
- Remediation Area F – This includes small areas of impacted sediment north of Remediation Area A and on the north-eastern shore within SMU 5.

The designation for SMU 8 has not been revised.

Remediation Area boundaries, as shown in Figures 3.2 through 3.4, were established using the extensive sediment database available from the RI and five phases of design-related investigations. The boundaries were drawn from point to point based on sampling locations where the sediment cleanup criteria (*i.e.*, neither a mean PECQ of 1 nor a mercury concentration of 2.2 mg/kg) were not exceeded. This provides for a more conservative establishment of remediation boundaries than methods that rely on interpolation or kriging between sampling locations to estimate remediation boundaries, and ensures all sediments exceeding cleanup criteria will be addressed.

Remediation Area boundaries were drawn from point to point based on sampling locations where the sediment cleanup criteria were not exceeded at any depth from the shoreline out to a water depth of 20 ft (6 meters). This conservative approach will prevent impacted subsurface sediments underlying sediments that do not exceed criteria from potentially being exposed in the future due to natural processes such as erosion.

Remediation Area boundaries between 20 ft (6 meters) and 30 ft (9 meters) were drawn from point to point based on sampling locations where the sediment cleanup criteria were not exceeded in the top 1 ft of sediment. Due to the depth of overlying water in these areas, existing sediments are stable even under a 100-year storm event in water depths from 20 to 30 ft (6 to 9 meters) in Remediation Areas A, B, C, and F, and would be expected to see only minor disturbances in Remediation Area E, as documented in Appendix D. This demonstrates that deeper impacted sediments would not be exposed even under extreme events (*e.g.* 100-year storm). Therefore, determination of Remediation Area boundaries in these deep water areas is appropriate based on consideration of the top 1 ft of sediment. These areas are also net depositional, so the thickness of clean surface sediments in these areas will increase over time.

As shown in Figure 3.3 and detailed in Appendix A, the remedial boundary addressed in this IDS includes a small portion of SMU 8 directly adjacent to Remediation Area D. This Remediation Area D addendum cap area (approximately 5.6 acres) has elevated Mean PECQ values; therefore, a chemical isolation cap rather than a thin layer cap is appropriate for this area of SMU 8. Chemical isolation cap details are provided in Section 4.1. All other SMU 8 surface sediment mean PECQ values in the vicinity of Remediation Area D have a Mean PECQ value less than 2, and therefore, will be addressed via thin-layer capping and monitored natural recovery, consistent with other areas of SMU 8. Thin-layer capping of SMU 8 sediments will be detailed in the SMU 8 IDS.

Remediation Area C includes the localized area around sample location S48. This sample location does not exceed remediation criteria, but showed a chironomid mortality greater than 50% during the RI. The remediation boundary around sample location S48 was based on surrounding sample locations that did not exceed remediation criteria, consistent with other remedial area delineation.

Appendix A provides documentation pertaining to development of these remediation area boundaries. Discussion on boundaries associated with capping versus dredging is provided in Section 4.2. The Remediation Area boundaries as well as the boundaries for capping areas and dredging areas shown in Figures 3.1 through 3.4 may be revised based on ongoing technical evaluations and additional sediment data to be collected.

SECTION 4

CAPPING AND HABITAT RESTORATION

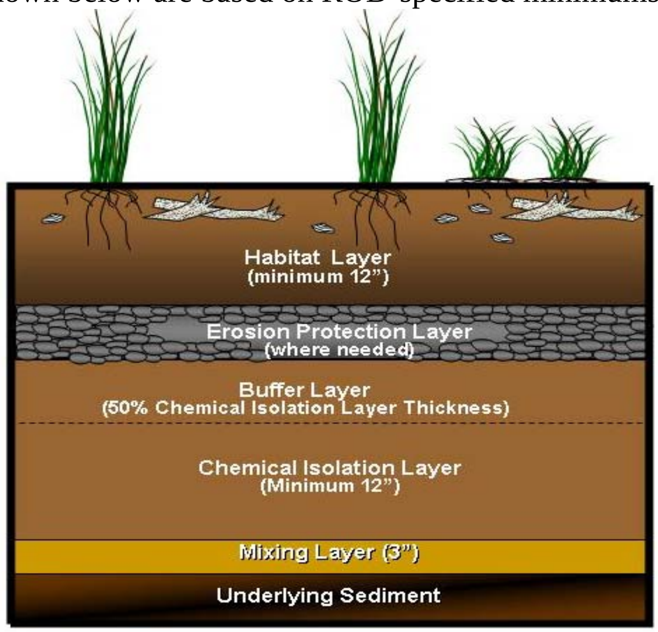
Restoring diverse, functioning and sustainable habitats to the remediated areas of Onondaga Lake is one of the top priorities of this remedial program. Therefore, habitat considerations are at the forefront of the various design evaluations for the lake and have been fully integrated into this document. Habitat considerations are a major factor in developing cap thicknesses. The cap will provide long-term chemical isolation of underlying impacted sediments. It will be resistant to erosive forces such as wind/wave-generated currents, tributary and other inflows, and ice. It will also provide a suitable habitat substrate that plants, animals, and fish can use without impacting the chemical isolation layer.

The depth of sediments requiring dredging in many parts of the lake is determined by the depth of water desired and the thickness of the cap. Water depths following dredging were developed in the Lake Wide Habitat Plan to achieve optimum habitat conditions. For example, in areas near the mouth of Ninemile Creek, the habitat restoration goal includes development of areas where floating aquatic plants such as lilly-pads will thrive. This type of habitat is currently absent from Onondaga Lake. The required water depth for floating aquatic plants is 1 to 3 ft. Dredging to achieve a water depth of 7 ft prior to placement of a 5 ft thick cap (including a 2 ft. habitat layer) would result in a post-remediation water depth of 2 ft, which is ideal for floating aquatic plants. Because dredge depths are developed based on these types of considerations in many areas, the cap and habitat restoration goals and design are developed in this section prior to presentation of the dredging design in Section 5 even though dredging will be completed prior to capping as part of the construction sequence.

Detailed technical evaluations presented below demonstrate that capping will be effective in Onondaga Lake. Capping of subaqueous contaminated sediments is an accepted and proven long-term engineering option for managing dredged materials and for *in situ* remediation of contaminated sediments (USEPA, 1994, 2005; NRC, 1997, 2001; Palermo, Clausner, *et al*., 1998, Palermo, Maynord, *et al*., 1998), and is a significant component of the Onondaga Lake remedy. Sediment caps are a proven technology and have been implemented at numerous sediment remediation sites, including the Fox River in Wisconsin, the St. Louis River Interlake Duluth Tar site in Minnesota, and Port Hueneme in California. Based on the cleanup objectives established for the lake, the functions for the cap include:

- restoration and enhancement of aquatic habitat in the lake;
- physical isolation of the contaminated sediment from the aquatic environment;
- reduction or elimination of the flux of dissolved contamination into the upper layers of the cap such that cap performance criteria are not exceeded; and
- stabilization of contaminated sediment, preventing resuspension and transport of contaminants to the profundal area and other areas of the lake.

To ensure that these goals are met and that the cap provides long-term protection of human health and the environment, the cap will include specific layers dedicated to various purposes. These layers will include a habitat layer, an erosion protection layer, a buffer layer and a chemical isolation layer, as well as an allowance for mixing of the bottom of the chemical isolation layer with the underlying existing lake sediment, as shown in the schematic below. Minimum thicknesses shown below are based on ROD-specified minimums.



General Schematic of Sediment Cap

A detailed discussion of each cap layer and the basis for the layer thickness and substrate type is provided in Sections 4.1 through 4.3. Based on evaluations presented in these sections, the minimum habitat layer thickness will range from 1 to 2 ft depending on the water depth. The habitat layer material will range from sand to coarse gravel, consistent with the intended habitat for specific areas of the cap. The minimum erosion protection layer will range from 0.25 to 1 ft thick for various areas of the cap. The erosion protection layer material will range from sand to coarse gravel, consistent with the erosion protection requirements for specific areas of the cap as detailed below. In areas where the habitat layer material is consistent with the erosion protection layer material requirements, the layers will be combined since a single layer can function as both in such cases.

The chemical isolation layer will consist primarily of sand. Based on detailed modeling, the chemical isolation layer will be 1 ft thick throughout the capped area. In select areas, amendments will be added to the chemical isolation layer to ensure that the 1 ft thick layer will be protective in the long term. These amendments are appropriate where high pH in underlying sediments, such as the ILWD, could impede microbial degradation within the isolation layer. Amendments will be incorporated to buffer the pH and thus promote microbial action and biological decay of key contaminants. Activated carbon will also be incorporated in select areas to improve sorption of contaminants within the isolation layer to provide an added level of protectiveness. The chemical isolation layer placement will include an allowance for mixing of the bottom of the cap with the underlying existing lake sediment.

Details regarding how the cap design integrates with the Habitat Plan are provided in Sections 4.1 through 4.3. Capping and habitat plans for each Remediation Area are shown in Figures 4.1 through 4.10.

The actual thickness of each cap layer constructed in the field will typically exceed the minimum required design thickness based on engineering analyses due to operational considerations of how the cap materials will be placed in the lake. The contract requirements will specify that the contractor will need to place a minimum thickness for each layer. To ensure that the minimum required cap thickness is obtained, the capping construction contract will allow for over-placement beyond the minimum target cap layer thickness. This over-placement allowance addresses the tolerances contractors can achieve given the water depths, bathymetry, currents, waves, capping equipment and other factors. For each specific layer (*e.g.* chemical isolation, erosion protection, and habitat) the contract documents will specify the minimum thickness and the allowable amount of over-placement. The result of this approach will be that the final thickness of each layer will be more than the specified minimum thickness in each area. However, over-placement will be controlled to prevent excessive cap material placement so that target water depths can be achieved for specified habitat objectives. Section 4.3.3 discusses how cap over-placement allowances and target habitat water depths were considered in the design of the dredge depths and areas.

The over-placements assumed for the conceptual design of the cap are based on over-placements achieved on other capping sites and the practical experience of the design team in placement of various material types using conventional capping methods. Both the type of material and the required placement thicknesses were considered in developing the assumed over-placements for each cap layer shown in Table 4.1.

For finer substrate materials, such as sand and fine gravel, a 0.5 ft over-placement was assumed. Different methods of placement result in similar over-placements for the finer substrate materials. A 0.5 ft over-placement was also used for coarse gravel where the required thickness was 1.0 ft or greater. An increased over-placement of 0.75 ft was assumed for coarse gravel where the required thickness was 0.25 to 0.1 ft over-placement was assumed in the design for the cobble substrate taking into consideration the placement thickness relative to the large stone size. This material will be placed by mechanical methods due to the size of the stones.

There are several areas associated with design and construction of the cap where adaptive management concepts may be appropriate. Adaptive management refers to enhancements to project implementation based on lessons learned and from actual experience gained during the course of the project. These lessons learned can lead to revisions to the assumptions that were made during the course of the design, allowing the project construction schedule and final effectiveness to be optimized. Specific areas of the cap design and construction where adaptive management may be appropriate include over-dredge and cap material over-placement allowances, cap mixing layer thickness, water quality monitoring, debris removal, and project sequencing. Each of these areas of the cap design are discussed in detail below.

4.1 CHEMICAL ISOLATION LAYER

The chemical isolation layer will physically and chemically isolate aquatic plants, benthic organisms, animals and humans from the underlying sediment. Chemical isolation is achieved because contaminants migrate so slowly through the chemical isolation layer that it will take hundreds or even thousands of years before they migrate through the chemical isolation layer, or because the contaminants biologically decay within the chemical isolation layer and as a result never migrate through the chemical isolation layer.

This section discusses design and performance criteria, the methods and results from bench testing, preliminary design evaluations, computer modeling, and the conceptual design for the chemical isolation layer of the caps.

4.1.1 Chemical Isolation Layer Design and Performance Criteria

Design and performance criteria for the chemical isolation layer based on ROD requirements and other project-specific considerations are listed below.

- Computer modeling will be used to determine the required thickness of the chemical isolation layer such that concentrations of contaminants, which may migrate into the habitat layer, do not exceed cap performance criteria.
- As required by the ROD, the chemical isolation layer will be a minimum of 1 ft thick, regardless of isolation layer modeling results.
- As required by the ROD, a buffer layer, or safety layer, equal to 50% of the thickness of the chemical isolation thickness will be added to the overall cap thickness. As part of the design, a decision will be made regarding what portion (if any) of the buffer layer may be considered part of the habitat restoration layer.
- The point of compliance, consistent with the ROD, is at the bottom of the habitat layer. The isolation layer will be designed to prevent unacceptable concentrations of contaminants throughout the habitat restoration layer.
- The performance criteria for the cap at the point of compliance and throughout the habitat layer will be the PEC for each of the contaminants that have been shown to exhibit acute toxicity on a lakewide basis (see Table 3.1), as well as the NYSDEC sediment screening criteria for benzene, toluene, and phenol.
- A thin layer cap in lieu of the isolation cap may be appropriate based on design evaluations in some depositional portions of the littoral zones in water depths from 20 to 30 ft (6 to 9 meters) provided it can be demonstrated that it will be effective in meeting remedial goals.

The design team undertook extensive bench-scale evaluations, initial design analyses, and analytical modeling to develop the chemical isolation layer design in accordance with these design criteria, the results of which are discussed below.

4.1.2 Chemical Isolation Layer Bench-Scale Evaluations

Tests were conducted to simulate site-specific conditions, evaluate *in situ* fate and transport processes and to assess potential cap amendment performance for select areas of the lake. The design of the chemical isolation layer of the cap is supported by over four years of site-specific laboratory and bench-scale testing. Bench tests were designed and executed in consultation with and by leading researchers in the field of sediment cap design. Specifically, bench-scale experiments were conducted to evaluate:

- biological degradation rates for use in cap modeling to determine the isolation layer thickness;
- whether significant gas is generated within lake sediments, and if so, whether it could result in contaminant migration through the cap;
- whether consolidation of underlying sediments resulting from cap placement could result in NAPL migration into the cap;
- contaminant partitioning onto cap material for use in cap modeling to determine the isolation layer thickness;
- effectiveness of sorption amendments (carbon, organoclay and peat) in reducing contaminant migration through the cap; and
- effectiveness of amendments for buffering pH in order to promote biological decay of contaminants within the cap.

The following sections provide detail on each of these evaluations including a summary of the results and a discussion on their application and relevance to the initial chemical isolation layer design. Complete reports and work plans referenced below are available in the Onondaga Lake public repositories, or will be available once they receive approval by NYSDEC.

4.1.2.1 Biological Degradation Bench Testing

Biological degradation of organic contaminants within the chemical isolation layer is an important contaminant fate process considered in the design of the chemical isolation layer. Natural biological processes will degrade organic contaminants as they migrate upwards into the cap. Concentrations will be reduced across the isolation layer such that concentrations within the overlying habitat layer are below levels of concern. Several stages of bench-scale experiments were conducted to evaluate the rate of biological decay anticipated to occur within the cap for key compounds present in lake sediments and porewater.

The first stage of bench testing included batch slurry experiments as part of the Phase II PDI to qualitatively assess biological degradation (Parsons, 2006). Under these experiments, sealed vials of a mixture of lake sediment and water were sampled and analyzed over time for contaminant biological decay. The slurry experiments indicated that biological decay of those organic compounds anticipated to drive the cap design can occur naturally in most areas of the lake (Parsons, 2009e). The slurry experiments also suggested that biological decay within the cap in Remediation Area D would likely not occur at significant rates without neutralization of the pH of porewater as it passes through the cap due to the high pH of the underlying ILWD.

Building on the results of the batch slurry experiments, column studies were executed during Phase III of the PDI (Parsons, 2007). The column studies simulated *in situ* cap conditions and provided a realistic representation of microbe density and contaminant fate and transport through a sand cap. A layer of Onondaga Lake sediment (approximately 6 inches thick) was placed at the bottom of each column, and layer of sand capping material was added over the top of the sediment layer. Water flow was introduced through each column and effluent water samples were collected and analyzed periodically from the top of the column above the sand cap layer.

In general, the results of the Phase III PDI column tests were similar to those observed in the batch slurry experiments. Biological decay was observed in columns collected in Remediation Area E (SMU 6 and 7), while columns collected in Remediation Area D (ILWD) showed little to no biological activity (Parsons, 2009f). In addition to identifying the presence/absence of biodegradation, these column tests also provided biological decay rate information for key contaminants. Biological decay rates are an important model input parameter for the chemical isolation layer design models discussed further in Section 4.1.3. The biological decay rates developed from the Phase III column studies are used as input to the chemical isolation model in Appendix B (Reible and Smith, 2009).

Additional column experiments are underway to supplement the results of the Phase III PDI testing. These experiments are designed to collect additional information on biological decay rates in areas not impacted by elevated pH or where pH will be neutralized as part of the capping remedy (Parsons, 2008). In addition, a second set of batch slurry experiments are underway as part of the Phase V PDI. These batch slurry experiments will support the results of Phase II, III, and IV evaluations and provide additional detail on biological degradation rates and mechanisms and geochemical processes (Parsons, 2009f). Following completion of the Phase IV and V PDI biological decay evaluations, model inputs will be re-evaluated and the chemical isolation model may be updated to reflect the results of the ongoing testing.

4.1.2.2 Mercury Transport Bench Testing

The mercury partitioning coefficient is a key input parameter to the cap model evaluation. Prior to disassembling the Remediation Area D (SMU 1) Phase III PDI biological decay columns described above, the flow rate of water was increased significantly (to generate the necessary volume for analysis) and effluent water samples were collected and analyzed for mercury. Samples were also collected along the cap profile and analyzed for mercury. These results indicated that there was no transport of mercury through the cap over the course of the experiment (Parsons, 2009f). Given the lack of mercury transport into the cap, it was not possible to determine a quantitative partitioning coefficient for mercury.

Current model inputs for mercury are based on the results of the isotherm experiments as discussed in more detail in Section 4.1.2.5.1. Additional mercury-specific column experiments are underway as part of the Phase IV PDI. These column experiments focus exclusively on mercury transport. Results from these columns will be compared to the results from the isotherm experiments and used in future chemical isolation layer modeling.

4.1.2.3 Gas Generation Bench Testing

Bench study results, as well as the technical team's experience at other capping sites, indicate that contaminant mobilization driven by gas generation will not occur at significant levels in Onondaga Lake. Gas generation experiments were designed during Phase II of the PDI to measure the gas generation potential of sediments underlying the cap and to assess the potential for gas to impact contaminant migration (Parsons, 2006). These experiments involved measuring gas generation and release in closed tubes filled with lake sediment. Based on the gas generation rates measured in the batch studies, potential contaminant transport was assessed through column experiments. In the gas column experiments, gas was introduced to a sediment layer at a rate consistent with the upper range of gas generation rates measured in the batch tests. Monitoring results did not detect significant contaminant migration as a result of gas generation. (Parsons, 2009e).

4.1.2.4 Settlement-Induced NAPL Migration Bench Testing

Bench test results indicate that NAPL migration will not result due to consolidation of Onondaga Lake sediments as a result of capping. Settlement-induced NAPL consolidation studies were conducted during Phase II of the PDI to assess the potential for increased mobility of NAPL in Onondaga Lake sediments due to the physical loading of a sediment cap (Parsons, 2006). These studies involved subjecting a series of sediment samples to loads equivalent to the range of potential loading anticipated from placement of a sediment cap. These studies were focused on samples from areas of known high contaminant concentration and where stained sediments potentially indicative of discontinuous "blebs" of NAPL were observed.

Neither the application of a load exceeding the maximum that would result from cap placement or the resulting consolidation of the lake sediments resulted in NAPL release in any sample. The intermittent and weathered form of NAPL observed in the sample cores was not consistent with the type of NAPL that has a high potential for migration into the cap as settlement occurs.

4.1.2.5 Amendment Bench Testing

Following the biological decay bench testing conducted during the Phase II and Phase III PDI discussed in Section 4.1.2.1, it became evident that in Remediation Area D where elevated levels of pH impact biological activity, cap amendments would likely be appropriate in order to meet the cap performance criteria specified in the ROD. Therefore, a series of bench testing was conducted to evaluate potential cap amendments. These studies focused on amendments that would increase the sorbtive capacity of the cap, as well as amendments that would neutralize the high pH within the cap resulting from elevated pH in the underlying sediment.

4.1.2.5.1 Isotherm Testing of Organoclay, Sand, Peat, and Activated Carbon

Isotherm testing was conducted during the Phase IV PDI on selected organic contaminants and mercury using representative porewater from Remediation Areas D and E (SMUs 1 and 6/7, respectively) to assess the contaminant sorbtive capacity of sand, activated carbon, organoclay and peat (Parsons, 2008). Based on the results of the isotherm experiments, subsequent modeling, and constructability considerations, activated carbon was selected as the most effective and appropriate cap amendment to improve contaminant sorption in areas where cap amendments will be incorporated.

Prior to full isotherm development, preliminary isotherms were conducted on four types of activated carbon to identify the best candidate to study in detail. The preliminary isotherm experiments were designed to obtain the necessary information for executing the full isotherm experiment. These experiments were also designed to identify the form of activated carbon most resistant to fouling by natural organic matter through a comparison of isotherm results in organic free water with those results obtained from SMU 1 porewater. The preliminary experiments identified Calgon Carbon Corporation Filtrasorb™ 400 (F400) 12 x 40 mesh as the optimal activated carbon to conduct full isotherm studies based on the sorption capacity measured as well as the fact that F400 carbon is a standard product subject to less variability than regenerated carbon. Regenerated carbon also performed well in the screening experiments, demonstrating effective sorption and resistance to organic fouling similar to the virgin F400 carbon (Parsons, 2009f), and may be considered for application as the design progresses.

Sorption onto sand, organophyllic organoclays PM-199 and XB-1, and peat were also evaluated. Results from the carbon isotherm studies were used in the cap modeling evaluation of Remediation Area D. Results from the sand isotherm studies for mercury are used as input to the cap modeling evaluation for all cap areas.

As part of the Phase III PDI column studies described under Section 4.1.2.1, two columns were also initiated using activated carbon. These column studies are ongoing to further demonstrate the long-term performance of activated carbon.

4.1.2.5.2 pH Amendment Evaluation

Bench test results, in conjunction with constructability considerations, were used as the basis for selecting granular siderite as the preferred pH amendment. The pH amendment testing was completed during the Phase III PDI to evaluate methods to neutralize pH within the sediment cap in order to enhance biological decay in areas where pH is elevated in underlying sediments (Parsons, 2007). The amendments tested included three forms of siderite (powder, pelletized and granular), iron sulfate, aluminum sulfate, iron phosphate, aluminum phosphate, and peat. Batch testing was used to derive information on pH neutralization rates and endpoints for different application rates of the amendments tested (Parsons, 2009f). Granular siderite successfully lowered the pH and did not drop the pH below a circumneutral pH endpoint (between 6 and 8).

Two different leaching tests were also performed on siderite to evaluate potential impacts due to trace metals and other impurities possibly present in the material. As detailed in Appendix I, results from this testing confirm that there would be no adverse environmental impacts in the lake due to placement of siderite as part of an amended cap layer.

4.1.3 Chemical Isolation Layer Design Evaluations

Design of the chemical isolation layer was based on site-specific data, laboratory bench-scale evaluations and computer models that simulate cap processes and evaluate long-term cap performance. Two design models, developed by experts in the field of sediment cap design, were employed to evaluate: 1) steady state; and 2) transient concentrations throughout the cap profile and to calculate concentrations within the habitat layer.

The steady-state model was used to predict concentrations that would exist after contaminants have travelled upwards into the cap and an equilibrium condition becomes established between advective and diffusive transport, biodegradation, and exchange with the overlying water column. This model was used primarily to evaluate the more mobile contaminants, such as VOCs.

The transient model was used to predict time-varying concentrations within the cap system, and was used to evaluate the extent to which activated carbon retards the transport of VOCs, as well as the timeframes over which less mobile contaminants (such as mercury and semi-organic volatile compounds [SVOCs]), would migrate into the cap. The transient model is useful in these situations since steady-state conditions for these types of contaminants may not be established for thousands of years.

These models have been published and discussed in peer reviewed literature (Lampert and Reible, 2009 and Palermo, Maynord, *et al.*, 1998) and have been tested by Parsons and independent reviewers by benchmarking against other models. Appendix B provides additional detail on the models employed, modeling strategy, modeling framework and model results. Modeling results are summarized in Section 4.1.4. Isolation layer modeling was conducted in Remediation Areas A, D, and E, which constitutes the majority of areas requiring an isolation cap. Additional data collection is required in Remediation Areas B and C in order to facilitate isolation layer modeling of these smaller areas, which will be completed as part of the intermediate design.

The following schematic indicates the general structure and processes simulated by the cap models.

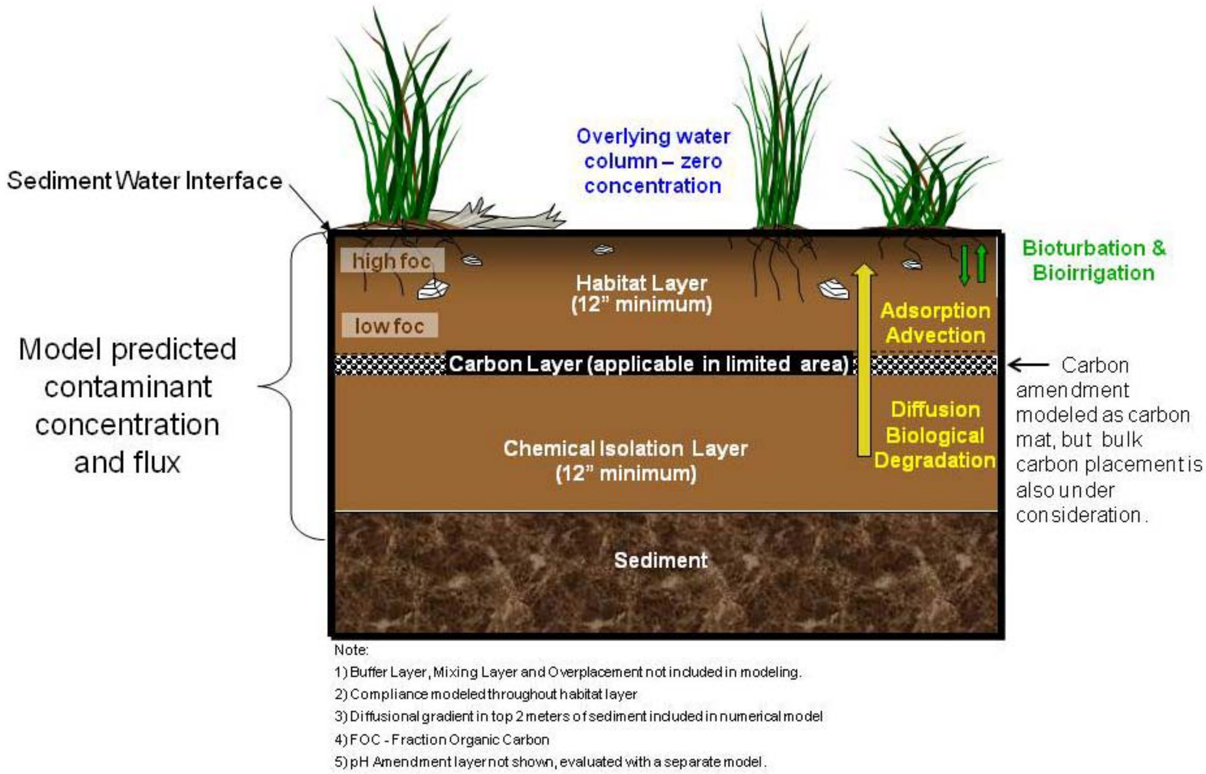


Illustration of Cap Processes Modeled and Structure of Model

As discussed in Section 4.1.2.5, biological decay bench testing conducted during the Phase II and Phase III PDI indicated that in areas where elevated levels of pH impact biological activity within the cap, cap amendments would be appropriate in order to meet the cap performance criteria specified in the ROD. These conditions are present in Remediation Areas B and D and in the northern portion of Remediation Area C. Modeling of activated carbon amendment performance was completed using the chemical isolation layer modeling described above. Details on the pH Geochemical Modeling used to evaluate pH amendment performance are provided in Appendix I.

Site-specific data were utilized in the model to maximize the accuracy and reliability of the results. An extensive site-specific database for the most important model input parameters has been developed based on the RI and five years of PDI data and laboratory studies, which includes the analytical results from over 7,000 samples. Site-specific model input parameters include:

- initial contaminant porewater concentration;
- fraction of organic carbon (foc) in the isolation layer and habitat layer;
- groundwater upwelling velocity, organic carbon partitioning coefficient (Koc) for the isolation and habitat layers; and
- the biological decay rate for the isolation layer.

Site-specific data was also collected to evaluate the performance of cap amendments including activated carbon sorption parameters and pH buffering capacity and rate of neutralization.

The modeling does not consider the additional cap thickness that would physically be placed as a mixing layer or as over-placement of material that results during construction of each layer to ensure minimum required thicknesses are achieved. The modeling also does not include the ROD requirement for a buffer layer that adds an additional thickness of 50% of the chemical isolation layer thickness. This additional material will result in increased biological decay and lower concentrations throughout the habitat layer, adding conservatism into the design. Further, in general, the model input parameters were on the conservative end of the potential range of input values, thus make the model under-predict the effectiveness of the cap. Additional conservative assumptions used in the cap model are described in Appendix B.

4.1.4 Chemical Isolation Layer Conceptual Design

The chemical isolation layer will consist primarily of sand. Based on treatability testing summarized Section 4.1.2, elevated sediment pH is an indicator of where amendments to the sand consisting of activated carbon and siderite will be appropriate in order to achieve cap performance criteria. Amendments to the cap will be implemented in Remediation Areas B and D and in the northern portion of Remediation Area C in the vicinity of the SMU 2/SMU 3 boundary, where the pH is typically in the range of 10 to 11. The pH in portions of Remediation Area A and in the southern portion of Remediation Area C are elevated to a lesser degree, with some pH values in the 8 to 10 range. For the purpose of conceptual design, it is assumed that cap amendments will not be required in these areas. Results from ongoing bench-scale testing will be used to confirm this assumption.

Results from the modeling based on site-specific conditions and incorporation of conservative assumptions, as described in Section 4.1.3 and detailed in Appendix B, are summarized in the table below. Remediation areas are subdivided as appropriate into modeling areas as discussed following the summary table.

Chemical Isolation Layer Design Summary

Remediation Cap Area	Required Thickness Based on Modeling (feet)	Design Thickness (feet)[a]	Comment
A (77 acres)	Less Than 0.5	1	Applies to Model Areas A1 and A2.
B (16.1 acres)	Not Yet Modeled*	1	Will include amendments. Assume 1 ft. for conceptual design.
C (18.9 acres)	Not Yet Modeled*	1	Will include amendments in northern portion. Assume 1 ft. for conceptual design.
D (98.5 acres)	Less Than 0.5	1	Will include amendments. Applies to all modeled sub-areas.
E (173.8 acres)	Less Than 0.5	1	Applies to Model Areas E1 and E2.

a Consistent with the ROD, the minimum thickness of the chemical isolation layer will be 1 ft. Where cap modeling indicated less than 1 ft was necessary to achieve cap performance criteria, the design thickness was increased to 1 ft.

* Will be evaluated in future design stages.

4.1.4.1 Chemical Isolation Layer Thickness

The chemical isolation layer thickness required for each Remediation Area is discussed below. The isolation layer thicknesses required for each area are based on computer modeling for all 26 contaminants for which cap performance criteria were established. The thicknesses determined below were determined assuming amendments will be used and have been incorporated into the cap as required. Amendments to the isolation layer to be applied in select areas are discussed in Section 4.1.4.2. Chemical isolation layer thicknesses will be updated as appropriate based on additional porewater and groundwater upwelling data collected in 2009 as part of the Phase V PDI, as well as additional data resulting from ongoing bench testing and PDI for data gaps anticipated during 2010. Results of revised modeling will be incorporated into future design submittals.

<u>Remediation Area A.</u> As listed above and shown in Figure 4.1, Remediation Area A was segregated into Cap Model Area A1 and Cap Model Area A2. Cap Model Area A2 was delineated due to the presence of higher levels of VOCs in sediment porewater in this area compared to those in Cap Model Area A1. A chemical isolation layer thickness of less than 0.5 ft would provide chemical isolation in Cap Model Areas A1 and A2 based on modeling results, however, the actual thickness will be a minimum of 1 ft consistent with the ROD.

<u>Remediation Area B.</u> Remediation Area B is relatively small (4% of the total cap area), as shown in Figure 4.3. Contaminant levels and groundwater velocities are generally similar to or less than those in Remediation Area D. As discussed below, the chemical isolation layer thickness for Remediation Area D was designed to be 1 ft based on modeling, therefore a 1 ft chemical isolation layer is assumed for Remediation Area B for purposes of the conceptual design. In order for this thickness to be effective for long-term chemical isolation, amendments for pH buffering and increased sorption will be incorporated into the cap in this area, as

discussed in Section 4.1.4.2. Modeling of this area will be completed as part of the intermediate design.

Remediation Area C. Remediation Area C is relatively small (approximately 5% of the total cap area), as shown in Figure 4.5. Contaminant levels and groundwater velocities are generally similar to or less than those in Remediation Area D. As discussed below, the chemical isolation layer thickness for Remediation Area D was designed to be 1 ft based on modeling; therefore, a 1 ft chemical isolation layer is assumed for Remediation Area C for purposes of conceptual design. In order for this thickness to be effective for long-term chemical isolation, amendments for pH buffering and increased sorption will be incorporated into the cap in this area, as discussed in Section 4.1.4.2. Modeling of this area will be completed as part of the intermediate design.

Remediation Area D. As shown in Figure 4.7, Remediation Area D is segregated into four subareas based on differing levels of contamination in the four areas. A chemical isolation layer thickness of less than 0.5 ft would be effective in each model area based on modeling results, however, the actual thickness will be a minimum of 1 ft consistent with the ROD. In order for this thickness to be effective for long-term chemical isolation, amendments for pH buffering and increased sorption will be incorporated into the cap in this area, as discussed in Section 4.1.4.2.

As shown in Figure 4.7 and discussed in Section 3, there is a relatively small area in SMU 8 adjacent to Remediation Area D where the 6-inch thin-layer cap to be implemented in areas of SMU 8 that exceed the Mean PECQ of 1 may be inappropriate due to elevated levels of contamination in this area. The appropriate design for this Remediation Area D addendum cap area will be determined as part of future design evaluations. This area may be refined in the future based on additional sediment sampling.

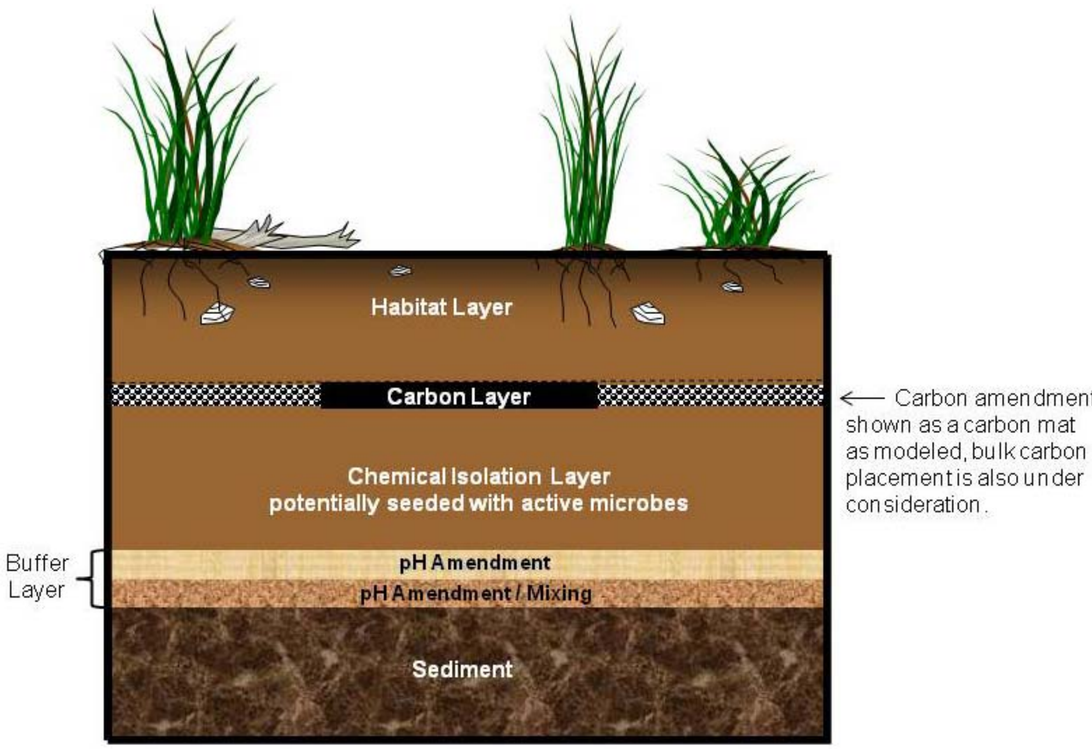
Remediation Area E. Similar to Remediation Area A, Remediation Area E was divided into Cap Model Area E1 and Cap Model Area E2, as shown in Figure 4.9. Cap Model Area E2 was delineated due to the presence of higher levels of VOCs in sediment porewater in this area compared to those in Cap Model Area E1. A chemical isolation layer thickness of less than 0.5 ft would be effective in Cap Model Areas E1 and E2 based on modeling results; however, the actual thickness will be a minimum of 1 ft consistent with the ROD.

Buffer Layer. As discussed above, the isolation layer thickness required to meet remediation goals in Remediation Areas A and E based on current modeling is less than 0.5 ft. Placing a 1-ft isolation layer consistent with the minimum ROD requirements in these areas, results in a safety factor greater than 100%. Therefore, the buffer layer required by the ROD as a thickness equal to 50% of the chemical isolation layer thickness will be applied to the habitat layer in Remediation Areas A and E.

The isolation layer thickness required to meet remediation goals in Remediation Area D based on current modeling is also less than 0.5 ft. However, for conceptual design purposes it is assumed that the buffer layer thickness will be applied to the pH amendment layer rather than the habitat layer in Remediation Area D, as well as in Remediation Areas B and C.

4.1.4.2 Amendment Design

As discussed above, cap amendments will be incorporated into the design of the isolation cap in Remediation Areas B and D and the northern portion of Remediation Area C. Based on bench-scale testing summarized in Section 4.1.2, these amendments will consist of siderite to neutralize elevated pH and facilitate biological decay of key contaminants within the cap, and activated carbon to provided an extra level of protectiveness. A general schematic of an amended cap is shown below, followed by a discussion of the amendments and how they will function as part of the isolation layer. Alternative cross-sections may be evaluated as part of the intermediate design, such as mixing of bulk carbon into the chemical isolation layer in lieu of a carbon mat.



Example Schematic of an Amended Cap

The pH amendment will consist of siderite, which is a mined rock that is used primarily as an iron supplement for livestock. It consists of approximately 77% iron carbonate, 12% quartz, 10% clay, and trace amounts of pyrite by weight (specific gravity of 8.3). Prior to the application, the siderite will be crushed and screened to result in a grain size similar to sand. Based on geochemical modeling presented in Appendix I, the siderite will be mixed with sand at approximately 1.8% by weight and placed in a pH amendment layer with a minimum thickness of 0.5 ft., resulting in an application rate of 1 lb/sq ft. in order to provide long-term pH neutralization. This will constitute the base layer of the amended cap, and will include the “mixing” layer of the cap. Mixing of the siderite with the underlying sediment will not impact the siderite’s pH neutralization capacity. As porewater passes through the pH amendment layer, it will be neutralized to a pH of approximately 7, facilitating microbial activity and biological decay of key contaminants as they migrate through the sand layer.

With the amended pH, it is anticipated that biodegradation activity will be established in the isolation layer within a relatively short period of time (*i.e.*, a few months) provided suitable microorganisms and growth conditions are established. Additional laboratory testing is underway to identify growth conditions that support biodegradation activity and to verify that these conditions will be present within the cap. Conditions within the pH-amended cap that will encourage the development of appropriate microbial populations to biodegrade the contaminants include: 1) a source of electron donor and carbon to promote the growth of microorganisms and the dechlorination of chlorobenzenes; 2) a sufficient concentration of the contaminants to support the growth and maintenance of biodegrading population of microorganisms; and 3) sufficient nutrients (such as nitrogen, phosphorus, trace elements).

Microbes will naturally colonize the chemical isolation layer over time. To expedite microbial recolonization, the chemical isolation layer material may need to be "seeded" with sediments from another location within the lake to provide the required baseline microbial community. Bench studies currently underway will assess the potential need for microbial seeding. Microbial seeding is a common remediation approach, particularly for remediation of contaminated soil and groundwater. If needed, the sediment used for seeding could be from an uncontaminated area of the lake, or from an area of the lake impacted by organic compounds that does not have an elevated pH. This sediment could be mixed within the chemical isolation layer material or in the lower portions of the cap material at low percentages such that contaminants within the seeding sediment would not significantly impact the chemical isolation layer. Alternatively, the seeding sediment could be placed as a separate layer underlying the chemical isolation layer. The addition of sediments exposed to contaminants may increase the likelihood of including microbial populations acclimated and capable of biodegrading the contaminants; however, even the addition of un-impacted sediments will be beneficial as it should introduce sufficient and diverse biomass to establish conditions under which biodegradation of the contaminants are known to occur. Additional laboratory testing is underway to evaluate seeding of chemical isolation layer material with impacted and non-impacted sediments from other portions of the lake.

The time to develop the required population of microorganisms within the chemical isolation layer seeded with sediments from elsewhere within the lake will be a function of the concentration of viable microorganisms provided by the initial seeding; the inherent growth rate of the microorganisms; and the degree to which environmental conditions are optimized for growth of these microorganisms. The time to achieve the appropriate level of microbial activity can be estimated if the growth rate (often expressed as doubling time or the time to double the number of microbial cells) of the biodegrading microorganisms, their initial population density and the appropriate population density are known. For example, the *Dehalococcoides* (*Dhc)* microbial culture KB-1® biodegrades chlorinated ethenes to ethene. The doubling time of *Dhc* under optimal laboratory conditions and at room temperature can be as fast as 0.5 days (Cupples *et al.*, 2003). However, doubling times are typically longer under ambient lake temperatures and geochemical conditions. Microbial suppliers of *Dhc* use doubling times of 5 to 20 days for typical field applications of bioaugmentation (SiREM, Personal Communication).

Based on the rapid doubling times for microbial populations, a robust microbial population would develop in a relatively short time. For example, if 3% (by weight) native sediment is added to the chemical isolation layer material before placement, and it is conservatively assumed that only 10% of the cells in the native sediment used for seeding are successfully transferred into the chemical isolation layer, it would take just less than 9 cell doublings to achieve the same cell density in the cap as was present in the original lake sediment. If a conservative doubling time of 20 days is assumed, then it would only take about 180 days to observe the same biodegradation activity as in the original sediment. Additional laboratory testing is underway to evaluate microbial growth rates resulting from seeding of chemical isolation layer material with impacted and non-impacted sediments from other portions of the lake.

As an added level of protection beyond the siderite amendment and microbial seeding, if required, activated carbon will be placed within or at the top of the chemical isolation layer. Site-specific bench-scale testing of granular activated carbon and subsequent modeling has demonstrated that carbon will effectively adsorb dissolved organic contaminants for time scales ranging from multiple decades to centuries as described in detail in Appendix B. This will allow more than sufficient time for biological activity to reach sufficient levels such that long-term compliance with cap performance criteria will be achieved. Conceptual design level evaluations assume that the activated carbon will consist of approximately 1/8 inches of activated carbon encapsulated in a nonwoven core matrix bound between two geotextiles (i.e., activated carbon mat) to ensure uniform placement. This type of installation process has been successfully implemented at several other sediment remediation sites including the Stryker Bay site in Minnesota and the Island End River site in Massachusetts. As the design progresses, alternative carbon placement methods will also be evaluated, such as mixing of bulk carbon with sand prior to placement.

4.1.5 Mixing Layer Allowance

The chemical isolation layer placement will include an allowance for mixing of the bottom of the cap with the underlying existing lake sediment. Based on a review of mixing layer thicknesses measured at other recently completed capping sites, a mixing layer thickness of 0.25 ft (3 inches) was determined to be a conservative and appropriate estimate of constructed mixing layer depths. The sites evaluated varied with respect to cap construction, water depth, placement mechanism and substrate properties, resulting in a relatively heterogeneous cross section of site types. Overall, sediment mixing appears to be relatively minimal for all of the 17 sites which were reviewed. Of the eight sites where quantitative results were available, one reported a mixing depth of 4 inches, while the remaining seven reported a mixing depth of 2 inches or less. For those sites where mixing depths were not reported, the qualitative information indicated minimal mixing was noted or that a clear cap/sediment boundary was identified.

The 3-inch mixing allowance, combined with the range of over-placement allowance that is expected for all cap layers (estimated on the order of 0.25 to 2 ft as shown in Table 4.1), significantly exceeds the 0.5 ft that was assumed in the ROD to account for mixing and over-placement.

4.1.6 Six to Nine Meter Thin Layer Capping

As detailed in Section 4.1.1, a thin layer cap in lieu of the isolation cap may be appropriate based on design evaluation in some depositional portions of the littoral zones in water depths from 20 to 30 ft (6 to 9 meters) provided it can be demonstrated that it will be effective in meeting remedial goals. A thin layer cap typically refers to placement of approximately 0.5 ft of sand to reduce contaminant levels in surface sediments, and is a significant component of the SMU 8 remedy. For evaluation of thin layer capping in the 6 to 9 meter zone, a more robust thin-layer cap was developed, as detailed below.

Based on cap modeling, as summarized in Section 4.1.4.1, 0.5 ft is sufficient thickness to achieve chemical isolation throughout Remediation Areas A and E. Therefore, the cap in the 6 to 9 meter zone in these areas will consist of a 0.25 ft mixing layer, a minimum 0.5 ft chemical isolation layer, and a 1 ft minimum habitat layer, as shown in Figures 4.1 and 4.9. Cap modeling also supports application of a 0.5 ft thick chemical isolation layer in Remediation Area D. However, given the more complex amended cap design, the minimum chemical isolation layer thickness of 1 ft will be applied in the 6 to 9 meter zone of Remediation Areas B, C, and D.

4.2 EROSION PROTECTION LAYER

The erosion protection, or armor layer, will overlie and protect the chemical isolation layer from erosional processes including:

- wind-generated waves (waves resulting from winds blowing across the lake);
- ice scour (stresses induced from ice freezing to the bottom of the lake in shallow water);
- tributary flows (high flows discharging into the lake resulting from the creeks and other discharges) ;
- currents within the lake; and
- vessel-related effects including propeller wash (high velocities resulting from the propellers on recreational and commercial boats operating on the lake) and vessel-generated waves (*i.e.*, vessel wake).

Design and performance criteria and the methods and results from preliminary design evaluations pertaining to the erosion protection layer are discussed below and further detailed in Appendix D. Based on the evaluations detailed in Appendix D, wind-generated waves present the greatest potential erosive forces and therefore dictate the erosion protection layer design. The minimum erosion protection layer will range from 0.25 to 1 ft thick for various areas of the cap. The erosion protection layer material will range from sand to coarse gravel, consistent with the erosion protection requirements for specific areas of the cap as detailed below. In areas where the habitat layer material is consistent with the erosion protection layer material requirements, the layers will be combined since a single layer can function as both in such cases.

4.2.1 Erosion Protection Layer Design and Performance Criteria

USEPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA 2005) states that:

> *"The design of the erosion protection features of an in situ cap (i.e., armor layers) should be based on the magnitude and probability of occurrence of relatively extreme erosive forces estimated at the capping site. Generally, in situ caps should be designed to withstand forces with a probability of 0.01 per year, for example, the 100-year storm."*

Incremental increases in erosive forces due to events with a return frequency of greater than 100 years tend to be smaller (when compared to frequencies lower than 100); hence, such effects should be localized, resulting in minor damage potential and an easier repair of any resulting disrupted areas. Thus, in accordance with USEPA guidance and precedents from similar projects, the 100-year extreme events were used in the armor layer design to ensure long-term effectiveness of the cap.

Based on ROD requirements and other project-specific considerations, design and performance criteria for the erosion protection layer are listed below:

- The erosion protection layer will be physically stable under conditions predicted to occur based on consideration of 100-year return-interval waves. The 100-year wave is the highest wave that would be expected to occur, on average, once every 100 years). The cap will also be stable from waves induced by vessel wake.
- The erosion protection layer, specifically the areas potentially impacted by influent from tributaries, will be physically stable under conditions predicted to occur during a 100-year flood flow event.
- The cap will be designed to prevent the chemical isolation layer from being disturbed by ice.
- The cap will be designed such that the chemical isolation layer will not be negatively impacted by erosive forces resulting from propeller scour.

Preliminary design analysis methods and results pertaining to development of the erosion protection layer design to meet these criteria are provided below.

4.2.2 Erosion Protection Layer Design Evaluations

The erosion protection layer is designed to provide long-term protection of the chemical isolation layer using methods developed by the USEPA and the USACE specifically for *in situ* caps. This includes the methods included in Armor Layer Design of Guidance for *In Situ* Subaqueous Capping of Contaminated Sediments (Maynord, 1998). The armor layer design presented herein involved evaluating the particle size (ranging from sand to cobbles) required to resist a range of erosive force expected on Onondaga Lake. Appendix D presents the details of the armor layer design evaluations.

Wind measurements from 1942 to 2009 were obtained from the Hancock International Airport (formerly Syracuse Municipal Airport) and used for the wind/wave analysis. Statistical analysis was performed on the data to estimate the 100-year wave height and duration. The wind-wave analysis was used to determine the depth of the surf zone, where breaking waves result in larger required grain-sized material for erosion protection. Once the height and duration of the 100-year event was derived, the particle grain size required to withstand the erosive forces inside and outside of the surf zone was calculated.

In addition to wind-generated waves, a tributary analysis was performed to evaluate the stable particle sizes resulting from the 100-year flood flow for the armor layer of the cap. Velocity fields generated by the 100-year flows from Ninemile Creek and Onondaga Creek were modeled using a 2-dimensional hydrodynamic model. Particle sizes necessary to withstand the 100-year flood flow were computed for the 100-year flood flow from Ninemile Creek and Onondaga Creek as well as current velocities observed under typical conditions within the lake.

As a vessel or boat moves through the water, the propeller produces an underwater jet of water. This turbulent jet is known as propeller wash (or propwash). If this jet reaches the bottom, it can contribute to resuspension or movement of bottom particles. Types and operating conditions of commercial and recreational vessels that use Onondaga Lake were obtained. Representative vessels were selected for this analysis and the resulting particle size necessary to withstand potential propeller wash erosion from those vessels was calculated.

Finally, an evaluation of the ice processes and the potential for ice erosion along shoreline caps was performed. The analysis involved a field reconnaissance, reviews of published literature on ice processes, observations of water temperature and ice formation at Onondaga Lake, and evaluation of data from other lakes. This evaluation was used to develop required design considerations for protection of the cap against ice scour.

4.2.3 Erosion Protection Layer Initial Design

The erosion protection layer material will range from sand to coarse gravel, consistent with the erosion protection requirements for specific areas of the cap, as detailed in Table 4.2. Details pertaining to the grain size distribution corresponding to the grain size descriptions in the table are provided in Appendix D. As shown on Table 4.2, the minimum erosion protection layer thickness will range from 0.25 to 1 ft. for various areas of the cap. The design of the erosion protection layer is driven primarily by consideration of wind-generated waves. Analysis of vessel wake-induced waves concluded that wind-induced waves would be more of a significant potential impact to the armor layer.

The tributary analysis resulted in stable particle sizes of fine gravel for the portions of the cap near the discharge of both Ninemile Creek (Remediation Area A) and Onondaga Creek (Remediation Area E). The required particle sizes are less than or equal to the stable particles computed from the wind-wave results (see below). Ninemile Creek and Onondaga Creek are the two largest inflows to the lake. Evaluation of erosive forces from other tributaries and discharges to the lake, such as from stormwater and other outfalls, will be completed as part of future design efforts, but is not anticipated to result in significant design revisions. The assessment of typical current velocities measured in the lake (away from the influence of tributary flows) indicated a stable particle size of fine sand, which is less than or equal to the stable particles computed from the wind-wave results.

Based on a review of the types of vessels and operating procedures for these vessels in Onondaga Lake, there will generally be two types of vessel operations over the cap: 1) commercial and recreational vessels operating frequently in the New York State Canal Corporation (NYSCC) navigation channel to the Inner Harbor in Remediation Area E, and 2) recreational vessels operating in shallower water depths. The propeller wash analysis indicates that particle sizes in the coarse gravel range (1- to 2-inches) would be required for the armor layer in the NYSCC navigation channel. For the other areas of the cap, recreational vessels will likely operate infrequently and randomly. That is, these vessels will not start and stop or pass over the same location on a regular basis. Due to the limited area impacted by propeller wash from an individual vessel, significant movement of armor layer is not expected from propeller wash. In addition, in shallow water, a dedicated 1.5 to 2-ft thick habitat layer is planned above the armor and chemical isolation layers. Any potential disturbance to particles within a localized area is expected to "self-level" soon after disturbance due to natural hydrodynamic conditions within the lake.

Ice freezing to the bottom of the lake is expected in shallow water at the shoreline of Onondaga Lake. In such cases, it is expected that the normal thickening of ice will encounter the bed and freezing will continue. It was determined that the freezing of ice to the lake bottom is limited to water depths of less than 1.5 ft. To protect the chemical isolation layer for the cap, the armor layer and chemical isolation layer will be placed below the ice freezing depth of 1.5 ft. Using a low lake water level of 362.0 ft North American Vertical Datum (NAVD) 88, the ice freezing zone would be above 360.5 ft. The top of both the armor layer and chemical isolation layer will be placed below an elevation of 360.5 ft to protect against ice scour. Effects associated with ice, if any, are expected to be localized and restricted to the habitat layer thickness.

Although not a true erosive force, a bearing capacity evaluation demonstrating that human wading in near shore areas will not exceed the cap bearing capacity is also presented in Appendix D. Bearing capacity pertaining to structure associated with habitat restoration will be completed as part of future evaluations following further identification of potential habitat structure requirements.

4.3 HABITAT LAYER

The habitat restoration layer is a critical part of the overall habitat restoration program. It will be the upper-most layer of the cap and will provide the appropriate substrate to promote an active and diverse environment for a wide variety of species, allow for natural movement in the lake system, and exhibit micro-topography. The habitat layer thicknesses are based on an understanding of bioturbation, plant and animal biology (e.g. rooting and burrowing depth), professional experience of local and national experts, and a review of relevant scientific literature and technical guidance. Design and performance criteria and the methods and results from preliminary design evaluations pertaining to the habitat layer are discussed below and presented in more detail in Section 4 of the Habitat Plan (Parsons, 2009a).

4.3.1 Habitat Layer Design and Performance Criteria

Based on the requirements specified in the ROD and other project-specific considerations, the design and performance criteria developed for the habitat layer are listed below:

- The specific habitat layer thickness and habitat layer substrate (*i.e.* grain size) will be consistent with the target habitat conditions developed as part of the Habitat Plan;
- The habitat layer thickness will be determined based on consideration of plant rooting depth and animal burrowing and nesting depth species typical of central New York as well as human use;
- The habitat layer will be a minimum of 1 ft thick in all remediation areas; and
- The habitat layer may also serve as the erosion protection layer in some areas provided the substrate requirements are consistent.

Preliminary design analysis methods and results pertaining to development of the habitat layer design are provided below.

4.3.2 Habitat Layer Design Evaluations

General habitat restoration goals are established within the Habitat Plan. The first general restoration goal is to maintain or increase diversity of habitats, communities and species in all habitats by maintaining or improving the:

- size, diversity, and function of wetlands;
- connectivity of the lake habitats with adjacent stream and upland habitats;
- function of the littoral zone;
- function of the shoreline habitat;
- access for public use; and
- conservation and/or creation of threatened and/or endangered species habitats.

The second general restoration goal is to design conditions that discourage the establishment of invasive species (*e.g.*, avoid creating conditions conducive for invasive species) to the extent practicable.

The third general restoration goal is to develop conditions that require minimal maintenance and minimal public use restrictions. Once implemented, the habitat restoration designs are intended to provide self-sustaining, functioning habitats that require little or no maintenance over the long term. In addition, the restored areas should be open and accessible to the public to the extent practicable within the constraints of the remedy.

In order to meet the general restoration goals, the Habitat Plan describes more specific restoration objectives. To achieve the habitat-specific goals and objectives, the Habitat Plan and the cap and dredge area and depth conceptual design (this report) were developed concurrently.

Habitat layer thickness and substrate requirements have been developed within the Habitat Plan and are summarized below.

4.3.3 Habitat Layer Preliminary Design

Based on the evaluations summarized above and detailed within the Habitat Plan, the following habitat layer thickness criteria have been developed:

- the habitat layer will be a minimum of 2 ft thick in water depths from the shoreline to a water depth of 3 ft;
- the habitat layer will be a minimum of 1.5 ft thick in water depths from 3 to 7 ft;
- the habitat layer will be a minimum of 1 ft thick in water depths from 7 to 30 ft; and
- the minimum habitat layer thickness requirements includes the erosion protection layer.

The estimated average and maximum habitat layer thicknesses are greater than the minimums specified above, as shown in Table 4.1. This is due to the over-placement of habitat material during the installation of the habitat layer in order to ensure that the minimum thickness is achieved.

These thickness requirements were developed consistent with habitat modules described in the Habitat Plan. Habitat modules are areas with specific physical characteristics suitable for various representative species of fish, birds, plants, etc. In-lake habitat modules are defined by three basic habitat parameters: water depth, substrate type, and water energy. Habitat modules within the lake and the associated substrate are summarized below. As discussed in Section 6.1, these habitat layers will also be placed in areas that are dredged to cleanup criteria even though no isolation cap is required in these areas.

HABITAT MODULE SUMMARY

Module	Water Depth (ft)	Substrate/Energy
1 - Deep water	20 to 30	Sand. Low to medium energy.
2A - Mid water depth	7 to 20	Sand/fine gravel. Low to medium energy.
2B - Mid water depth	7 to 20	Coarse gravel/cobble. High energy.
3A – Shallow water	2 to 7	Sand/fine gravel. Low energy.
3B – Shallow water	2 to 7	Sand/Coarse gravel. High energy.
4A - Floating aquatics wetland	1 to 3	Sand Very low energy.
5A - Non-persistent emergent wetland	0.5 to 2	Sand/fine gravel. Low energy.
5B - Shoreline shallows/limited [illegible]	0.5 to 2	Sand/coarse gravel. High energy.
6A - Persistent emergent wetland	1 ft. above water to [illegible]	Sand. Low energy.
6B - On shore to shallows/limited [illegible]	1 ft. above water to [illegible]	Coarse gravel/sand. High energy.
7A - Mudflats/unvegetated shoreline	0.7 ft. above water to 0.7 ft. deep	Fines/sand substrate or cobble/gravel. High energy or fluctuating water levels.

The habitat layer substrate listed in Table 4.1 is consistent with the resulting post-capping habitat module requirements for each area, as detailed in the Habitat Plan. Plan views and conceptual cross-sections of the cap for various areas in each Remediation Area and the resulting habitat modules are shown on Figures 4.1 through 4.10. The dredging approach to achieve the resulting habitat modules in each area is discussed in Section 4.3.

The habitat module plans are conceptual and may be revised as additional data are gathered and as the design progresses. Due to the complexities associated with predicting the exact post-capping water depth, the designs have accounted for each consideration that may impact the water depth to ensure success. In order to achieve a minimum required thickness for a specific cap layer, some over-placement (additional thickness beyond the minimum required by the design) will likely result based on consideration of the expected construction equipment and methods. This is required in order to achieve minimum cap thickness, which is protective and discussed in more detail at the beginning of Section 4. Similarly, in areas requiring dredging prior to capping, there would be some over-dredging allowance provided for in the design in order to achieve a target minimum dredge cut that will be protective. In addition, the weight of the cap will result in some consolidation over time of the underlying sediments, provided that the weight of sediment dredged prior to capping does not exceed the weight of the cap, as detailed in Appendix E. Predicting the magnitude and time-rate of this settlement has been done using state of the art models to estimate the implications of this parameter.

Natural variability of the lake bottom and associated water depths will be present in the restored lake system. Some variance in post-construction water depth and habitat module boundaries is expected due to the variability of sediment characteristics and construction tolerances. Additional details on the placement and water depth tolerances in each area will be presented in the intermediate design. The habitat module boundaries are also likely to shift over time after cap placement due to natural processes such as wind and wave activity. This process is consistent with how natural habitat systems function and will enhance the variability of the cap surface as would be expected in a natural system.

In shallow water areas there is less tolerance for water depth variation due to the need to meet more stringent habitat-based water depth goals. In areas with a post-capping Habitat Module goal of Module 4A, 5A, 5B, 6A, or 6B (*e.g.* target water depths of 3 ft or less), a more rigorous dredging and capping plan has been developed to ensure post-capping water depths are within the target water depth range. The dredging and capping design and construction strategy to achieve these target water depth ranges is outlined below and shown on Figure 4.11.

1. The maximum total cap thickness was calculated as the sum of the minimum thickness for each layer plus the maximum over-placement allowance for each layer, as listed in Table 4.1.
2. The minimum post-dredging water depth (*e.g.* not including over-dredging allowances) was determined based on the minimum water depth for the target habitat module (*e.g.* 1 ft for Module 4A) plus the maximum cap thickness with all applicable over-placement allowances. The inclusion of the over-placement ensures that there will be sufficient water depth to achieve the required thickness for all layers.

3. Following placement of all cap layers to at least the minimum required thickness, except the habitat layer, bathymetry will be measured. The thickness of the habitat layer placement will be increased if necessary in order to ensure that the final surface of the habitat layer is within the target water depth range.

Settlement of the underlying sediment due to the increased load from the cap has been conservatively assumed to be zero in these areas for purposes of developing the dredge depth requirements at this initial design stage. However, settlement calculations may be incorporated in the dredging prism in future designs. Although some settlement may occur over time, it will be less than in other capped areas because dredging of surface sediments will occur prior to cap placement. In addition to settlement in these areas, post remediation bathymetry will also likely change over time due to other natural processes, such as movement of the habitat materials locally due to wind and wave activity. This movement is expected, desired, and consistent with a natural lake system.

Habitat module-based target elevations will be met on an area-wide-average basis. Variation in water depth will occur in localized areas to support the goal of microtopography on the lake bottom, which has been identified as a beneficial habitat feature in the Habitat Plan.

The post-capping water depths shown in Figures 4.1 through 4.10 and in Appendix F are based on maximum cap thickness, , which is conservative and will allow for the water depth to be slightly deeper. The post-capping water depths also include settlement estimates (Appendix E), except for Habitat Modules 4, 5, and 6 as discussed above.

In the majority of the cap areas, particularly in deeper water (7 to 30 ft), the grain-size requirements for the erosion protection layer are consistent with the habitat layer objectives. In those areas, the habitat layer will consist of materials that meet the requirements for habitat and erosion protection, as shown in Table 4.1. In water depths less than 7 ft, which is the most biologically active area as well as the area requiring the most rigorous erosion protection, the substrate used for the habitat layer may need to be finer grained material and will be designed to meet the habitat objectives in these areas.

4.3.4 SMU 3 and SMU 5 Habitat Enhancement

The ROD identified two locations where habitat enhancement activities would be applied even though remediation activities are not required in these areas based on contaminant concentrations. The areas are along an estimated 1.5 miles (2.4 km) of SMU 3 shoreline, and over approximately 23 acres of lake bottom in SMU 5 to stabilize calcite deposits and oncolites and promote submerged aquatic plant growth. Each of these areas is discussed below. Additional detail is provided in the Habitat Plan.

SMU 3 (Shoreline Stabilization)

The shoreline stabilization in SMU 3 will be designed to reduce resuspension and turbidity along the shoreline of SMU 3. This stabilization will ultimately be integrated with the remedy for Wastebeds 1 through 8, which is still under development. Therefore, the shoreline stabilization described in this section is specific to the shallow water portion of SMU 3 up to an elevation of approximately 365 ft (NAVD 88), which is close to the highest high water mark for Onondaga Lake (*i.e*., 95% of all recorded water surface elevations are at or below 365 ft [NAVD 88]). Stabilization measures for the shoreline areas above the 365 ft (NAVD 88) elevation will be developed as part of the Wastebed 1 through 8 remedy.

The results of the wind/wave analysis completed for Onondaga Lake were used to determine the extent of the surf zone and the size of stone needed to stabilize the substrate (Appendix D). The surf zone associated with the 10-year wind/wave event was selected as the basis of design for defining the treatment area, resulting in a treatment area which extends to a water depth of approximately 2.5 ft. This results in a total treatment area of approximately 16.2 acres, as detailed in the Habitat Plan (Parsons, 2009a).

The 10-year wind/wave event was used as the basis of design for determining the stable particle size in order to balance between stability and gravel size. Based on this analysis, medium sized graded gravel will be placed within the surf zone to stabilize the substrate and reduce resuspension. This material will be placed on top of a fabric layer to prevent sinking into the Solvay waste material and will be a minimum of 0.5 ft thick in underwater portions along the entire SMU 3 shoreline to a water depth of approximately 2.5 ft. Shoreline stabilization will not be needed in areas where dredging and/or capping will be conducted.

The approach for stabilizing the calcite deposits above the waterline from 362.5-365 ft along the SMU 3/Wastebeds 1-8 shoreline will use bioengineering techniques to the greatest extent possible to minimize hardening of the shoreline and provide a transition between the Wastebeds 1 through 8 and the lake. These bioengineering techniques may include the use of a live crib wall, live fascines (woody vegetation bundles such as *Salix spp*.) and vegetative mattresses (brush material buried in trenches) that will be installed in a 1 ft thick layer of topsoil and gravel. The majority of bioengineering techniques incorporate larger sized stone near the toe of the slope which corresponds with the surf zone of SMU 3.

SMU 5 (Habitat Enhancement)

As described in the ROD, habitat enhancement was planned to occur over approximately 23 acres in Remediation Area F (SMU 5) to stabilize calcite deposits and oncolites and promote submerged aquatic plant growth. The approach described in the ROD was based on stabilizing the oncolitic sediments to allow plant colonization. The target of 23 acres was based on increasing the percent cover of the littoral zone to provide optimal habitat for largemouth bass.

Since that time, the area covered by plants has increased significantly, largely due to water quality improvements associated with the upgrades to the Metro facility. Therefore, the habitat enhancement activities, which were designed to increase aquatic plant cover to provide optimal habitat for the largemouth bass, may not be necessary to meet the objectives noted in the ROD. Additional detail regarding why habitat enhancement in SMU 5 may no longer be required is provided in the Habitat Plan.

4.4 CAP MATERIAL SOURCES, TRANSPORT AND STAGING AREAS

4.4.1 Cap Material Source Design and Performance Criteria

Project requirements applicable to the specific cap materials are detailed in Sections 5.1 through 5.3. The source(s) of the material must have enough supply to provide the project with the specified material in the appropriate time frame. Material transport from the sources must be reliable, safe and have the capabilities to provide the material in sufficient quantities. In order to ensure minimal cap placement operational downtime, stockpiling a surplus of materials may be required.

As discussed in Section 2.2.2, as part of its sustainability program, Honeywell is committed to minimizing the carbon footprint of construction activities anticipated as part of the execution of the remedy. To the extent practicable, use of renewable energy sources, utilization of locally produced/sourced materials and supplies, reduction/elimination of waste, efficient use of resources and energy, and other sustainable practices will be incorporated into cap material sourcing and transport. Details pertaining to the incorporation of sustainable practices will be included in subsequent design submittals.

4.4.2 Material Sources

Materials required for the capping operations in the lake include aggregate materials and potentially, pH and carbon amendments, as well as biological seed materials. Material will be brought in bulk directly from the mines, quarry pits, and other material supply facilities. Multiple sources of each material may be required to facilitate the overall cap design quantities.

Aggregate materials such as sand and gravel required for the cap, including chemical isolation, erosion protection and habitat materials, can be found local to the Syracuse area, as well as State and nationwide. Onondaga and surrounding counties provide over 150 active mines, pits, and quarries to potentially provide material for the capping of lake sediments. Material properties, available quantities and transport methods from identified source locations are currently being investigated. Due to the proximity of the NYSCC, and access to nearby railroad spurs, options for materials imported from further distances may also be available for this project.

Additional opportunities are also being investigated for potential cap materials sources. Clean material dredged for marine navigation at other sites may be proposed for portions of the cap. Other construction and development projects that present a beneficial re-use opportunity are also currently being reviewed.

Siderite will be used as a pH amendment as required for portions of the cap. The siderite used for pH bench studies was produced by a mine in Texas. This mine encompasses over 200 acres and has the resources and capabilities to produce the required siderite for the project. Additional potential siderite mines, some active and some not active, are located throughout the United States.

Granular activated carbon will be used for portions of the cap. Carbon isotherm studies were developed to determine carbon sorption for site conditions using a coal based carbon from

Calgon Carbon Corporation. Granular activated carbon is produced in Pennsylvania, Kentucky and other locations. Carbon can be supplied by bulk transport (truck or rail car). The carbon will be produced to size and specifications required at the carbon activation facility. As the design is finalized, reactivated or additional carbon vendors may be considered. Use of reactivated carbon or additional vendors would require additional isotherm studies.

4.4.3 Material Transport

Onondaga Lake's proximity to major transport modes provides the project with inherent transportation advantages. The lake connects to the New York State Canal System, making barge transport of capping materials viable. Rail lines of the Finger Lakes Railway run adjacent to the lake and connect to CSX, Norfolk, Southern and Geneva and other major rail carriers. The lake is also located adjacent to major vehicle transportation routes from both the east/west and north/south. Each transport mode is a viable option that is under consideration. Sources of materials and the best modes of transportation are being evaluated for the project.

Aggregate sand and stone products may be supplied by barge directly from the source mine or material pit. Some material sources are located adjacent to waterways that can direct load a barge for the capping materials. From the Seneca River, which discharges from Onondaga Lake, through the New York State Canal System, barge travel to Cayuga Lake, Oneida Lake (on the Erie Canal) and Lake Ontario are possible. Once on the Canal System, travel from around the world is possible.

Rail transport of materials may also present opportunities for the transport of capping materials. Materials can be imported on the Finger Lakes Railway to a nearby siding. Multiple sidings local to shoreline operations may be utilized. A single rail car can transport three to five times more material than an over the road trailer truck. Siding locations that can directly load a barge are a potential option. Alternatively, trucks may be used to transport the material from the siding to the shoreline operations.

Over the road trucking may also be utilized for importing materials to the site. Onondaga Lake is located adjacent to Interstate 90 and 690, major east/west routes through New York State. It is also located adjacent to Interstate 81 which is a major north/south interstate.

4.4.4 Material Staging

To keep the capping of the lake on schedule, material stockpiles may be utilized to provide the material to the capping operations when needed. Strong daily coordination efforts between the material supplier and the capping operations will keep the supply of material delivered to the project as it is requested. This daily coordination will provide the most efficient cap placement in order to keep the capping operations on schedule.

Stockpiles of surplus materials will be required on the project. Stockpiles will allow some flexibility of the material supply to the project, and provide materials to the capping operations as they are needed. There are multiple areas adjacent to the lake that may be assessed as potential stockpile locations. Due to the existing projects that are scheduled to take place at many of these areas, coordination with each project site would be required. Potential adjacent stockpile sites include Wastebed B and the existing causeway staging area. Stockpile size and locations will be evaluated in more detail in future design submittals.

4.5 CAP MATERIAL PLACEMENT

This section provides an overview of the potential cap placement technologies/ methodologies, outlines design and performance criteria for cap placement, and discusses potential quality control procedures to assure appropriate cap placement.

Several methods have been employed on previous projects to place granular capping materials, including:

- direct placement with a mechanical clamshell bucket;
- surface release from a barge, hopper, conveyor belt, or broadcast spreader;
- spreading with hydraulic pipeline and baffle box or plate;
- jetting off of a barge;
- submerged diffuser or tremie pipe; and
- pneumatic placement in very shallow water or marsh areas.

Selection of the most appropriate placement method will be detailed in future design submittals and will incorporate input from the selected capping construction contractor. Selection of the placement method will consider numerous factors including, but not limited to:

- site conditions (*e.g.* water depth, water currents);
- stability of existing sediment and the potential for resuspension during cap placement;
- method of material delivery to site (*e.g.* by barge, truck, rail, etc);
- distance between material stockpile (if applicable) and placement location;
- site access limitations (*e.g.* shallow water, pilings, docks, etc.);
- grain size and volume of material being placed;
- site-specific placement requirements (*e.g.* production rates, lift.-thicknesses, etc.); and
- availability of placement equipment (*i.e.*, market factors).

4.5.1 Cap Placement Design and Performance Criteria

Cap placement will conform to a series of strict design and performance criteria. The design and performance criteria presented in this section were developed to ensure that cap materials will be placed to the thickness and extent required by the design in a controlled manner, thereby providing an environmentally protective cap. The following presents preliminary cap placement performance criteria and may be enhanced or appended as the remedial design progresses.

- Real-time horizontal position control – Each cap placement operation will be outfitted with a positioning system that will track, in real-time, the position of the placement equipment. This typically includes the use of global positioning system (GPS) sensors, inclinometers, tilt sensors, and/or other positioning equipment mounted directly on the placement equipment (*e.g.* the boom of a mechanical excavator). The positioning equipment will be connected to a computer software package specifically designed for tracking and logging the position and movement of the equipment.

- Material quantity tracking – Each cap placement operation will be outfitted with equipment to monitor the quantity and rate of material being placed.
- Compliance with project water quality standards (see Section 4.6) – The contractor will be required to implement a series of best management practices (BMPs) and contingency planning to minimize turbidity generation as a result of cap placement.
- Thickness tolerances – A set of project specifications will be developed that provide minimum and maximum cap layer thicknesses and completed habitat layer elevations based on the design. The contractor will be required to place the cap within these tolerances in order to satisfy chemical isolation, erosion protection, and habitat thickness/elevation objectives. Compliance with minimum cap layer thicknesses will be verified during construction, as described in Section 4.5.5.

4.5.2 Sand, Gravel and Stone Placement

Natural materials (sand, gravel, and stone) planned for placement as part of the Onondaga Lake caps will range from silt-and sand-sized to cobble-sized, depending on the layer (chemical isolation, erosion protection, and habitat), Remediation Area, water depth, and Habitat Module. Based on this range of particle sizes, it may be necessary to use different cap placement equipment depending on the material gradation. For instance, sand-sized material planned for use in the chemical isolation and habitat layers can be efficiently transported and placed via either mechanical or hydraulic means. Conversely, placement of the larger armor materials (*e.g.* coarse gravel and cobbles) is likely only feasible using a mechanical bucket since these materials cannot be efficiently transported or placed via hydraulic slurry or broadcast spreader. Based on reasonable limits of hydraulic slurry transport and placement, cap materials with a median particle size (D_{50}) in excess of 0.75 to 1 inch (maximum particle size of 1.5 to 2 inches) will likely be placed by mechanical equipment.

4.5.3 Cap Amendment Placement

As discussed in Section 4.1.3, cap amendments will be necessary for portions of the cap. The cap amendments are expected to include siderite (a mineral composed of iron carbonate) to neutralize the pH of upwelling groundwater as well as activated carbon (either as a bulk granular material or contained within a geotextile mat) for improved sorbtive capacity of the cap.

The siderite planned for use as part of the amended cap will be granular (sand-sized particles) with a specific gravity of approximately 3.8 (greater than sand). The siderite will be mixed with the sand material forming the base layer of the cap including the mixing layer. This mixing of the sand and siderite could be performed through upland processing or potentially just prior to placement by merging two "streams" of sand and siderite being transported (hydraulically or mechanically) to the cap placement equipment. Therefore, the siderite could be placed either mechanically or hydraulically, depending on the method selected for placement of the sand chemical isolation layer. Additional design analyses will be performed to determine the most efficient/effective means of placing the siderite.

The activated carbon that is being considered for amendment portions of the chemical isolation layer may be placed as a bulk layer mixed with the sand cap layer, or encapsulated in a non-woven core matrix bound between two geotextiles (*i.e.*, activated carbon mat) and placed as a discrete layer. If an activated carbon mat is used, it would likely be delivered to the site on rolls measuring 15 to 16 ft wide by 100 to several hundred feet long. Installation of the activated carbon mat would likely involve the use of a barge-mounted crane to hoist the roll and the assistance of other support vessels to unroll the mat. Carbon amended caps and/or mats have been successfully implemented at several other sediment remediation sites including the Stryker Bay site in Minnesota, the Anacostia River site in Washington D.C., the Gasco Site, in Oregon, the Collins Cove site in Massachusetts and the Island End River site in Massachusetts.

As discussed in Section 4.1.4.2, it may be appropriate to “seed” the chemical isolation layer of the cap in portions of the lake with sediments from another location within the lake to provide the required baseline microbial community, thereby facilitating biodegradation of the contaminants. Means and methods for placement of this seeding sediment, such as mixing with the chemical isolation layer sand prior to placement, will be evaluated in future phases of the design.

4.5.4 Capping Production Rate

Production rates for granular cap material will vary between mechanical and hydraulic placement methods as well as due to varying material types (sand versus gravel) and site conditions (water depth, size of contiguous capping area, etc.). Production rates for placement of the activated carbon will vary depending on the water depths, bottom slope, weather conditions (i.e. wind), and other factors.

Depending on the overall sequence and schedule of construction operations, multiple capping operations may be working simultaneously. This may include separate capping operations for different Remedial Areas and/or separate operations for the different material types. A review of previously completed or ongoing sediment capping projects including the Fox River in Wisconsin, the Grasse River in New York, and others, indicates that placement rates for granular cap material (silt, sand, and gravel) can range from 40 to 100 CY per hour using either mechanical or hydraulic placement equipment. Experience at the St. Louis River site in Minnesota, indicates that geotextile fabric mats can be installed as subaqueous caps at a rate of nearly 1 acre per day. Given the very large scale of operations that is required for the Onondaga Lake project, it is expected that production rates for granular cap material and activated carbon mats, if utilized, will likely be towards the upper end, or higher, than the ranges achieved on previous smaller scale projects.

4.5.5 Placement Quality Control

Strict quality control measurements will be performed throughout cap placement to verify that the cap materials have been placed to the thicknesses and lateral limits specified by the design and in accordance with the performance criteria (*e.g.* within specified construction tolerances). Multiple quality control procedures will be implemented to ensure compliance with the placement criteria. The following methods may be used for quality control:

- Accurate material volume tracking: Volumes of material placed within a known area will be used to compute theoretical cap thickness, which can be used to validate other thickness verification methods.
- Tracking of horizontal position: The position of cap placement equipment will be accurately measured and tracked through the cap construction to verify that cap materials have been placed within the specific horizontal limits.
- Geophysical surveys: Acoustical and/or manual bathymetric surveying, or other geophysical measurement approaches such as sub-bottom profiling, performed prior to and after cap placement can be used to evaluate the thickness of the placed cap. The specific equipment to be used and accuracy of these surveys will be dependent on site conditions and may not be suitable for thickness verification in all areas of the lake.
- Physical samples: Post-placement cores or "catch pans" may be used to collect a physical sample of the cap material placed. No chemistry samples will be collected, but rather visual observations of the cap thickness will be made. These types of physical measurements may not be suitable for verifying the placement of large armor stone or in deep water portions of the lake.
- Diver surveys: In some portions of the lake where bathymetric surveying or core sampling is not feasible, divers may be used to visually verify that cap material have been placed according to the design. This may include the amended cap area where activated carbon will be included as part of the chemical isolation layer.

Specific details and utility of the various quality control procedures will be further developed during future design submittals.

4.6 MANAGEMENT OF AMBIENT WATER QUALITY DURING CAPPING

The design will require a water quality management program during construction to monitor and mitigate potential environmental effects associated with the construction activities. This section provides a preliminary overview of the management program for capping activities including the process for developing design and performance criteria, potential methods for monitoring to verify compliance with performance criteria, and best management practices to prevent unacceptable impacts.

4.6.1 Design and Performance Criteria

Water quality criteria for in-lake remedial construction activities will be established during intermediate phases of the design. Capping is inherently a low impact activity. Based on experience at numerous other capping sites, cap placement does not result in significant disturbance of contaminated sediments or release of significant contamination to the water column. The development of water quality criteria will consider the existing ambient water quality of the lake and incorporate spatial (*e.g.,* distance from capping operations) and temporal (*e.g.,* daily average) components. Proposed water quality criteria will likely consist of two tiers:

1) performance monitoring station; and 2) compliance monitoring stations. The intent of the performance monitoring stations will be to monitor near field water quality in the general vicinity of the construction area. Specific locations of the performance monitoring stations will be developed to identify and manage any capping-related impacts, so that early warning is available to refine the capping process. Response to an exceedance of the early warning alert level may include additional monitoring and engineering improvements (see proposed BMPs in Section 4.6.2). Compliance monitoring stations will serve as the official compliance location for water quality and will be developed to assure environmental protectiveness.

Following establishment of water quality criteria, a construction monitoring plan will be developed with a tiered sampling approach that provides for an efficient and environmentally protective program. The program would consist of an initial period of real-time turbidity data collection in the performance monitoring stations, coupled with initial weekly analytical sampling at the compliance monitoring stations at the start of the capping activities. Water quality monitoring would transition into a routine monitoring schedule consisting of real-time turbidity monitoring when the initial period of monitoring is favorable. The details of the monitoring plan and contingency and response action levels that will be undertaken to assure environmental protectiveness during the project will be presented in the future design documents, as part of a construction monitoring plan. A flow chart depicting the monitoring stations and the associated monitoring and response protocols will also be included as part of this plan.

4.6.2 Best Management Practices (BMPs)

BMPs (*i.e.*, operational and/or physical controls) will be employed to minimize construction related impacts. Typically, two tiers of BMPs are employed. The first tier will be required as part of the contract. The second tier will be employed only if field conditions warrant them based on water quality monitoring results.

Example “Tier 1” BMPs include:

- capping materials will generally be placed uniformly over the sediment surface minimizing disturbance to the sediment or previously placed cap material;
- optimizing the sequence of capping (upcurrent to downcurrent, offshore to onshore, or with respect to number of lifts);
- capping materials will be placed as an initial thin lift over large sub-areas prior to placement of subsequent lifts;
- on slopes steeper than a set angle (*e.g.* steeper than 25 horizontal to 1 vertical), capping materials will be placed from the toe up to the top of the slope; and
- location and material control equipment will be required to maximize controlled placement of cap material.

Examples of "Tier 2" BMPs include:

- optimizing specific operations (such as bucket speed, height/depth of release of cap material from bucket);
- limiting placement operations to calmer environmental/weather conditions (*e.g.* stopping placement when wave heights or wind speeds exceed a certain value);
- decreasing the cap lift thickness; and
- installing turbidity controls to contain construction related impacts.

BMPs will be further developed as part of the Intermediate Design Submittal.

4.7 CAPPING DATA GAPS

Remediation boundaries and cap areas are well defined based on data from the RI and five years of design-related investigations. As discussed in Section 1.4, these activities have provided more than 800 sediment sampling locations, almost 10,000 environmental samples, and more than 200,000 chemical and geotechnical analyses to support design of the selected remedy. It is anticipated that additional sediment data will be gathered in 2010, which may result in minor modifications to remediation boundaries and related cap areas. For example, additional data will be collected along the remediation boundaries developed in Section 3 where the extent of sediments exceeding cleanup criteria have not been fully established. This includes the western end of Remediation Area A in the 6 to 9 meter zone, the northern end of Remediation Area E in the 6 to 9 meter zone, and in portions of Remediation Area F. In addition, additional sampling may be completed to evaluate whether remediation areas in certain locations can be modified, such as in the Remediation Area D addendum cap area. .

An extensive data base related to porewater and groundwater upwelling velocity has also been developed based on over five years of design-related investigations. Porewater and groundwater upwelling velocity-related data collected as part of the 2009 PDI are included in Appendix C but have not yet been incorporated into the design evaluations. In addition, it is anticipated that additional porewater and groundwater upwelling velocity data may be gathered in 2010 in localized areas to validate or allow revision of current isolation layer model inputs. For example, additional groundwater upwelling velocity data in certain nearshore areas may be appropriate to refine the design. This data may also result in modifications to the boundaries between the isolation cap and areas that will be dredged to cleanup criteria. .

As described in Section 4.1.2, there are ongoing column and batch slurry bench studies related to contaminant biodecay rates and cap enhancements. Data from these tests will be used to refine the chemical isolation layer model and design as appropriate, as well as to assess whether there are additional data gaps associated with these design parameters.

In addition to the ongoing bench studies referenced above, additional treatability studies will be implemented to facilitate the detailed cap design. For example, additional activated carbon isotherm studies will be completed to validate the work completed to date and/or to evaluate the performance of other activated carbon types. In addition, laboratory evaluations related to cap enhancement and constructability will be implemented, such as studies to evaluate methods to place activated carbon and/or microbial seeding of the chemical isolation layer.

Details regarding the potential data gaps discussed above are still under evaluation and will be detailed in future investigation work plans, which will be submitted to NYSDEC for review and approval.

SECTION 5

DREDGING AREA, DEPTH, AND VOLUMES

Dredging of contaminated sediments is a significant part of the overall Onondaga Lake remedy. The remedy for the lake as specified in the ROD includes dredging of as much as 2,653,000 CY. This was an estimate of the dredge volume required to achieve the ROD-specified goals based on RI data and FS-level evaluations conducted in 2004. Subsequent data collection and more detailed design evaluations between 2004 and 2009 have allowed for a more accurate estimate of the dredge volume required to meet the ROD-specified remedial goals, resulting in a design dredge volume to use for operations design of 2,172,000 CY. Details pertaining to this dredge volume estimate are provided in Section 5.2.

Based on the evaluations presented in Section 5.2, the estimated dredge volume has gone up in some SMUs and down in other SMUs compared to the ROD estimates. For example, the estimated dredge volume in SMU 2 decreased by approximately 280,000 CY based on the ESD issued by the NYSDEC December of 2006 and other less-significant refinements.

Design and performance criteria and the methods and results from preliminary design evaluations pertaining to dredging, including detailed volume estimates, are discussed below.

5.1 DREDGING DESIGN AND PERFORMANCE CRITERIA

Design and performance criteria relative to dredging can be organized into three general categories: ILWD dredging, elevation-based dredging, and dredging to cleanup criteria. ILWD dredging will be to a specified elevation, but it is listed separately due to its significance to the overall dredging program. Based on ROD requirements and other project-specific considerations, design and performance criteria pertaining to dredging are listed below.

- ILWD dredging:
  - Dredging will be performed to remove sediments and/or wastes to an average depth of 6.6 ft (2 meters) in SMU 1. Dredging of ILWD that extends into SMU 2 and SMU 7 will also average 6.6 ft (2 meters) in each of these areas.
  - In areas of the ILWD defined as hot spots, dredging will be performed to remove an additional 3.3 ft (1 meter). Hot spots will be defined as those sediments and or wastes that contain contaminants above the criteria specified in the ROD, as listed below. As specified in the ROD, these criteria may be revised based on refined modeling during the design, using an assumed groundwater upwelling velocity of 6 cm/yr.
    - Benzene 208 mg/kg
    - Chlorobenzene 114 mg/kg
    - Dichlorobenzenes 90 mg/kg

- Naphthalene 20,573 mg/kg
- Xylene 142 mg/kg
- Ethylbenzene 1655 mg/kg
- Toluene 2625 mg/kg
- Mercury 2924 mg/kg

– Dredging of ILWD material will be performed if necessary to ensure the geotechnical stability of the isolation cap. The determination of geotechnical stability will consider both static and seismic stability of the ILWD. The determination of seismic stability will be based on an analysis of cap stability during an operating level event (*i.e.* a seismic event with a 50% chance of exceedance in 50 years) and a contingency level event (*i.e.*, a seismic event with a 10% chance of exceedance in 50 years).

- Elevation-based dredging. Dredging will be performed as necessary to ensure that after the cap is placed there is no loss of lake surface area. In certain areas, dredging will also be performed to achieve a specific post-capping water depth based on habitat considerations. Dredging will be performed to a specified elevation in these areas based on the thickness of the cap and the desired post-capping water depth.
- Dredge to cleanup criteria. In certain nearshore areas, dredging will be performed to achieve numeric cleanup criteria. Dredging in these areas will remove the sediments such that the remaining sediment chemical concentrations will be below the individual PEC for each of the 23 contaminants and the NYSDEC sediment screening criteria for benzene, toluene, and phenol.

In areas where dredging to cleanup criteria is implemented, habitat reestablishment material will be placed to a minimum thickness of 2 ft in water depths between 0 and 3 ft, 1.5 ft in water depths between 3 and 7 ft, and 1 ft in water depths between 7 and 30 ft, consistent with cap habitat layer requirements.

5.2 DREDGING DESIGN EVALUATIONS AND PRELIMINARY DESIGN

Discussion regarding design evaluations and the resulting preliminary design for dredge areas, depths and volumes for Remediation Areas A through E is presented below. Remediation Area F consists of two small areas (less than 1 acre combined area) where additional data collection is required to determine the most appropriate remedial approach, and will be addressed in future design submittals. The estimated dredge volume of 1,926,000 CY, as presented in Sections 5.2.1 through 5.2.5 and listed in Table 5.1, is considered the best estimate at the time of this IDS. However, as the design is advanced, this volume may increase or decrease. To account for potential volume increase, the design dredge volume to use for advancement of the operations design (*e.g.* slurry transport system, SCA, and water treatment components) is 2,172,000 CY, as detailed in Section 5.2.6.

To account for the potential dredge volume associated with cleanup passes that may be required in the dredge to cleanup criteria areas, the total dredge volumes listed in Table 5.1

include a volume equivalent to an average additional removal of 1.0 ft over the entire area where dredging to cleanup criteria will be implemented. This volume is in addition to the dredge volumes developed in Appendix F.

The Appendix F dredge volumes are based on achieving a minimum post-dredging water depth. To achieve this minimum water depth, some overdredging will result. Overdredge is an allowance provided to the contractor to account for equipment accuracy and assure that target (required) elevations are met. Typical overdredging in past similar projects has averaged 4 to 6 inches. Therefore, the total dredge volumes listed in Table 5.1 include an average overdredge of 0.5 ft in addition to the dredge volumes developed in Appendix F.

5.2.1 Remediation Area A

With anticipated overdredging and cleanup passes, the total estimated dredge volume in Remediation Area A is approximately 133,000 CY, as shown in Table 5.1. The basis for this estimate is provided below and in Appendix F.

Dredging to cleanup criteria will be completed out to the first line of groundwater upwelling measurement locations used for cap modeling and design (Appendix C), referred to as Dredge Area A-1 in Figure 4.1. Dredging to cleanup criteria will be implemented in these areas because groundwater upwelling velocities are higher in nearshore areas, which negatively impacts cap effectiveness. Based on design-related investigation data, the contamination depth in the nearshore area east of Ninemile Creek is approximately 1 ft deep in the majority of the area. However, dredging of 2.5 ft of sediment is required in this near shore area in order to allow placement of the required habitat material while maintaining current bathymetry. In the nearshore area west of Ninemile Creek, contamination is approximately 8 ft deep adjacent to the western peninsula and 2 ft deep in the western portion.

Additional groundwater upwelling velocity data was collected in Remediation Area A as part of the PDI in 2009 which has not yet been incorporated into detailed design evaluations. However, based on preliminary evaluation of this data, it may be possible to extend the isolation cap closer to shore west of Ninemile Creek. In addition, the area where dredging to cleanup criteria is implemented in portions of the area east of Ninemile Creek may extend further offshore then currently depicted. Any design revisions based on this data will be reflected in the intermediate design.

Consistent with Onondaga Lake and Ninemile Creek decision documents, the outlet of Ninemile Creek will also be dredged to cleanup criteria as part of the lake remedy. This is the area between the two spits that protrude into the lake at the mouth of Ninemile Creek. The dredging will extend 300 ft upstream from the tip of the western spit. Dredging to cleanup criteria will extend to a depth of 6.6 ft (2 meters) in this area based on investigation results.

The dredging along the western spit of the Ninemile Creek outlet and within the Creek is shown as a vertical removal in Appendix F. Ongoing investigation of the spits will be used to determine the appropriate removal depths and restoration approach for the spits and allow integration of the lake remedy with the remedy for the spits to be completed as part of the Ninemile Creek remedy.

The dredging in the area immediately offshore from this (Dredge Area A-2) will be to a target elevation (*i.e.*, elevation-based dredging) in order to achieve a target post-capping water depth based on habitat considerations. The capping and dredging strategy in Habitat Modules 4, 5, and 6 within Dredge Area A-2, where there is less tolerance for water depth variation due to the need to ensure tighter habitat-based water depth goals are met, is detailed in Section 4.3.3.

5.2.2 Remediation Area B

With anticipated overdredging, the total estimated dredge volume in Remediation Area B is approximately 20,000 CY, as shown in Table 5.1. The basis for this estimate is provided below and in Appendix F.

To achieve post-cap water bathymetry for designed habitat modules, dredging to a target elevation will be completed to a maximum distance of approximately 200 ft from shore, as shown in Figure 4.3. Shoreline groundwater controls are currently being designed for the shoreline of Wastebeds 1 through 8 as part of the remedy for that site. This will reduce nearshore groundwater upwelling velocities, allowing the cap to be effective up to the shoreline.

5.2.3 Remediation Area C

With anticipated overdredging and cleanup passes, the total estimated dredge volume in Remediation Area C is approximately 38,000 CY, as shown in Table 5.1. The basis for this estimate is provided below and in Appendix F.

Dredging to cleanup criteria will be completed in a portion of the area adjacent to the east side of the NYSDOT turnaround area out to the first line of groundwater upwelling measurement locations used for cap modeling and design (Appendix C), referred to as Dredge Area C-1 in Figure 4.5. Dredging to cleanup criteria will be implemented in this area because groundwater upwelling velocities may be higher in nearshore areas, which could negatively impact cap effectiveness. The southern portion of Dredge Area C-1 extends significantly beyond the first line of groundwater upwelling measurement locations. Dredging to cleanup criteria rather than capping will be implemented in this area in order to increase water depth and facilitate potential future use of the NYSDOT turnaround area as a boat launch. The dredge depth in this area will be approximately 4 ft. based on design-related investigation data.

Capping up to the shoreline is shown in the area adjacent to the northern portion of the NYSDOT turnaround area and along the shoreline north of this. To achieve post-cap water bathymetry for designed habitat modules, dredging to a target elevation will be completed in this area. Contamination in excess of criteria has been detected to depths up to 11 ft along the northern edge of the NYSDOT turnaround area. Due to geotechnical stability concerns resulting from the steep slope and deep contamination in this area, capping rather than dredging to cleanup criteria will be implemented in this area.

In Dredge Area C-2 along the Willis-Semet IRM Barrier Wall, there will be reduced groundwater upwelling in nearshore areas, therefore, dredging to an elevation-based goal followed by capping will be implemented in this area.

5.2.4 Remediation Area D

The ROD requires removal to an average depth of 6.6 ft (2 meters) in SMU 1, which constitutes the majority of the ILWD area, plus up to an additional 3.3 ft (1 meter) in areas defined as hot spots. This same removal approach is required in the portions of the ILWD that extend into SMUs 2 and 7. The ILWD dredging will include dredging of an estimated 1,056,000 CY to achieve the average removal goal of 6.6 ft (2 meters) and dredging of an estimated 91,000 CY to address hot spots, resulting in a total estimated dredge volume of 1,147,000 CY. Details regarding the development of the dredge volumes are provided below.

A rigorous evaluation of the extensive ILWD sediment and porewater database was completed to develop the removal approach that optimizes contaminant mass removal and reduction of sediment and porewater contaminant concentrations underlying the cap, as detailed in Appendix G. Based on this evaluation, the ILWD was divided into four sub-areas based on chemical concentration and distribution, and optimal removal strategies were developed for each of these sub-areas, as shown in the plan view in Figure 5.1. The primary removal strategy and basis for the removal strategy for each sub-area are summarized below and are detailed in Appendix F. Example contaminant versus depth plots that were used to identify contaminant distribution trends and the removal strategies listed below are provided in Figure 5.2.

- SMU 1/SMU 7 ILWD Eastern Area: Removal of the top 9.9 ft (3 meters) in this area will remove the highest sediment and porewater concentrations of chlorobenzene and dichlorobenzene measured anywhere in the ILWD, and will lower the concentration in this area for numerous other contaminants in sediment and/or porewater.
- SMU 1 ILWD Center Area: Sufficient dredging will be completed to ensure that the post-capping bathymetry is consistent with current bathymetry in areas where the current water depth is 7 ft or less. The amended cap thickness in this area is anticipated to be 4.6 ft assuming average over-placement, with a maximum thickness of 5.7 ft assuming maximum over-placement of each layer. Therefore, the removal depth in this area is anticipated to be approximately 5.5 ft out to a water depth of 7 ft.
- SMU 1 ILWD Western Area: Contaminant concentrations were generally lower in this area and patterns of concentration versus depth were less defined. However, removal of the top 9.9 ft (3 meters) in a portion of this area will reduce the concentrations of several contaminants in sediment and/or porewater, including toluene and total SVOCs.
- SMU 2 ILWD Area: Contaminant concentrations are significantly lower in this area than elsewhere within the ILWD. Therefore, habitat considerations were the primary consideration in developing the removal approach in this area. In general, the dredge removal was selected to increase water depth near shore to enhance future shoreline fishing opportunities.

As shown in Figure 5.1, there will be transition zones between the full removal depth and shoreline and approaching the littoral area boundary based on habitat and other considerations. There are also transition zones between the removal areas.

Following development of the removal approach that results in an average removal of 6.6 ft (2 meters), sediment data for the next 3.3 ft (1 meter) down was evaluated to identify exceedances of the hot spot criteria listed in the ROD and the subsequent hot spot removal approach. Hot spots are defined as those wastes/sediments that contain select contaminants (based on their presence at significantly elevated concentrations in the ILWD and/or the compounds to which the cap model is most sensitive) above threshold concentrations. Based on existing data, only chlorobenzene, dichlorobenzenes, and xylenes exceed their respective cap threshold values in the ILWD. The resulting hot spot removal areas A through J are shown on Figure 5.1.

Hot spot areas A through J shown on Figure 5.1 cover approximately 15 acres. The dredge area around sampling points that exceeded hot spot criteria was developed based on interpolation with surrounding data points that did not exceed the hot spot criteria using conservative assumptions, as detailed in Appendix G. Based on these hot spot areas and a dredge cut side slope of 1 on 5, the estimated hot spot dredge volume is 91,000 CY. All hot spot dredging will be based on existing data, no additional design-related or confirmatory sampling will be performed.

The baseline dredge prism to achieve an average 6.6 ft (2 meter) removal may be revised in future design submittals based on additional design evaluations. For example, if the cap is thicker than currently anticipated in areas of shallow water based on revised isolation layer modeling, additional dredging may be required in these areas to achieve a target habitat-based bathymetry. However, the strategic approach depicted in these figures will be maintained. The detailed dredge prisms and associated design and contracting plan will be developed to ensure the volume-based goal of an average removal of 6.6 ft (2 meters) is achieved (exclusive of hot spot dredging) on a SMU-specific basis. This results in dredge volumes in the ILWD in SMU 1, SMU 2, and SMU 7 as follows:

	Area	**Dredge Volume**
SMU 2 ILWD 2-meter average	7.1 Acres	75,400 CY
SMU 1 ILWD 2-meter average	83.9 Acres	888,300 CY
SMU 7 ILWD 2-meter average	7.5 Acres	92,400 CY
Subtotal based on 2-meter average removal	98.5 Acres	1,056,000 CY
Hot spot removal volume	15	91,000 CY
Total ILWD removal volume	NA	1,147,000 CY

The SMU 7 dredge volume equates to greater than a 1 meter average removal in order to achieve the SMU 1/SMU 7 ILWD East removal goal listed above of 3 meters in the southern portion of this area. In the northern portion of SMU 7, contaminant concentrations for key contaminants decrease after 2 meters, so a 2 meter removal is appropriate in this area.

In summary, the ILWD dredging will include dredging of an estimated 1,056,000 CY to achieve the average removal goal of 6.6 ft (2 meters) and dredging of an estimated 91,000 CY to address hot spots, resulting in a total estimated dredge volume of 1.147,000 CY.

Geotechnical stability evaluations were completed to evaluate seismic stability of the ILWD, as detailed in Appendix H. These stability evaluations concluded that the ILWD is stable following the removal described above and no additional removal is required to meet seismic stability goals listed in Section 5.1.

5.2.5 Remediation Area E

With anticipated overdredging and cleanup passes, the total estimated dredge volume in Remediation Area E is approximately 588,000 CY, as shown in Table 5.1. The basis for this estimate is provided below and in Appendix F.

Dredging to cleanup criteria will be completed out to the first line of groundwater upwelling measurement locations used for cap modeling and design (Appendix C), referred to as Dredge Area E-1 in Figure 4.9. Dredging to cleanup criteria will be implemented in this area because groundwater upwelling velocities are higher in nearshore areas, which negatively impacts cap effectiveness. The contamination depth from the shore to the first line of groundwater upwelling locations extends to a depth of approximately 3 ft in most areas, although deeper dredging in localized areas will be required based on contaminant data.

In areas beyond the near shore dredge to cleanup criteria area, out to a current water depth of approximately 8 ft of water depth, and in the area along Remediation Area D and Onondaga Creek, dredging will be completed to target elevation for required habitat modules (Dredge Area E-2). Adjacent to Remediation Area D, contamination near shore is significantly deeper, and the Wastebed B/Harbor Brook IRM shoreline barrier wall will be present. The barrier wall will reduce groundwater upwelling; therefore, dredging to an elevation-based goal followed by capping will be implemented in this area.

Nearshore contamination is also relatively deep at the mouth of Onondaga Creek. Channel depth at the mouth of Onondaga Creek must be sufficient to accommodate commercial boat traffic that uses Onondaga Creek and the Inner Harbor. Therefore, the proposed approach in this area is to dredge to a sufficient depth to allow cap placement while maintaining minimum required navigational depths as provided by the New York State Canal Corporation (NYSCC).

5.2.6 Dredging Design Summary

With anticipated overdredging and cleanup passes, the total estimated dredge volume for all remediation areas is approximately 1,926,000 CY, as shown in Table 5.1. This is considered a current best estimate based on all available data and engineering analysis performed to date. Due to ongoing design evaluations and additional data collection, which will continue through the summer of 2010, the final total dredge volume may be higher or lower than this estimate.

A significant goal of this IDS is to develop a dredge volume that the ongoing design pertaining to sediment dredging and related operations can be based on. To ensure sufficient dredging and operational capacity to complete the dredging in four years, this dredge volume should be consistent with a reasonable estimate of the maximum anticipated potential dredge volume. The recommended dredge volume to use for advancement of the design associated with sediment dredging and related operations is the sum of the current best estimate volume and the contingency volume, which is approximately 2,172,000 CY. Dredge volume increases beyond the best estimate of 1,926,000 CY pertain primarily to potential revisions to: dredge areas and depths based on additional design-related investigation data; dredge depths to achieve post-capping elevation goals; and cleanup passes.

Future dredge volume increases based on additional design related investigation are expected to be relatively minor and associated with Remediation Areas A, B, C, E, and F only. Based on Table 5.1, an estimated dredge volume of approximately 779,000 CY will be dredged over an area of approximately 117 acres in Remediation Areas A, B, C, and E. This equates to an average dredge depth in these areas of approximately 4.1 ft. The recommended contingency volume for these areas is 189,000 CY based on an additional 1 ft over this area. In addition, a 5% contingency volume for the ILWD dredge volume is included, resulting in an additional contingency volume of 57,000. This results in a total contingency volume of 246,000 CY. The recommended dredge volume to use for advancement of the design associated with sediment dredging and related operations is the sum of the current best estimate volume and the contingency volume, which is approximately 2,172,000 CY.

5.3 DREDGING DATA GAPS

Dredging areas and depths are well defined based on data from the RI and five years of design-related investigations. However, it is anticipated that additional sediment data will be gathered in 2010 which may result in minor modifications to dredging areas and depths. In addition, the boundary between the cap and the areas that will be dredged to cleanup criteria may be revised based on additional data that will be collected to support the cap design, as discussed in Section 6.

SECTON 6

IN-LAKE DEBRIS AND UTILITY MANAGEMENT

6.1 DEBRIS

This section provides the basis and considerations for accommodating debris encountered within the areas of Onondaga Lake to be capped. The identification and handling of debris during dredging activities will be addressed in subsequent dredging-related design submittals.

6.1.1 Debris Design and Performance Criteria

The primary goal in debris management, as it pertains to capping, is to achieve the remedial objectives through incorporation or removal of debris within the cap area to ensure the integrity and long-term effectiveness of the cap is not impacted. Detailed criteria regarding debris size and type that will require removal or special consideration such as additional cover thickness will be established in future design submittals.

6.1.2 Debris Characterization in Cap Areas

Debris refers to wood, concrete, plastics, glass, metal, cable, tires, rocks, and other objects located on the surface of or within lake sediment. The primary source of information that documents in-lake debris is the Phase I PDI geophysical survey work conducted during the fall of 2005 for Honeywell (CR Environmental, 2007), which included side-scan sonar and magnetometer surveys. Side-scan sonar equipment detected debris and obstructions, referred to as contacts, as small as 1 to 2 ft located on or above the mudline. Magnetometer surveys detected contacts containing iron or items that have been fired (such as bricks) located either at or below the mudline.

Figure 6.1 presents locations of debris identified during the Phase I PDI geophysical survey work. An extensive data set was generated during this investigation. To facilitate management of the data, only debris that was equal to or greater than 5 ft in size was reported. However, the resolution of the data set will allow for a detailed evaluation of smaller targets if required during future design evaluations. For additional information and descriptions of how and what debris has been located to date, refer to Section 4.2 of the Dredging, Sediment Management & Water Treatment IDS.

Onondaga Lake also contains some debris that may be of historical significance, including potential wrecks that may be considered underwater archeological resources. As described in Section 3.12 of the Sediment Management & Water Treatment IDS (Parsons, 2009c), a Phase 1B Underwater Archaeological Resource Work Plan for the lake bottom and a Phase 1B Archeological Work Plan that includes the shoreline and several of the upland sites have been prepared. Underwater archeological resources identified during implementation of the cultural resources investigation will be addressed prior to any debris removal or capping operations.

Details pertaining to the management of archeological resources in dredge and cap areas will be further developed following implementation of the Phase IB Investigation.

6.1.3 Debris Management in Cap Areas

Debris management in cap areas will fall into two categories; management of debris in cap areas not requiring prior dredging (*e.g.*, cap-only areas), and management of residual debris in dredge areas to receive a cap (dredge-and-cap areas). As noted above, the identification, handling and overall management of debris during dredging will be addressed in subsequent dredging design-related submittals.

Subsequent design submittals will establish more detailed specifications regarding what debris can be left in place, and what debris will require removal to ensure cap effectiveness. These design evaluations will take into account various cap layer thicknesses (*i.e.*, chemical isolation layer, buffer layer, erosion protection layer, habitat layers). Debris that would penetrate the cap surface will require consideration for encapsulation or removal. The area, depth, quantity and spacing/density of debris or debris fields (*i.e.*, multiple low profile items versus singular high profile) will be considered in these evaluations. Another consideration will be the integrity of the debris to serve as an effective and integral component of the cap. These design evaluations will also take into consideration sediment consolidation after cap placement around the perimeter of debris as well as depth over the debris, to account for acceptable final grades and contours post settlement. A protocol for addressing debris during construction that was not previously identified will also be developed in future design submittals.

6.2 UTILITY AND STRUCTURE MANAGEMENT

This section provides the basis and considerations for accommodating utilities and structures located within the areas of Onondaga Lake to be capped. The impact of utilities and structures on the dredging operation was discussed in the Dredging, Sediment Management & Water Treatment IDS (Parsons, 2009c), and will be discussed in greater detail in future dredging-related design submittals.

6.2.1 Utility and Structure Design and Performance Criteria

The primary goal in utility and structure management, as it pertains to capping, is to achieve the remedial objectives through incorporation, modifications to, or removal of those items within the area to be capped as necessary to insure the integrity and long-term effectiveness of the cap.

6.2.2 Utility and Structure Characterization in Cap Area

Utilities and structures consist of active and inactive pipelines, culverts, outfalls, water intakes, and undefined magnetic anomalies on the sediment surface or buried on the lake bottom. For purposes of this submittal, pilings are considered a structure.

The primary source of information that documents utilities and structures is the Phase I PDI geophysical survey work conducted during the fall of 2005 for Honeywell (CR Environmental, 2007), which included side-scan sonar and magnetometer surveys. A list of utilities and supporting information (*i.e.*, owner, material of construction, remediation area location, dimensions, active status and potential fate) is provided on Table 6.1. Figure 6.1 presents the locations of utilities and structures, as determined by the analysis of the geophysical surveys and available historical records identified during the geophysical survey work.

For additional information and descriptions on how utilities and structures were located, refer to Section 4.2.4 of the Dredging, Sediment Management & Water Treatment IDS.

6.2.3 Utility and Structure Management in Cap Areas

To the extent practicable, utilities and structures within the dredging and/or capping areas will be left in place and incorporated into the final cap. To accommodate these structures, it may be necessary to modify the cap grade, providing sufficient draft and habitat criteria can be maintained. Another consideration will be the integrity and ability of the utility or structure itself to serve as an effective and integral component of the cap. Utilities or structures that penetrate the cap surface will require consideration for encapsulation or removal on a case by case basis. Management strategies that may be considered for utilities and structures include:

- leave active or inactive utilities and structures in place and install the cap up to and adjacent to these items;
- leave active or inactive utilities and structures in place and install the cap over these items taking into consideration potential cap enhancement details that may be necessary to insure cap stability and integrity (*i.e.*, cap enhancement/erosion protection in high energy discharge on intake locations);
- provide utility or structure modifications to preserve the intent and functionality of the utility or structure (*i.e.*, extend pipe discharge or intake locations with additional pipe lengths or add risers to structures so these elements daylight out beyond where the cap is placed;
- remove those portions of inactive utilities and structures that will inhibit or jeopardize dredging operations and/or the long term integrity or performance of the intended cap; and
- pull or cut timber piles at bottom of cap.

Utilities that are in continuous or intermittent use may need to be protected during the dredging and capping operations. Some of these utilities are not owned by Honeywell; therefore, discussions with the utility owners will be required before any management steps are taken. In some instances, the utility owners themselves may need to take management steps for their utilities prior to initiation of dredging and/or capping.

Analysis of utilities and/or structures, assessment of their impact on dredging and cap placement operations and cap effectiveness, and the development of mitigation strategies will be completed in greater detail as part of subsequent design submittals.

SECTION 7

CONSTRUCTION SEQUENCING AND SCHEDULE

This section provides a basis and overview of the sequencing and schedule considerations for dredging and capping activities as part of the in-lake remediation and other related upland remediation activities to be performed by Honeywell.

Consistent with the Dredging, Sediment Management & Water Treatment IDS (Parsons, 2009c), the scheduled goal for the lake remediation is to complete dredging in four years (beginning in 2012), and capping in four years (beginning 2013) with a potential one year lag between dredging and capping operations. A detailed sequencing plan and construction schedule will be developed, with input from remediation contractors, in subsequent capping design submittals.

7.1 INTERFACE WITH UPLAND REMEDIATION

There are potential Honeywell and non-Honeywell sources of contamination to the lake, and addressing them is necessary to help prevent the restored lake bottom from being recontaminated. In addition, the lake remedy design and implementation will take into consideration how remedial actions in adjacent nearshore areas, and actions associated with onshore support zones, will be integrated with remediation activities within the lake. For example, the shoreline in-lake remediation and habitat restoration activities will be integrated with remediation and habitat restoration activities within adjacent wetlands associated with the Ninemile Creek, Wastebed 1 through 8, and Wastebed B/Harbor Brook.

As the scopes and schedules for upland remedial activities are finalized, the information will be used to further define the approach for integrating these onshore activities with the lake remediation in future lake-related design submittals. A preliminary discussion of sequencing and integration considerations for each remediation area is provided below.

Several of the upland sites subject to potential remediation activities are directly adjacent to those in the lake. The integration of the onshore and in-lake remedies, as it pertains to habitat restoration, is being addressed in the Habitat Plan. The overall objective of this effort is to develop and implement a habitat restoration plan for remedial actions associated with the Onondaga Lake Bottom remedy and with remedies and IRMs for adjacent Honeywell sites that provides ecological, recreational, and/or aesthetic benefits as well as complies with applicable state and federal laws and regulations, executive orders, and policies for floodplains, wetlands and surface waters.

The average lake surface elevation is 362.8 ft NAVD88, but for both the cap and dredge design plans and habitat restoration design, an average lake surface elevation of 362.5 NAVD88 was used. This elevation corresponds to the average water level during the summer growing season and it was used to divide the lake area from adjacent aquatic and upland areas for remedial design purposes.

Remediation Area A

Remediation Area A lies at the mouth of Ninemile Creek. Completion of the Ninemile Creek remediation to prevent recontamination will be required prior to remediation of this area. This will include removal and/or capping of sediments within the creek and associated wetlands and floodplain along the lakeshore; therefore, future design submittals will provide additional information on transitions between the lake and Ninemile Creek remedies.

Remediation Area B

Remediation Area B is the area offshore of Wastebeds 1 through 8. The shoreline in this area is a relatively low-lying plateau of sediments and Solvay waste. Remediation of Wastebeds 1 through 8 to prevent recontamination will be required prior to remediation of this area. The scope for the Wastebed 1 through 8 remedy is still under development, but may include control of shallow groundwater discharging to the lake from this area. In addition, as part of the Wastebeds 1 through 8 remedy and to off-set potential loss of lake surface area and wetlands elsewhere, wetlands will be created on Wastebeds 1 through 8 adjacent to Remediation Area B. Future design submittals will provide additional detail on transitions between the lake and Wastebeds 1 through 8 remedies. This transition will also incorporate the shoreline stabilization required by the ROD to address erosion of Solvay waste material along the shoreline of Wastebeds 1 through 8.

Remediation Area C

No remedial activities beyond the already-installed Semet portion of the shoreline barrier wall are anticipated for the area adjacent to Remediation Area C. However, Tributary 5A discharges to this area and will require remediation prior to remediation of this area to prevent potential recontamination. Dredging and capping design in this area will take into consideration that the western sub-area surrounds a boat launch frequently used for small boats as well as shoreline fishing. The boat launch area is located on top of hard slag waste material, which was deposited in the lake by industrial processes not associated with Honeywell or its predecessors.

Remediation Area D

Remediation of Wastebed B/Harbor Brook is necessary to prevent recontamination of this area.

The shoreline of the western third of Remediation Area D consists of the exposed sheet pile barrier wall installed in 2008 as part of the Willis/Semet IRM. Dredging design and implementation in this area will ensure dredging and capping operations and shoreline support activities do not subject the sheet pile wall to excessive stress and compromise structural integrity that could lead to potential damage and safety risks.

The remainder of the shoreline in this area consists of the low-lying area of the Wastebed B/Harbor Brook site, some of which consists of delineated wetlands. Remedial action in the area between the Wastebed B/Harbor Brook Willis-Semet IRM Barrier Wall and the lake will likely be required. This may include removal of material and construction of an isolation cap to allow for restoration of wetlands in this area, as well as remediation and relocation of Harbor Brook south of its current discharge. An integrated approach to design and implementation of remedial actions in Remediation Area D and this area of Wastebed B/Harbor Brook will be developed as part of future design submittals.

Remediation Area E

Consistent with the area adjacent to Remedial Area D, remediation and wetland restoration may be required in the area of the Wastebed B/Harbor Brook site designated as AOS 1 which is adjacent to the southern end of Remediation Area E, as well as in wetland SYW-12 adjacent to the northern end. An integrated approach to design and implementation of remedial actions in the lake and these shoreline areas will be developed as part of future design submittals.

7.2 DREDGE SEQUENCING

A significant goal in sequencing the dredging activities is to minimize the potential for recontamination of previously capped or dredge to cleanup criteria areas resulting from deposition of contaminated sediment that may be resuspended as a result of dredging (referred to as “generated residuals”) or due to wind/wave action. General factors that will be considered in developing the detailed sequence for dredging activities are listed below. Based on these considerations, dredging will likely be performed in a general counter-clockwise direction, beginning in Remediation Area C and proceeding through Areas D and E. Dredging of Remediation Areas A and B will likely be scheduled independent of the other areas since they represent a low risk of recontamination to other remediation areas, primarily due to the large distance between these and other remediation areas.

- **Other nearshore remediation activities (see Section 7.1).** In-water work adjacent to nearshore work will be coordinated to avoid potential recontamination.
- **Seasonal construction window.** Depending on weather and freezing temperatures, it is estimated that dredging activities will occur from April 15 to November 15 of each year. Mobilization, demobilization, equipment maintenance, and general construction planning (*e.g.,* material stockpiling, etc) will occur to the extent practicable outside of these seasonal construction windows.
- **Production “shake down” or “ramp up” periods.** It is anticipated that during the first year of dredging, the optimal dredging production rate (*i.e.,* cubic yards per hour or dredge days) may not be realized while developing and optimizing the system-wide integration of debris removal, dredging, slurry transport, processing dredged material at the SCA and water treatment. Dredge production will gradually increase to the optimal production rate to complete dredging in four years. This period of less-than-optimal production rates is referred to as the “shakedown” or “ramp up” period, and serves a similar function as a pilot test. Dredging production in years 2, 3, and 4 will have a shorter ramp up period than year 1.

- **Lake circulation patterns.** General circulation patterns in Onondaga Lake are in a counter clockwise pattern in response to prevailing wind directions from the west. The circulation of the water within the lake is generated by wind speed and direction, tributary inflows, the outflow at the northern end of the lake, shoreline configuration, and stratification (Parsons, 2004). In the littoral areas where dredging will be performed, currents will generally move in the directions of the wind and waves. Therefore, resuspended dredged material will move parallel to the shore (long-shore transport) as well as in onshore/offshore direction (cross-shore transport). Dredging and subsequent capping would be phased to generally proceed in an up-current to down-current direction to minimize the potential recontamination. Winds and wind-generated waves within Onondaga Lake will likely be the primary transport mechanism in the Remediation Areas during dredging activities rather than the overall circulation pattern.

- **Dredge slopes.** In areas where targeted dredge slopes are greater than a given angle (*e.g.* 50 horizontal:1 vertical [50H:1V] or 20H:1V), dredging will generally be performed in a top to bottom of slope direction to minimize potential suspended sediment or sloughed sediment transported down slope. However, in some cases there may be a need to dredge upslope into a Remediation Area due to shallow water depths that limit dredge access/mobility.

- **Production rate.** Dredging production rates will vary based on equipment, thickness of cut and material characteristics. For additional information and descriptions on dredging production, refer to Section 4.1.6 of the Dredging, Sediment Management & Water Treatment IDS. In addition, the number and location of dredges will affect the overall production rate and therefore sequencing. One or multiple dredges can work in exclusive areas, advancing sediment removal to final dredge grade elevations, prior to relocating. Another option for multiple dredges is to have a larger dredge perform “production” dredging, focusing on areas of relatively thick dredge cuts thereby optimizing the efficiency, and a smaller dredge(s) following behind the large dredge to perform “clean up pass” dredging aimed at accurately achieving the target elevation.

- **Dredge area and volume.** Table 5.1 presents a summary of the currently anticipated dredge volumes and areas for each Remediation Area. The sequence and schedule for dredging will consider the amount of area that can be completed in a given year based on a production rate and dredge volume for each deposit.

7.3 CAP SEQUENCING

Depending on the overall sequence and schedule of dredging operations, multiple capping operations may be working simultaneously. This may include separate capping operations for different remedial areas and/or separate operations for the different material types (*e.g.* sand, erosion protection, or habitat material). General factors for developing guidelines for sequencing of cap operations include:

- **Other nearshore remediation activities (see Section 7.1).** In-water work adjacent to nearshore work will be coordinated to avoid potential recontamination.

- **Seasonal construction window.** Depending on weather and freezing temperatures it is estimated that capping construction activities will occur between April 15 to November 15 of each year. Mobilization, demobilization, equipment maintenance, and general construction planning (*e.g.*, material stockpiling, etc) will occur to the extent practicable outside of these seasonal construction windows.
- **Coordination with dredging.** Capping operations will generally follow dredging operations in a similar pattern and sequence.
- **Production rate.** Capping production rates will vary based on equipment, thickness of cap and material type. For additional information and descriptions on capping production, refer to Section 4.5.4 of this document.
- **Capping slopes.** In areas where slopes to be capped are greater than a given angle (*e.g.* 50 horizontal:1 vertical [50H:1V] or 20H:1V), capping operations will generally place material from the bottom of a slope up to the top of slope to minimize the loss of material during placement. This sequence of slope capping has been successfully completed on other projects.
- **Interim residual cap.** In areas where pre-cap dredging has been completed, but the final cap cannot be completed within the same construction season, an interim residual cap layer may be placed within portions of the dredge area to manage potential residual sediments if they present a risk of recontaminating remediated areas. Future remedial design evaluations will include an assessment of post-dredge sediment and/or site conditions that warrant use of an interim residual cap. When placed, the interim cap will be considered to contribute to the full cap design to be placed in the following years (*e.g.*, the interim residual cap may function as the “mixing” zone of the overall cap design).
- **Cap area and volume.** Table 6.1 presents a summary of the currently anticipated cap areas and volumes for each Remediation Area. The sequence and schedule for capping will consider the progress of the prior dredging as well as the amount of area that can be capped in a given year based on the capping production rate and cap thickness of each area.

7.4 IMPLEMENTATION SCHEDULE

Future design submittals will provide a detailed schedule for sequencing of the dredging and capping operations. Since much of the sequencing will depend on specific equipment, this schedule and sequencing plan will incorporate input solicited from the selected dredging and cap construction contractor(s). The detailed sequencing plan and schedule integrating both dredging and capping activities will be developed in future design submittals.

SECTION 8

POST CONSTRUCTION CAP MONITORING AND MAINTENANCE STRATEGY

The cap will be designed to provide a high level of long-term protection and to be resistant to disruption by forces such as erosion due to wind generated waves. Post-construction monitoring and maintenance of the capped areas will be performed to verify that the overall integrity of the cap is maintained so that it remains physically stable (*i.e.*, does not erode) and chemically protective over time. The conceptual cap monitoring and maintenance plan outlined below provides a high-level overview of monitoring and maintenance activities to be implemented. A discussion of potential institutional controls is also provided below.

8.1 POST CONSTRUCTION CAP MONITORING PLAN

Long-term monitoring of the caps will include physical monitoring to verify stability and sampling of the caps to verify their chemical integrity, as detailed below.

Physical Monitoring

Physical monitoring typically involves verifying that the armor layer and underlying chemical isolation layer are stable using bathymetric surveys and/or other physical or geophysical methods. USEPA (2005) recommends that the cap integrity be monitored both routinely and following storm/flood events that exceed a threshold design storm magnitude. The frequency of routine monitoring of select capped areas is typically greater initially after construction (*e.g.* several monitoring events within the first 5 to 10 years) and is reduced or discontinued over time once the monitoring is able to establish a consistent pattern of cap performance. Details of the monitoring methods, frequencies, and procedures and contingency response actions will be developed based on joint discussions with NYSDEC and will be presented in future submittals.

Chemical Monitoring

Chemical monitoring typically involves measuring chemical concentrations within or at the surface of the placed capping materials to verify that contaminants are not moving through the cap at rates and concentrations that exceed specified remedy success metrics. Details of the chemical monitoring methods, frequencies, procedures, and response actions will be developed based on joint discussions with NYSDEC and will be presented in future design submittals.

8.2 POST-CONSTRUCTION CAP MAINTENANCE PLAN

In the unlikely event that the monitoring plan discussed above identifies areas where the cap is not performing consistent with expectations, contingency response actions will be taken to maintain and repair the cap as necessary. Cap contingency and maintenance actions will be detailed in the Cap Maintenance Plan. The maintenance plan will include criteria for when a response action is required based on physical and chemical monitoring and the appropriate type of response action. For example, if bathymetric or other surveys from either the routine or event-based surveys show evidence of disruption of the armor layer, then a typical response would include an additional assessment of the affected cap areas, potentially including underwater video surveying and/or core sampling. If cap erosion is confirmed by additional assessment such that the performance of the chemical isolation layer is compromised, then response actions may be applied. Possible response actions after the cause of erosion is determined could include:

- Place additional armor or otherwise repair the cap within the identified area of erosion (*e.g.*, reestablish cap thickness) if the performance standards are no longer being met; and
- Enact managerial or institutional controls to help control any further cap erosion if it is being caused by activities such as boat traffic or stormwater discharges.

Potential response actions will also be developed based on the results of the long-term chemical monitoring. Details of the cap maintenance response actions will be developed based on joint discussions with NYSDEC and will be presented in future submittals.

8.3 INSTITUTIONAL CONTROLS

As described in Section 4.2, the cap armor layer has been designed to protect the chemical isolation layer from recreational vessel operations and from commercial vessel traffic in the NYSCC navigation channel. Therefore, the only institutional control envisioned to promote the long-term integrity of caps is to prevent disturbance of the caps by dredging or other in-water construction activities. It is anticipated that “No Dredge Areas” will be established over the capping areas by the NYSDEC and NYSCC to prevent removal of the capping materials. These restrictions would also include anchoring of commercial vessels and certain in-water development activities, such as setting utility or cable corridors. The restrictions can be marked by the NYSCC on the NOAA Navigation Chart for Onondaga Lake (currently included as Chart Number 14786 for the Small-Craft. Book Chart for the New York State Barge Canal System). The New York State Office of Parks, Recreation and Historic Preservation currently maintains navigation buoys in Onondaga Lake to warn boaters of hazards in water less than 4 ft in depth and beyond 100 ft from shore. The “No Dredge Areas” could also be identified on figures submitted to the public and appropriate websites pertaining to the lake.

SECTION 9

SUBCONTRACTING STRATEGY

An integrated team of in-house resources, teaming partners, and key subcontractors will execute the final design and implementation of the entire remedial action. The design team will interact with the personnel that will execute the construction and operations to assure that the final design components are complete, implementable, and meet the project objectives. In addition, key members of the design team will have functional quality assurance/quality control responsibilities during the construction efforts.

The design and subcontracting strategy for the capping component of the remedy will be a design-bid-build approach. The design under this approach will incorporate agency review with public input into the intermediate design and subsequent final design phases. It is anticipated that subcontractor selection will be completed before submittal of the draft final design.

SECTION 10

DESIGN SUBMITTAL AND CONSTRUCTION SCHEDULE

Critical to the success of the lake remedial action is the sequencing of events and interrelations of design and construction activities to assure the process is efficient and completed within the appropriate timeframe. A logical progression of the decisions, analysis, and planning needed to execute the work has been established during the initial design phase. This section outlines the schedule milestones established to accomplish the capping and dredge area and depth design aspects of the remedial action consistent with the Consent Decree schedule requirements. The schedule is based on receipt of NYSDEC comments within 60 calendar days of submittal.

CAPPING AND DREDGE AREA AND DEPTH DESIGN AND CONSTRUCTION MILESTONES	
Submit Capping, Habitat, and Dredge Area and Depth Intermediate Design to NYSDEC	10/27/10
Submit Capping, Habitat, and Dredge Area and Depth draft Final Design to NYSDEC	8/25/11
Submit Capping, Habitat, and Dredge Area and Depth Final Design to NYSDEC	1/4/12
Begin Dredging	May 2012
Begin Capping	May 2013
Dredging Complete	1/4/16
Capping Complete	1/4/17

SECTION 11

REFERENCES

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TABLES

TABLE 1.1
ONONDAGA LAKE PREVIOUSLY SUBMITTED DESIGN-RELATED DOCUMENTS

Date*	Name of Document	Prepared for	Prepared by
General			
2004, November	Onondaga Lake Feasibility Study Report. Draft Final	Honeywell	Parsons in association with Anchor Environmental and Exponent
2008, October	Draft Remedial Design Work Plan for the Onondaga Lake Bottom Subsite	Honeywell	Parsons
2008, October	Draft Citizen Participation Plan for the Onondaga Lake Bottom Subsite Remedial Design Program	Honeywell	NYSDEC, Region 7
2007, September	Cultural Resource Management Report Phase 1A CRA Onondaga Lake Project Oct. 29, 2004	Honeywell/ Parsons	Christopher D. Hohman, RPA, Public Archaeology Facility, Binghamton University.
Phase I PDI			
2007, November	Onondaga Lake Phase 1 Pre-Design Investigation Geophysical Survey Report	Honeywell/ Parsons	CR Environmental, Inc.
2007, May	Onondaga Lake Pre-Design Investigation: Phase I Data Summary Report	Honeywell	Parsons
2005, September	Onondaga Lake Pre-Design Investigation: Phase I Work Plan	Honeywell	Parsons
2006, July	Phase I Pre-Design Investigation: Porewater Methods Evaluation	Honeywell	Parsons
Phase II PDI			Parsons
2006, August	Onondaga Lake Pre-Design Investigation Equilibrium Study Work Plan	Honeywell	Parsons in association with Dr. Andrew Jackson (Texas Tech)
2006, September	Onondaga Lake Pre-Design Investigation: Phase II Work Plan	Honeywell	Parsons
2006, September	Onondaga Lake Pre-Design Investigation: Phase II Work Plan - Addendum 1 Porewater Sampling	Honeywell	Parsons
2006, November	Onondaga Lake Pre-Design Investigation: Phase II Work Plan - Addendum 6 Cap Design Bench Scale Study	Honeywell	Parsons in association with Dr. Danny Reible (University of Texas)
2006, October	Onondaga Lake Pre-Design Investigation: Phase II Work Plan - Addendum 4 Groundwater Discharge Evaluation	Honeywell	Parsons in association with S.S. Papadopoulos
2009, August	Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report	Honeywell	Parsons
2009, August	Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report Appendix C Consolidation and Seepage Induced Consolidation (SIC) Data	Honeywell	Parsons in association with S.S. Papadopoulos
2009, August	Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report Appendix D Porewater Equilibration Study	Honeywell	Parsons in association with Dr. Andrew Jackson (Texas Tech)
2009, August	Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report Appendix F Geoprobe Conductivity and Temperature Profiles	Honeywell	Parsons in association with S.S. Papadopoulos
2009, August	Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report Appendix J Cap Design Bench Scale Study Report	Honeywell	Parsons in association with Dr. Danny Reible (University of Texas)
2009, August	Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report Appendix N Meteorological Station Data	Honeywell	Parsons
Phase III PDI			
2007, May	Onondaga Lake Pre-Design Investigation: Phase III Work Plan	Honeywell	Parsons
2007, August	Onondaga Lake Phase III Pre-Design Investigation Work Plan - Addendum 2	Honeywell	Parsons

TABLE 1.1
ONONDAGA LAKE PREVIOUSLY SUBMITTED DESIGN-RELATED DOCUMENTS

Date*	Name of Document	Prepared for	Prepared by
2007, October	Onondaga Lake Phase III Pre-Design Investigation Work Plan - Addendum 3 Column Studies	Honeywell	Parsons in association with Dr. Danny Reible (University of Texas)
2007, October	Onondaga Lake Pre-Design Investigation: Phase III Work Plan - Addendum 3 Attachment 1 SMU-1 Hyperalkaline PH Source Identification and Neutralization Evaluation	Honeywell	Parsons
2007, October	Onondaga Lake Phase III Pre-Design Investigation Work Plan - Addendum 4	Honeywell	Parsons in association with Geosyntec
2007, October	Onondaga Lake Phase III Pre-Design Investigation Work Plan - Addendum 5	Honeywell	Parsons
2009, October	Onondaga Lake Pre-Design Investigation: Phase III Data Summary Report	Honeywell	Parsons
2009, October	Onondaga Lake Pre-Design Investigation: Phase III Data Summary Report Appendix C Geoprobe Profiles and Seepage Meter Data	Honeywell	Parsons in association with S.S. Papadopoulos and Associates
2009, September	Onondaga Lake Pre-Design Investigation: Phase III Data Summary Report Appendix F Column Studie	Honeywell	Parsons in association with Dr. Danny Reible (University of Texas)
2009, September	Onondaga Lake Pre-Design Investigation: Phase III Data Summary Report Appendix G Meteorological Station Data	Honeywell	Parsons
2009, September	Onondaga Lake Pre-Design Investigation: Phase III Data Summary Report Appendix H CR Environmental Temperature/Conductivity Plots	Honeywell	Parsons in association with CR Environmental
2009, September	Onondaga Lake Pre-Design Investigation: Phase III Data Summary Report Appendix I Anchor Environmental Tributary Bathymetry Report	Honeywell	Parsons in association with Anchor Environmental
2009, September	Onondaga Lake Pre-Design Investigation: Phase III Data Summary Report Appendix J SMU-1 Hyperalkaline PH Source Identification and Neutralization Evaluation	Honeywell	Parsons in association with S.S. Papadopoulos and Associates
Phase IV PDI			
2008, June	Onondaga Lake Pre-Design Investigation: Phase IV Work Plan	Honeywell	Parsons
2008, July	Onondaga Lake Pre-Design Investigation: Phase IV Work Plan - Addendum 1 Habitat	Honeywell	Parsons in association with QEA
2008, April	Onondaga Lake Pre-Design Investigation: Phase IV Work Plan - Addendum 2 Cap Amendment Isotherm Developme	Honeywell	Parsons in association with Dr. Danny Reible (University of Texas) and Dr. Gregory Lowry (Carnegie Mellon)
2008, September	Onondaga Lake Pre-Design Investigation: Phase IV Work Plan - Addendum 3 Cap Cap Design Bench Scale Testing Additional Column Studies and Isotope Degradation Evaluation	Honeywell	Parsons in association with Dr. Danny Reible (University of Texas)
2008, November	Onondaga Lake Pre-Design Investigation: Phase IV Work Plan - Addendum 7 Cap pH Amendment Evaluation	Honeywell	Parsons
2009, April	Onondaga Lake Pre-Design Investigation: Draft Phase IV Data Summary Report	Honeywell	Parsons
2009, September	Onondaga Lake Pre-Design Investigation: Draft Phase IV Data Summary Report Appendix C Cap Amendment Isotherm Development Report	Honeywell	Parsons in association with Dr. Danny Reible (University of Texas) and Dr. Gregory Lowry (Carnegie Mellon)
2009, May	Onondaga Lake Pre-Design Investigation: Draft Phase IV Data Summary Report Appendix H Cap pH Amendment S	Honeywell	Parsons in association with S.S. Papadopoulos and Associates
2009, April	Onondaga Lake Pre-Design Investigation: Draft Phase IV Data Summary Report Appendix J Geoprobe Profiles	Honeywell	Parsons
2009, October	Onondaga Lake Pre-Design Investigation: Draft Phase IV Data Summary Report Appendix K Habitat Investigation	Honeywell	Parsons in association with AnchorQEA
2009, April	Onondaga Lake Pre-Design Investigation: Draft Phase IV Data Summary Report Appendix L Meteorological Station	Honeywell	Parsons
Phase V PDI			
2009, August	Onondaga Lake Pre-Design Investigation: Phase V Work Plan	Honeywell	Parsons

Note: Dates provided may represent draft versions of Appendicies and Addendums provided electronically to NYSDEC.

TABLE 2.1
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments
Nationwide Permit 38 (Sect. 404 Clean Water Act) **Joint Application For Permit**	**U.S. Army Corps of Engineers and NYSDEC with input from U.S. Fish and Wildlife Service (USFWS) and USEPA, as appropriate, through federal Executive Order 11990.**	**Dredging / Capping**	• Preconstruction notification (PCN) • Remediation Project Scope of Work narrative. Indicates it is an NPL/ CERCLA site. • Location Map (USGS Quad) • Site/Remediation/Grading Plan • Details (e.g., Erosion & Sediment Controls, cross-sections, treatment options) • Photographs of the Project Area • Statement of the status of Endangered/ Threatened Species Resources Archaeological Resources • Vegetative Community Species List • Wetlands Delineation Report • Wetlands Restoration Program/Plan • Cultural Resources Statement	• Activities undertaken entirely on a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site by authority of CERCLA as approved or required by USEPA (such as Onondaga Lake), are not required to obtain permits under Section 404 of the CWA or Section 10 of the Rivers and Harbors Act. (Sections 10 and 404). • Per discussions with local USACE staff, notification of USACE is not required on CERCLA Sites as USACE assumes USEPA will ensure compliance with appropriate regulations. • NYSDEC to determine compliance with substantive requirements of CWA as well as 6 NYCRR Parts 663 – 665.
401 Water Quality Certification	**USEPA** **NYSDEC**	**Dredging / Capping / Slurry Transport / SCA / WTP**	• Notice of Intent • Complete copy of package to be submitted to the New York District Army Corps of Engineers and to the NYSDEC • General Water Quality Certification, pursuant to Section 401 of the Clean Water Act, has been denied for Nationwide Permit 38. Individual Water Quality Certification must be obtained from the NYSDEC prior to undertaking activities described by this permit. This permit will then be subject to all terms and conditions placed upon the individual Water Quality Certification issued by the NYSDEC.	• Activities undertaken entirely on a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site by authority of CERCLA as approved or required by USEPA, are not required to obtain permits under Section 404 of the CWA or Section 10 of the Rivers and Harbors Act. (Sections 10 and 404) • NYSDEC to determine compliance with substantive requirements.
6 NYCRR Part 175 Special Licenses and Permits - Definitions and Uniform Procedures	**NYSDEC**	**Dredging / Capping / Slurry Transport / SCA / WTP**	• Properly completed department application form. • Submitted to the appropriate department office as identified on the application or application instructions. • If the applicant is a corporation, firm, partnership, association, institution, or public or private agency, the application must be signed on behalf of such entity by the president or an appropriate principal officer.	• New York State Fish and Wildlife License may be required to collect and possess fish and wildlife for investigative purposes.

TABLE 2.1
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments
6 NYCRR Part 360 – Solid Waste Management Facilities	**NYSDEC**	**SCA**	• Engineering drawings that set forth the proposed landfill's location, property boundaries, adjacent land uses and detailed construction plans. • Operation drawings that prescribe how the landfill will fulfill the regulatory requirements. • Landscape plan. • Engineering report that comprehensively describes the existing site conditions and a full engineering analysis of the landfill and its containment components, including closure and post-closure plans and criteria. • Construction quality assurance/construction quality control plan. • Operation and maintenance manual. • Contingency plan. • Hydrogeologic report (Completed for SCA). • Landfill siting report (Completed for SCA). • Leachate management plan • Mined land use plan. If the applicant plans to use on-site excavation of cover material for the proposed landfill. • The most recent closure cost estimate for the landfill and a copy of the documentation required to demonstrate financial assurance. • Where applicable, the most recent post-closure care cost estimate for the landfill and a copy of the documentation required to demonstrate financial assurance. • Where applicable, the most recent corrective action cost estimate for the landfill and a copy of the documentation required to demonstrate the financial assurance. • Where applicable, an engineering report demonstrating how the landfill will meet the landfill gas collection system requirements.	• Regulation contains requirements for siting, design and operation of solid waste landfills. The SOW attached to the Consent Order for the Onondaga Lake Bottom Subsite requires Honeywell to design, operate, and maintain the SCA in accordance with the substantive requirements of NYSDEC Regulations Part 360, Section 2.14(a) for industrial monofills. • Part 360–2.14 regulations are performance based and complementary to the USACE pathway analysis requirements for dredged sediment disposal facilities.

TABLE 2.1
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments
6 NYCRR Part 420 – Part 425 Mining Regulations	**NYSDEC**	**Capping**	• Completed application forms. • A mined land-use plan which shall set forth in detail an outline of the mining property and the affected land, the mining plan (description of the mining operation, including maps, plans, written materials and other documents as required by NYSDEC, such as Erosion Control, etc.) and the reclamation plan (description of operations to be performed to reclaim the land to be mined over the life of the mine including maps, plans, the schedule for reclamation, written material and other documents as required by NYSDEC). • A reclamation bond or appropriate substitute which is conditioned upon conformance with the mined land-use plan. • A renewal application shall contain the following: (i) completed application forms; (ii) an updated mining plan map consistent with the provisions of title 27 and including an identification of the area to be mined during the proposed permit term; (iii) a description of any changes to the mined land-use plan; and (iv) an identification of reclamation accomplished during the existing permit term.	• Mining means the extraction of overburden and minerals from the earth; the preparation and processing of minerals, including any activities or processes or parts thereof for the extraction or removal of minerals from their original location and the preparation, washing, cleaning, crushing, stockpiling or other processing of minerals at the mine location so as to make them suitable for commercial, industrial, or construction use; exclusive of manufacturing processes, at the mine location; the removal of such materials through sale or exchange, or for commercial, industrial or municipal use; and the disposition of overburden, tailings and waste at the mine location. Mining does not include the excavation, removal and disposition of minerals from construction projects, exclusive of the creation of water bodies, or excavations in aid of agricultural activities. • Mineral means any naturally formed, usually inorganic, solid material located on or below the surface of the earth • Performance of the Lake bottom dredging and backfilling operations is outside the definition of mining, so a mining permit is not required. However restoration materials, such as imported SCA dike and cap materials are considered minerals, so any operation supplying these materials to the project would be subject to the requirements of this part.

TABLE 2.1
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments
6 NYCRR Part 500 Floodplain Management Regulations Development Permits **Executive Order 11988** **Camillus Municipal Code, Chapter 31: Flood Damage Prevention** **Geddes Flood Protection Ordinance**	**NYSDEC** **USEPA** **Town of Camillus** **Town of Geddes**	**Slurry Transport / Support Facilities / Habitat Restoration** **(**Evaluating Relevance in Camillus**)**	• Application to the Region 7 Permit Administrator on application forms provided by the department. • Description of the location, type and extent of the proposed project • Other information or plans required or specified in 6 NYCRR Part 500, section 500.8 and 6 NYCRR Part 621.	• May be applicable for shoreline support facilities and for construction of the pipeline from the Lakeshore to Settling Basin 13, if routed within a floodplain. • Executive Order 11988 may apply. • Camillus Municipal Code Chapter 31 covers Flood Damage Prevention within the Town of Camillus, and Town of Geddes also has a Flood Protection Ordinance. Per discussions with NYSDEC, both Town ordinances would fulfill the requirement of 6 NYCRR Part 500. As a result, any work in areas of special flood hazard would require a permit from the town where the area is located.
6NYCRR Part 608 Use and Protection of Waters.	**NYSDEC**	**Dredging / Capping / Habitat Restoration**	• Application to Region 7 Permit Administrator • Plan of Proposed Project • Location Map (USGS Quad) • Other as determined by NYSDEC	• 6 NYCRR Part 608 and Section 404 of the Federal Clean Water Act together regulate alterations to protected waters such as dredging and filling. Approval would be governed by whether: (a) the proposal is reasonable and necessary; (b) the proposal would not endanger the health, safety or welfare of the people of the State of New York; and (c) the proposal would not cause unreasonable, uncontrolled or unnecessary damage to the natural resources of the state.

TABLE 2.1 (Cont.)
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments

6NYCRR Parts 200, 201, 211, 212, 255, 256, 257, and 291 Prevention and Control of Air Contamination and Air Pollution	**NYSDEC**	**SCA
		GWTP**
			• Preconstruction deliverables to NYSDEC Division of Air may include:
			  • Emission estimates
			  • Control technology description
			  • Air dispersion modeling protocol and analysis.
				• Although no permit was required for the Vapor Phase Treatment System (VPTS) at the Willis Ave. GWTP because the project was conducted under an Order on Consent, pre-approval by the NYSDEC was required prior to construction. VPTS at the GWTP is subject to 6 NYCRR Part 212 and DAR-1. Honeywell was also required to perform compliance testing to obtain the equivalent of "Certificate to Operate".
				• Will also apply to SCA leachate treatment plant if discharge to the atmosphere is included. Will need to coordinate with NYSDEC when leachate treatment design is ready.
				• The Site Remediation MACT (Subpart GGGGG) does not apply since the project will not emit pollutants above the "major source" thresholds.

Letter of Findings and Request for Concurrence. **National Historic Preservation Act 36 CFR Part 800**	**NYS Office of Parks, Recreation, & Historic Preservation (OPRHP) – State Historic Preservation Office (SHPO)**	**Continuing Relevance: Slurry Transport Dredging Capping** **NFA: SCA**	• Letter of Findings requesting SHPO to concur that no additional archeological work is necessary in the project area if Phase 1A or Phase 1B determines no need for additional work. • If Phase 1B indicates existence of resources potentially eligible for listing in the National Register of Historic Places are discovered, a Phase 2 investigation will be required. • If Phase 2 confirms eligibility and impact to the eligible resource cannot be avoided, a Phase 3 Data Recovery may be required.	• A Phase 1A Cultural Resource Assessment was conducted for the lake and the SCA. A Phase 1B Cultural Resources assessment will be performed for the Lake bottom. No further action was recommended for the SCA. Additional Phase 1B work may be required along the route of dredge material pipeline.
Request for Authorization Letter **Federal Endangered Species Act and 50 CFR Parts 17 and 23** **Fish and Wildlife Coordination Act (16 USC Section 662)**	**US Fish & Wildlife Service (USWFS)**	**All**	• Letter of Intent requesting USWFS to identify any potential endangered or threatened species or critical habitats in the project area. • Scope of Work - Brief narrative of remedy • Location Map (USGS Quad with site location)	• A letter from USFWS (6/25/02) in the Baseline Ecological Risk Assessment indicates one threatened species within two miles of Onondaga Lake. Will send copy of letter to USF&WS when we request an updated evaluation.

TABLE 2.1 (Cont.)
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments
Request for Authorization Letter NYS Endangered Species Act and 6 NYCRR Part 182	**NYS Natural Heritage Program (NYSNHP), NYSDEC Wildlife Resources Center**	**All**	• Letter of Intent requesting NYSNHP to identify any potential endangered or threatened species or critical habitats in the project area • Scope of Work - Brief narrative of remedy • Location Map (topographic map with site location)	• A letter from NY Natural Heritage Program (10/24/02) in the Baseline Ecological Risk Assessment indicates three threatened species within two miles of Onondaga Lake. Will send copy of letter to NYSNHP when we request an updated evaluation.
Stormwater Management & Erosion Control Plan - General Permit (Stormwater Pollution Prevention - SWPPP) SPDES general Permits GP-0-08-001 (Construction) GP-0-08-002 (MS4)	**USEPA, NYSDEC Division of Water Town of Camillus (Municipal Code, Chapter 43 – Stormwater Sewer System. Town of Geddes and City of Syracuse MS4 Regulations.**	**Slurry Transport SCA GWTP**	• Notice of Intent to Discharge • Stormwater management scope of work narrative. Indicate its an NPL/CERCLA site • Stormwater Pollution Prevention Plan	• Disturbance of more than 1 acre requires preparation of an erosion control plan meeting the substantive requirements of the regulations. • Camillus, Geddes, and Syracuse are all have regulated Municipal Separate Storm Sewer Systems (MS4) and must develop, implement, and enforce a stormwater management program (SWMP).

TABLE 2.1 (Cont.)
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments
SPDES Permit (6NYCRR Parts 750-757) **Clean Water Act, Sections 318, 402, and 405(a) and 40 CFR Parts 122 and 123.**	**NYSDEC Division of Water , USEPA**	**SCA** **GWTP**	• Notice of Intent to Discharge for discharge directly to NYS Surface Waters. • Wastewater management scope of work narrative. Indicate it's an NPL/CERCLA site. • Technical information including : 1) Site status & site number 2) DHWR Engineer contact 3) Treatment system description 4) Discharge rate and duration 5) Description of receiving stream 6) Wastewater monitoring data (e.g., if system is new, then provide soil/sediment, groundwater, and surface water sampling data as representative of projected influent constituents) • Request effluent discharge criteria (suggest that Best Available Technology/Best Available Practice (BAT/BAP) criteria be used, along with the applicable analytical methods) • Sampling & Analysis Plan - Implemented for the duration of the treatment system operation	• Would receive a "Permit Equivalent" letter from the Division of Environmental Remediation in lieu of an actual SPDES permit from the Division of Water for discharge directly to surface waters. • Should effluent from the Treatment plant be discharged to the Syracuse Metro Wastewater Treatment plant, the SPDES permit would be replaced with an Industrial Wastewater Discharge Permit issued by the Onondaga County Department of Water Environment Protection. A permit application would need to be completed in accordance with Article IV, Section 4.02 of the Onondaga County Rules and Regulations Relating to the Use of the Public Sewer System.

TABLE 2.1 (Cont.)
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments
CSX Access Agreement		**Capping Slurry Transport**	• Description of Work • Site Narrative • Plan of Proposed Project • Location Map (USGS Quad) • CSX Application Form • Insurance Certificate	• Determine if access agreement would be required if cap material were transported via rail. • Determine if access agreement would be required if area under railroad bridge over Ninemile Creek is utilized for dredge slurry piping (i.e. property under bridge owned by CSX).
Local Building Permit and Zoning Regulations (Bldg. Permit Application/Form)	**Town of Geddes (Town of Geddes Chapter 240 – Zoning.** **Town of Camillus (Municipal Code, Chapter 26 - Uniform Code Enforcement, Chapter 30 – Zoning Regulations of the Town of Camillus, Chapter 43 – Stormwater Sewer System, Chapter 48 - Waste Disposal, and Chapter 68 – Noise Law.** **City of Syracuse (City of Syracuse - Articles 5.1 through Articles 5.5 of the Building Code of the City of Syracuse)**	**All**	• Potential for Building Permit, Site Development Permit, Landfill Permit and Site Plan Approval, especially for the SCA, water treatment plant, shoreline processing facilities, and Pipeline. • Town of Camillus zoning regulations require planning board approval for a solid waste facility in areas zoned for industrial use (such as Settling Basin 13). • Location Map of the site (USGS Quad & Local) • Drawings of the structure (plan & profile) • Plan and profile for sediment transfer pipeline from the Lake shore to the SCA. • Truck access to SCA at Settling Basin 13 – Frequency and Route (Town of Camillus). • Placement of shoreline support facilities at Settling Basins 1-8 (Town of Geddes) and perhaps also at Settling Basin B (Town of Geddes and City of Syracuse) • Building and stormwater designs for shoreline support facilities. • Certificate of Occupancy for areas where workers will stay.	• Any work in the Town of Camillus may be subject to additional level of regulation and review if constructed in a "Stream Corridor Overlay District", dependent on the horizontal distance from the high water mark • Substantive requirements of applicable municipal building codes will need to be met.
Onondaga County Agreements	**Onondaga County**	**Dredging / Capping / Habitat Restoration**	• Access and building construction at northern portion of Settling Basins 1-8 as needed for dredging and capping support facilities.	• Truck access to Settling Basins 1-8 will also need to be coordinated with New York State Department of Agriculture & Markets (NYS Fair).

TABLE 2.1 (Cont.)
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments
Highway work permit and occupancy permit. (Honeywell submit application and proof of adequate insurance)	**NYSDOT, Onondaga County, and possibly local municipalities.**	**Slurry Transport**	• Perm 32 – Highway Work Permit Application for Utility Work. • Perm 33 – Highway Work Permit Application for Non-Utility Work. • Perm 44e – Surety Bond (Performance). • Perm 17 – Certificate of Insurance for Special Hauling, Divisible Load Overweight, and Highway Work Permit Insurance Requirements. • 17 NYCRR Part 131 – Accommodation of Utilities within State Highway Right-of-Way.	• Applicable if access to/from the SCA and/or Shoreline Processing area from I-690/SR-695 needs to be improved. • Applicable if pipeline routing requires crossing I-690. • 17 NYCRR Part 131 may also apply to pipeline route and/or access improvements.
Private Landowner Agreements	**TBD**	**Slurry Transport Capping**	• Access from Lakeshore to Settling Basin 13 (if a private landowner exists along selected ROW) • Quarry locations for SCA and lake cap materials (Candidate locations not yet identified. May also be subject to 6 NYCRR Part 420 - Part 425)	• Will need to review tax maps when routing of the pipeline from the lakeshore to the SCA is determined. Parsons has tax data in GIS and can generate required information. Also, data from Pictometry® Visual Intelligence may be useful.
Canal System Work Permit Canal Law, Article 2 § 10.	**NYS Canal Corporation**	**Dredging Capping**	• Canal Permit Application • Certificate of Insurance • Maps, Plans and Specifications of the proposed work • Copies of USACE and/or NYSDEC Approval • Application Fee	• May require permits and/or access agreements for: (a) Use of Barge Canal for material and equipment transfers; (b) Short-term navigation constraints during dredging and capping; and (c) Long-term cap protection institutional controls. • Per discussions with Canal Corp. personnel, Work Permit would allow the Canal Corp. to issue notices to navigation of work in progress in the lake and coordination with Canal Corp. maintenance activities. It would also help facilitate use of the Canal System for transport of equipment and supplies. • Estimated time requirements for obtaining permit for lake work would be approximately one month. Area of maximum interference would be with work in SMU 6 at the outlet of the Syracuse Terminal Channel. • Creation of an obstruction in Onondaga Lake such as a submerged outfall pipe or water intake

TABLE 2.1 (Cont.)
REGULATORY REQUIREMENTS

Requirement	Responsible Agency	Applicable Activities	Potential Supporting Documentation	Comments
Local Noise/Dust/Odor Regulations	**Town of Geddes (Town of Geddes Chapter 240-64 – Zoning, Operations Requirements.**	**Dredging / Capping / Slurry Transport**	• For Town of Geddes, operations plan will need to be submitted to Town which provides an overview of daily operations and maintenance schedules.	• Dust from operations and roadways will need to be controlled from leaving site. Odors to be controlled to prevent a nuisance to off-site properties. Noise limitations provided, and holiday limitations apply.
	Town of Camillus (Municipal Code, Chapter 68 – Noise Law	**Slurry Transport SCA / WTP**	• Special license may be required (see Ordinance).	• Town of Camillus zoning regulations provide sound level (in dB(A)) limits for continuous and intermittent sounds. Exceptions are permissible, and may need to comply with Municipal Chapter 26 – Uniform Code Enforcement.

TABLE 3.1

Contaminants Used in Mean PEC Quotient Calculation

	PEC
Metals (mg/kg)	
Mercury	2.2
Organic Compounds	
BTEX Compounds (μg/kg)	
Ethylbenzene	176
Xylenes	560.8
Chlorinated Benzenes (μ g/kg)	
Chlorobenzene	428
Dichlorobenzenes	239
Trichlorobenzenes	347
PAH Compounds (μ g/kg)	
Acenaphthene	861
Acenaphthylene	1301
Anthracene	207
Benz[a]anthracene	192
Benzo[a]pyrene	146
Benzo[b]fluoranthene	908
Benzo[ghi]perylene	780
Benzo[k]fluoranthene	203
Chrysene	253
Dibenz[a,h]anthracene	157
Fluoranthene	1436
Fluorene	264
Indeno[1,2,3-cd]pyrene	183
Naphthalene	917
Phenanthrene	543
Pyrene	344
Polychlorinated Biphenyls (μ g/kg)	
Total PCBs	295

The PECQ for a given contaminant is calculated as the concentration of that contaminant in a given location within the lake divided by the PEC value associated with that contaminant. The PECQ is first calculated for the first five chemical parameter of interest (CPOI) groups (mercury, ethylbenzene and xylenes, chlorinated benzenes, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) using detections. These values are then averaged to get the final mean PECQ for the station. For example, in a simplified hypothetical case where all contaminants for the five CPOI groups are detected at a station and PECQs of 1.0, 2.0, 3.0, 4.0 and 5.0 were calculated for the five groups, the mean PECQ for the station would be the average of the five PECQ values (i.e., (1.0+2.0+3.0+4.0+5.0)/5 = 3), resulting in a mean PECQ of 3.0 (i.e., 15/5) for the overall station.

Table 4.1
Summary of Cap Thicknesses (feet)

REMEDIATION AREA A

Water Depth/ Habitat Module	Mixing Layer	pH Amendment Minimum (ft)	pH Amendment Assumed Maximum With Over Placement (ft)	Chemical Isolation Layer Minimum (ft)	Chemical Isolation Layer Assumed Maximum With Over Placement (ft)	Habitat/Erosion Protection Layer Grainsize	Habitat/Erosion Protection Layer Minimum (ft)	Habitat/Erosion Protection Layer Assumed Maximum With Over Placement (ft)	Additional Habitat Layer Grainsize	Additional Habitat Layer Minimum (ft)	Additional Habitat Layer Assumed Maximum With Over Placement (ft)	Total Habitat Layer Minimum (ft)	Total Habitat Layer Assumed Maximum With Over Placement (ft)	Total Isolation Cap Minimum (ft)	Total Isolation Cap Assumed Maximum With Over Placement (ft)
0 to 3 ft of water depth 6A (+1-1 ft) 5A (Cap Area A-2) (0.5-2 ft) 5A (0.5-2 ft) 3A (Cap Area A-2) (2-3 ft) 3A (2-3 ft)	0.25	n/a	n/a	1.0	1.5	coarse gravel	0.25	1.0	medium sand	1.75	2.25	2.0	3.25	3.25	5.0
3 to 7 ft of water depth 3A (Cap Area A-2) (3-7 ft) 3A (3-7 ft)	0.25	n/a	n/a	1.0	1.5	fine gravel	0.25	0.75	fine gravel	1.25	1.75	1.5	2.5	2.75	4.25
7 to 20 ft of water depth 2A (Cap Area A-2) (7-20 ft) 2A (7-20 ft)	0.25	n/a	n/a	1.0	1.0	medium sand	1.0	1.5		-	-	1.0	1.5	2.25	2.75
20 to 30 ft of water depth 1 (20-30 ft)	0.25	n/a	n/a	0.50	0.50	medium sand	1.0	1.5		-	-	-		1.75	2.25

- Mixing and Chemical Isolation Layers grainsize are medium sand.

REMEDIATION AREA B

Habitat Module	Mixing & pH Amendment Layer	pH Amendment Minimum (ft)	pH Amendment Assumed Maximum With Over Placement (ft)	Chemical Isolation Layer Minimum (ft)	Chemical Isolation Layer Assumed Maximum With Over Placement (ft)	Habitat/Erosion Protection Layer Grainsize	Habitat/Erosion Protection Layer Minimum (ft)	Habitat/Erosion Protection Layer Assumed Maximum With Over Placement (ft)	Additional Habitat Layer Grainsize	Additional Habitat Layer Minimum (ft)	Additional Habitat Layer Assumed Maximum With Over Placement (ft)	Total Habitat Layer Minimum (ft)	Total Habitat Layer Assumed Maximum With Over Placement (ft)	Total Isolation Cap Minimum (ft)	Total Isolation Cap Assumed Maximum With Over Placement (ft)
0 to 3 ft of water depth 5A (0.5-2 ft) 3A (2-3 ft)	0.25	0.25	0.75	1.0	1.5	coarse gravel	0.3	1.0	fine gravel	1.7	2.2	2.0	3.2	3.5	5.7
3 to 7 ft of water depth 3A (3-4 ft) 3A (4-7 ft)	0.25	0.25	0.75	1.0	1.5	coarse gravel fine gravel	0.3	1.0	fine gravel	1.2	1.7	1.5	2.7	3.0	5.2
7 to 10 ft of water depth 2A (7-10 ft)	0.25	0.25	0.75	1.0	1.5	coarse sand	1.0	1.5		-	-	1.0	1.5	2.5	4.0
10 to 30 ft of water depth 2A (10-20 ft) 1 (20-30 ft)	0.25	0.25	0.75	1.0	1.0	medium sand	1.0	1.5		-	-	1.0	1.5	2.5	3.5

- Mixing & pH Amendment, pH Amendment and Chemical Isolation Layers grainsize are medium sand.

Table 4.1
Summary of Cap Thicknesses (feet)

REMEDIATION AREA C

Habitat Module	Mixing Layer	pH Amendment Minimum (ft)	pH Amendment Assumed Maximum With Over Placement (ft)	Chemical Isolation Layer Minimum (ft)	Chemical Isolation Layer Assumed Maximum With Over Placement (ft)	Habitat/Erosion Protection Layer Grainsize	Habitat/Erosion Protection Layer Minimum (ft)	Habitat/Erosion Protection Layer Assumed Maximum With Over Placement (ft)	Additional Habitat Layer Grainsize	Additional Habitat Layer Minimum (ft)	Additional Habitat Layer Assumed Maximum With Over Placement (ft)	Total Habitat Layer Minimum (ft)	Total Habitat Layer Assumed Maximum With Over Placement (ft)	Total Isolation Cap Minimum (ft)	Total Isolation Cap Assumed Maximum With Over Placement (ft)
0 to 3 ft of water depth 6B (+1-1 ft) 5B (0.5-2 ft) 3B (2-3 ft)	0.25	n/a	n/a	1.5	2.0	coarse gravel	0.3	1.0	fine gravel	1.7	2.2	2.0	3.2	3.75	5.5
3 to 7 ft of water depth 3B (3-4 ft) 3B (4-7 ft)	0.25	n/a	n/a	1.5	2.0	coarse gravel fine gravel	0.3	1.0	fine gravel	1.2	1.7	1.5	2.7	3.25	5.0
7 to 10 ft of water depth 2A (7-10 ft)	0.25	n/a	n/a	1.5	2.0	fine gravel	1.0	1.5		-	-	1.0	1.5	2.75	3.75
10 to 30 ft of water depth 2A (10-20 ft) 1 (20-30 ft)	0.25	n/a	n/a	1.5	1.5	medium sand	1.0	1.5		-	-	1.0	1.5	2.75	3.25

- Mixing and Chemical Isolation Layers grainsize are medium sand.

REMEDIATION AREA D

Habitat Module	Mixing & pH Amendment Layer	pH Amendment Minimum (ft)	pH Amendment Assumed Maximum With Over Placement (ft)	Chemical Isolation Layer Minimum (ft)	Chemical Isolation Layer Assumed Maximum With Over Placement (ft)	Habitat/Erosion Protection Layer Grainsize	Habitat/Erosion Protection Layer Minimum (ft)	Habitat/Erosion Protection Layer Assumed Maximum With Over Placement (ft)	Additional Habitat Layer Grainsize	Additional Habitat Layer Minimum (ft)	Additional Habitat Layer Assumed Maximum With Over Placement (ft)	Total Habitat Layer Minimum (ft)	Total Habitat Layer Assumed Maximum With Over Placement (ft)	Total Isolation Cap Minimum (ft)	Total Isolation Cap Assumed Maximum With Over Placement (ft)
0 to 3 ft of water depth 6B (+1-1 ft) 5B (0.5-2 ft) 3B (2-3 ft)	0.25	0.25	0.75	1.0	1.5	coarse gravel	0.3	1.0	medium sand	1.7	2.2	2.0	3.2	3.5	5.7
3 to 7 ft of water depth 3B (3-4 ft) 3B (4-7 ft)	0.25	0.25	0.75	1.0	1.5	coarse gravel fine gravel	0.3	1.0	medium sand	1.2	1.7	1.5	2.7	3.0	5.2
7 to 10 ft of water depth 2A (7-10 ft)	0.25	0.25	0.75	1.0	1.5	medium sand	1.0	1.5		-	-	1.0	1.5	2.5	4.0
10 to 30 ft of water depth 2A (10-20 ft) 1 (20-30 ft)	0.25	0.25	0.75	1.0	1.0	medium sand	1.0	1.5		-	-	1.0	1.5	2.5	3.5

- Mixing & pH Amendment, pH Amendment and Chemical Isolation Layers grainsize are medium sand.

Table 4.1
Summary of Cap Thicknesses (feet)
REMEDIATION AREA E

Habitat Module	Mixing Layer	pH Amendment		Chemical Isolation Layer		Habitat/Erosion Protection Layer			Additional Habitat Layer			Total Habitat Layer		Total Isolation Cap	
		Minimum (ft)	Assumed Maximum With Over Placement (ft)	Minimum (ft)	Assumed Maximum With Over Placement (ft)	Grainsize	Minimum (ft)	Assumed Maximum With Over Placement (ft)	Grainsize	Minimum (ft)	Assumed Maximum With Over Placement (ft)	Minimum (ft)	Assumed Maximum With Over Placement (ft)	Minimum (ft)	Assumed Maximum With Over Placement (ft)
0 to 3 ft of water depth															
6B (+1-1 ft) 5B (0.5-2 ft) 3B (2-3 ft)	0.25	n/a	n/a	1.0	1.5	cobbles	0.5	1.5	coarse gravel	1.5	2.0	2.0	3.5	3.25	5.25
3 to 7 ft of water depth															
3B (3-7 ft)	0.25	n/a	n/a	1.0	1.5	cobbles	0.5	1.5	coarse gravel	1.0	1.5	1.5	3.0	2.75	4.75
7 to 20 ft of water depth															
2B (7-10 ft) 2A (10-20 ft)	0.25	n/a	n/a	1.0	1.5	coarse gravel fine gravel	1.0	1.5		-	-	1.0	1.5	2.25	3.25
2A (Navigation Channel) (12 ft)	0.25	n/a	n/a	1.0	1.5	coarse gravel	0.5	1.5		-	-	-	1.5	1.75	3.25
20 to 30 ft of water depth															
1 (20-30 ft)	0.25	n/a	n/a	0.5	0.5	medium sand	1.0	1.5		-	-	-		1.75	2.25

- Mixing and Chemical Isolation Layers grainsize are medium sand.

Table 4.2
Summary of Wind/Wave Erosion Protection Particle Grain Size

	Remediation Area A		Remediation Area B		Remediation Area C		Remediation Area D		Remediation Area E	
Water Depth (ft)	**Particle Size**	**Minimum Thickness (inches)**	**Particle Size**	**Minimum Thickness (inches)**	**Particle Size**	**Minimum Thickness (inches)**	**Particle Size**	**Minimum Thickness (inches)**	**Particle Size**	**Minimum Thickness (inches)**
20’ to 30’	Fine sand	3	Fine sand	3	Fine sand	3	Fine sand	3	Medium sand	3
15’ to 20’	Fine sand	3	Fine sand	3	Medium sand	3	Medium sand	3	Fine gravel	3
10’ to 15’	Fine sand	3	Medium sand	3	Medium sand	3	Medium sand	3	Fine gravel	3
8’ to 10’	Medium sand	3	Coarse sand	3	Fine gravel	3	Fine gravel	3	Coarse gravel	3
6’ to 8’	Coarse sand	3	Fine gravel	3	Fine gravel	3	Fine gravel	3	Coarse gravel	3
Surf zone to 6’	Fine gravel	3	Fine gravel	3	Fine gravel	3	Fine gravel	3	Cobbles	6
Within surf zone	Coarse gravel	3	Coarse gravel	3.5	Coarse gravel	4	Coarse gravel	4	Cobbles	6

Notes:

1. The breaking wave depth is approximately 3.5 ft in Areas A and B, 4 ft in Areas C and D, and 7 ft in Area E.

2. The erosion protection layer thickness will be the greater of either 1.5 times the largest particle diameter, or 2 times the median particle diameter. For practical application considerations for construction, the minimum erosion protection layer thickness will be 3 inches (0.25 ft).

TABLE 5.1
ESTIMATED DREDGE VOLUMES

Dredge Area	Dredge to Cleanup Criteria Areas						Elevation-Based Dredge Areas					Total		
	Dredge Area (ft^2)	Dredge Area (acre)	Appendix F Dredge Volume (cy)	Over Dredge Volume (cy)	Cleanup Pass Dredge Volume (cy)	Total Dredge Volume (cy)	Dredge Area (ft^2)	Dredge Area (acre)	Appendix F Dredge Volume (cy)	Over Dredge Volume (cy)	Total Dredge Volume (cy)	Dredge Area (ft^2)	Dredge Area (acre)	Total Dredge Volume (cy)
RA-A	283,100	6.5	35,400	5,200	10,500	51,100	744,200	17.1	68,100	13,800	81,900	1,027,300	23.6	133,000
RA-B	0	0.0	0	0	0	0	125,800	2.9	17,300	2,300	19,600	125,800	2.9	20,000
RA-C	88,700	2.0	12,300	1,600	3,300	17,200	214,900	4.9	16,700	4,000	20,700	303,600	7.0	38,000
RA-D	0	0.0	0	0	0	0	3,884,600	89.2	1,147,300	0	1,147,300	3,884,600	89.2	1,147,000
RA-E	470,500	10.8	66,500	8,700	17,400	92,600	3,179,200	73.0	436,800	58,900	495,700	3,649,700	83.8	588,000
Total	842,300	19.3	114,200		31,200	160,900	8,148,700	187.1	1,686,200	79,000	1,765,200	8,991,000	206.4	1,926,000

Contingency Volume (summarized in section 5.2.6)	246,000
Total Assumed Volume for Operational Design	2,172,000

TABLE 6.1
LAKE UTILITIES SUMMARY TABLE

Utility	Owner	Construction	Rem Area	Length in Lake	Magnetic Anomaly	Side Scan Sonar Data	Current Activity Status	Potential Fate
Remediation Area A Features								
Eastern Feature	Honeywell	Cast Iron	A	unknown	Yes	No coverage	Abandoned	Fate to be determined following finalization of dredging prism
Western Feature	Honeywell	unknown	A	unknown	Yes	No coverage	Abandoned	Fate to be determined following finalization of dredging prism
Remediation Area C Culverts								
42" Culvert	Unknown	Concrete	C	Edge of Lake	-	-	Active	Fate to be determined following finalization of dredging prism
60" Culvert	Unknown	Concrete	C	Edge of Lake	-	-	Active	Fate to be determined following finalization of dredging prism
Cooling Water Intake Lines								
72" Intake Line	Honeywell	Cast Iron	D	1200 feet	Yes	No	Abandoned	Fate to be determined following finalization of dredging prism
84" Intake Line	Honeywell	Corrugated Steel	D	1240 feet	Yes	Yes	Abandoned	Fate to be determined following finalization of dredging prism
Water Inlet Pipes								
42" Suction Pipe (Atlas of Syracuse)	Honeywell	Cast Iron	D	1230 feet	Yes	No	Abandoned	Fate to be determined following finalization of dredging prism
30" Suction Pipe (Atlas of Syracuse)	Honeywell	Cast Iron	D	1145 feet	Yes	No	Abandoned	Fate to be determined following finalization of dredging prism
16" Suction Pipe (Atlas of Syracuse)	Honeywell	Cast Iron	D	890 feet	Yes	No	Abandoned	Fate to be determined following finalization of dredging prism
Diffuser Pipe								
60" Diffuser pipe	Honeywell	Coal Tar-lined Steel	D	790 feet	Yes	Yes	Abandoned	Fate to be determined following finalization of dredging prism
Oil Pipeline								
Sun Oil Pipeline	Sun Oil	Steel	D/E	2000 feet	Yes	Yes	Abandoned	Removal
Metro Discharge Points								
NPDES permitted outfall	Metro	unknown	E	Edge of Lake	-	-	Active (continuous)	Modifications to outfall unlikely, design will be modified to accommodate
NPDES permitted outfall	Metro	unknown	E	Edge of Lake	-	-	Active (continuous)	Modifications to outfall unlikely, design will be modified to accommodate
60" Outfall Pipe (Twin) (Southern pipe)	Metro	unknown	E	1700 feet	Yes	No	Not Currently Active	Modifications to pipeline unlikely, design will be modified to accommodate
60" Outfall Pipe (Twin) (Northern pipe)	Metro	unknown	E	1700 feet	Yes	No	Not Currently Active	Modifications to pipeline unlikely, design will be modified to accommodate
Remediation Area E Outfall								
Type 7 Outfall/Linear feature	Unknown	unknown	E	790 feet	Yes	Yes	Unknown	Fate to be determined following finalization of dredging prism

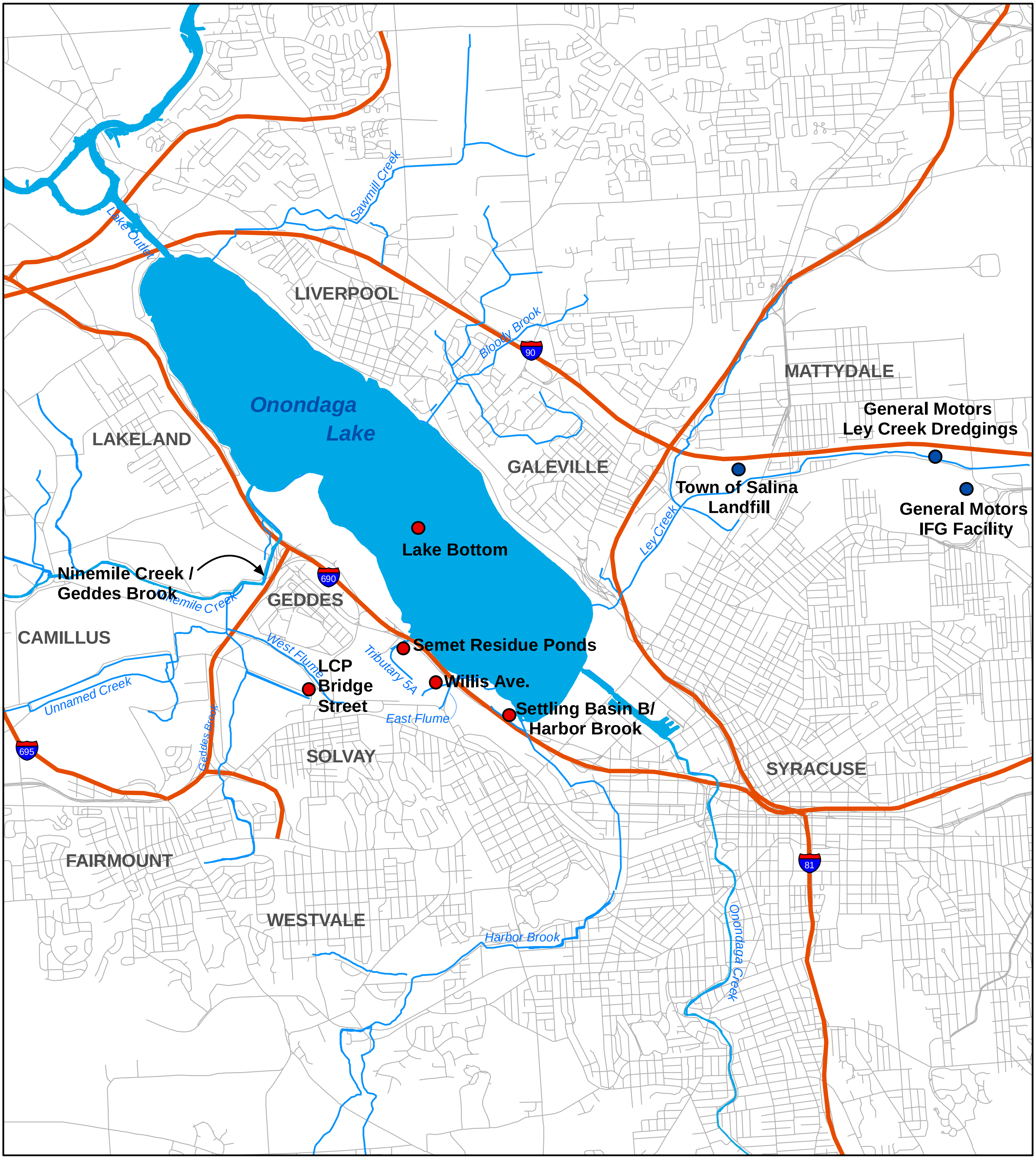
TABLE 7.1

ESTIMATED CAP MATERIAL VOLUMES

Remediation Area	Area (ft^2)	Area (acre)	Cap Material Volume (cy)
RA-A	3,636,000	83.5	361,300
RA-B*	1,409,000	32.4	107,500
RA-C	1,111,000	25.5	133,600
RA-D**	4,536,000	104.1	577,200
RA-E	8,030,000	184.5	914,300
Total	18,722,000	430.0	2,093,900

* includes shoreline stabilization materials along SMU 3.
** Includes 5.6 acres of RA-D addendum soil extending into SMU 8.

FIGURES



Honeywell NPL Site

Non-Honeywell NPL Site

N W E S

0 0.25 0.5 1 1.5 2 2.5

Miles

FIGURE 1.1

Honeywell Onondaga Lake Syracuse, New York

Site Location

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Q:\GIS\GIS_Lake\Operations_IDS\figure1-1.mxd

Wastebed

Sediment Management Unit (SMU) Boundary

NYSDEC Wetlands

Delineated Wetlands

Notes:
1. Wetland boundary delineations were performed during various upland site investigation programs. Some of the delineations are currently under NYSDEC review.

0 650 1,300 2,600 3,900 5,200
Feet

FIGURE 1.2

Honeywell

Onondaga Lake
Syracuse, New York

SMU Boundaries, Vicinity Wetlands, and Wastebeds

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212 Phone:(315)451-9560

(Q:\GIS\GIS_Lake\Operations_IDS\figure1-2.mxd) 1/29/2009 -- 10:23:09 AM

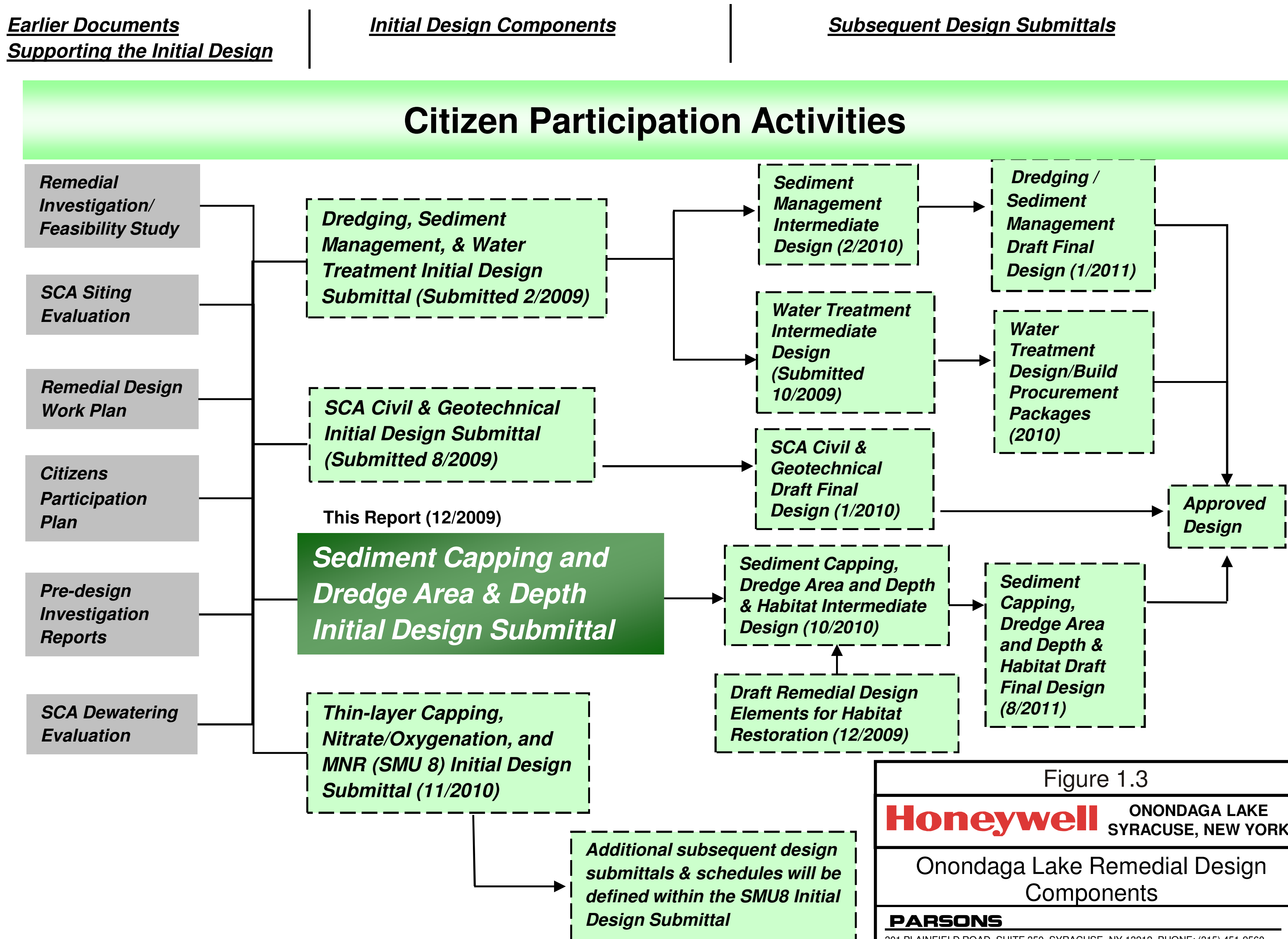


Figure 1.3

Honeywell ONONDAGA LAKE SYRACUSE, NEW YORK

Onondaga Lake Remedial Design Components

PARSONS
301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 PHONE: (315) 451-9560

FIGURE 3.1

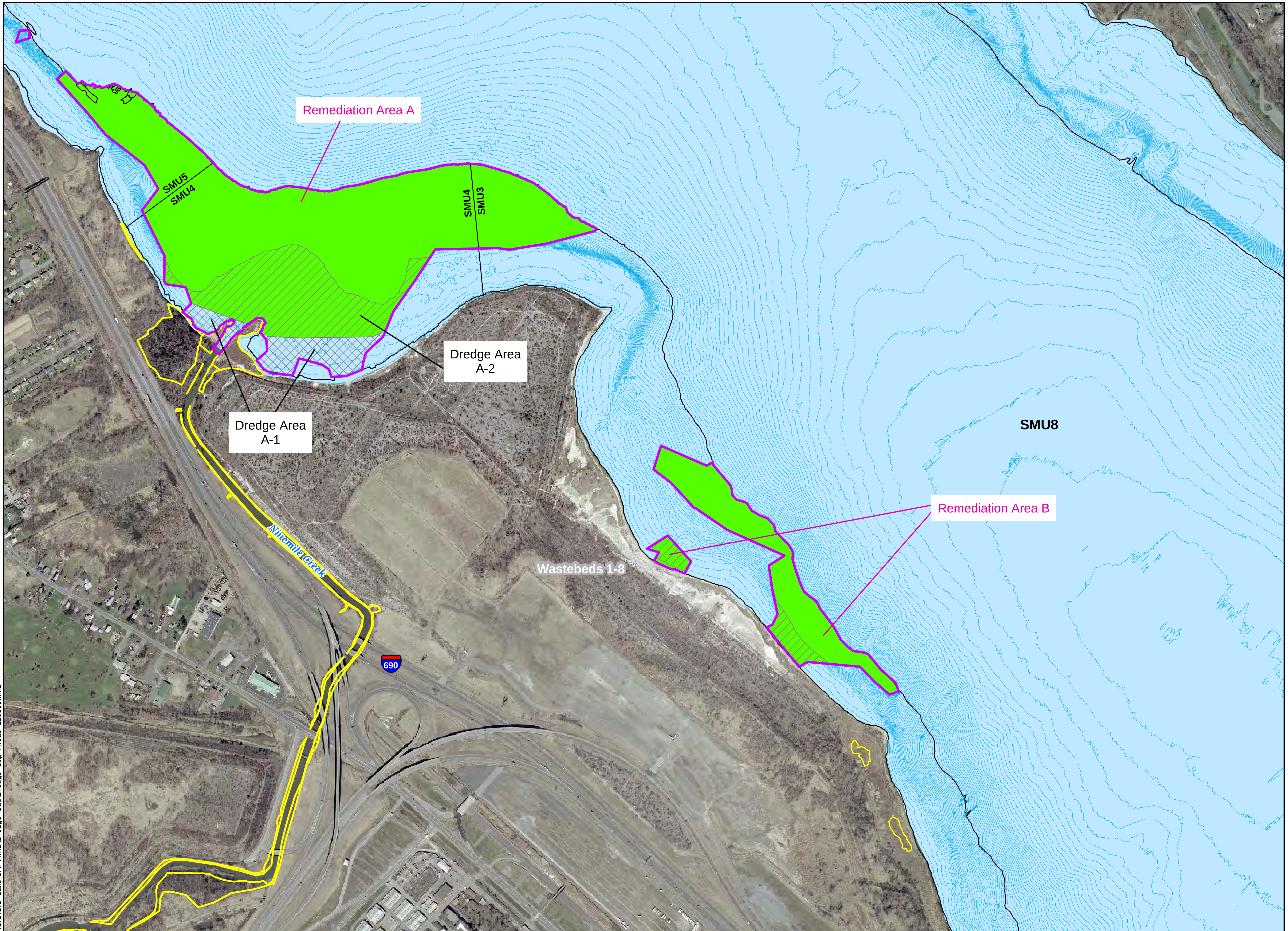
Honeywell — Onondaga Lake, Syracuse, New York

SMU Boundaries and Remediation Areas

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Q:\GIS\GIS_Lake\CAP\MXD\SMUs_Rem_Areas.mxd



Note: These areas will be modified as appropriate based on ongoing investigation and design activity.

- Remediation Area Boundary
- Cap Area
- Dredge to Achieve Cleanup Criteria
- Dredge to Achieve Target Elevation
- Delineated Wetland Boundaries
- Sediment Management Unit (SMU) Boundary

N
W E
S

New York State Digital Orthoimagery from 2003

690 345 0 690
Feet

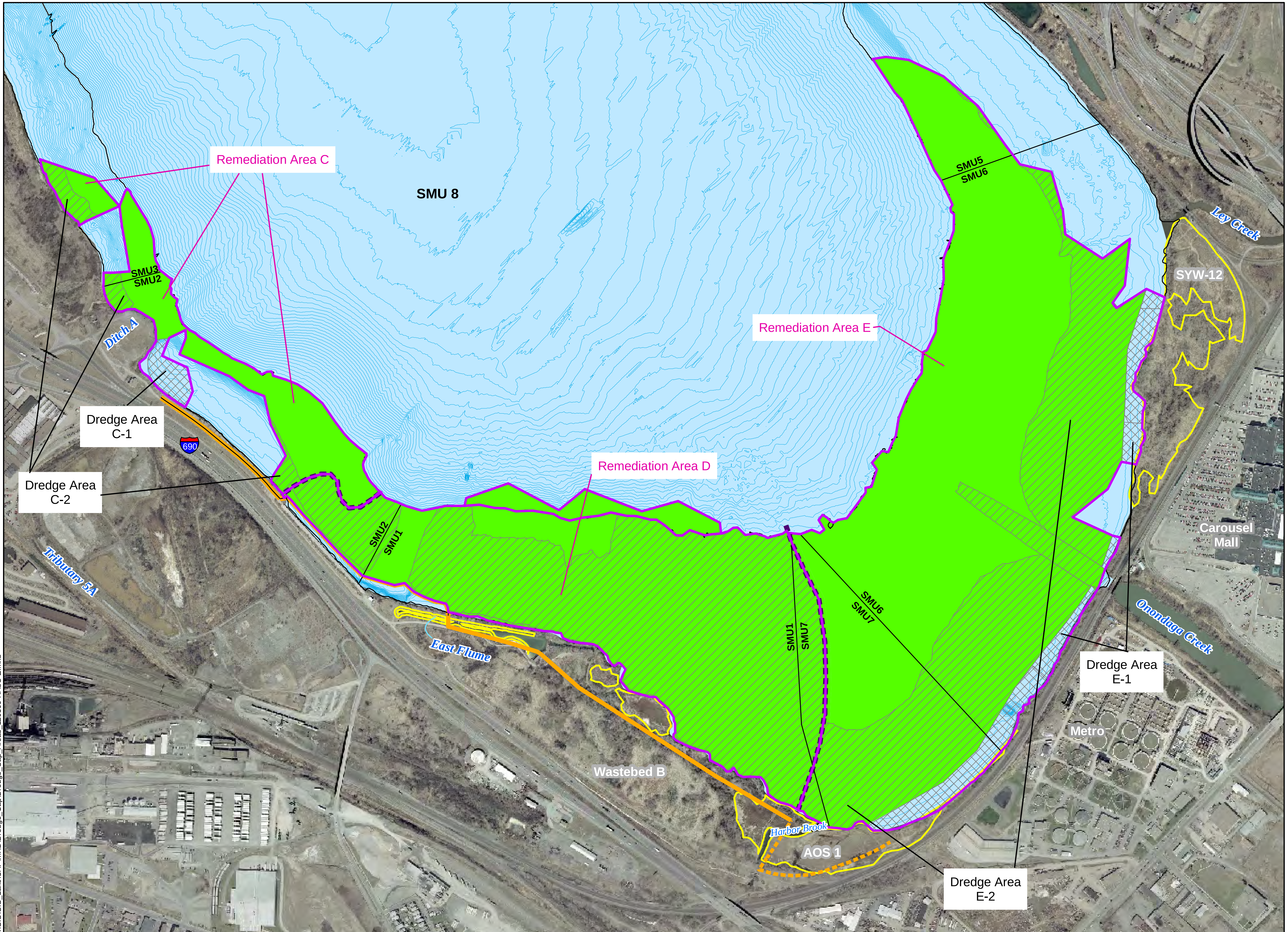
FIGURE 3.2

Honeywell — Onondaga Lake, Syracuse, New York

Remediation Areas A & B
Dredge and Cap Areas

PARSONS
301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Q:\GIS\GIS_Lake\CAP\MXD\Dredge_Cap\Dredge_Cap_Areas_120309.mxd



Note: These areas will be modified as appropriate based on ongoing investigation and design activity.

- Remediation Area Boundary
- Cap Area
- Dredge to Achieve Cleanup Criteria
- Dredge to Achieve Target Elevation
- Delineated Wetland Boundaries
- Sediment Management Unit (SMU) Boundary
- Extent of ILWD in Littoral Zone
- Willis/Semet IRM Barrier Wall
- West Wall Portion of the WB-B/HB IRM
- Approximate location of East Wall Portion of the WB-B/HB IRM

N W E S

New York State Digital Orthoimagery from 2003

650 325 0 650

Feet

FIGURE 3.3

Honeywell

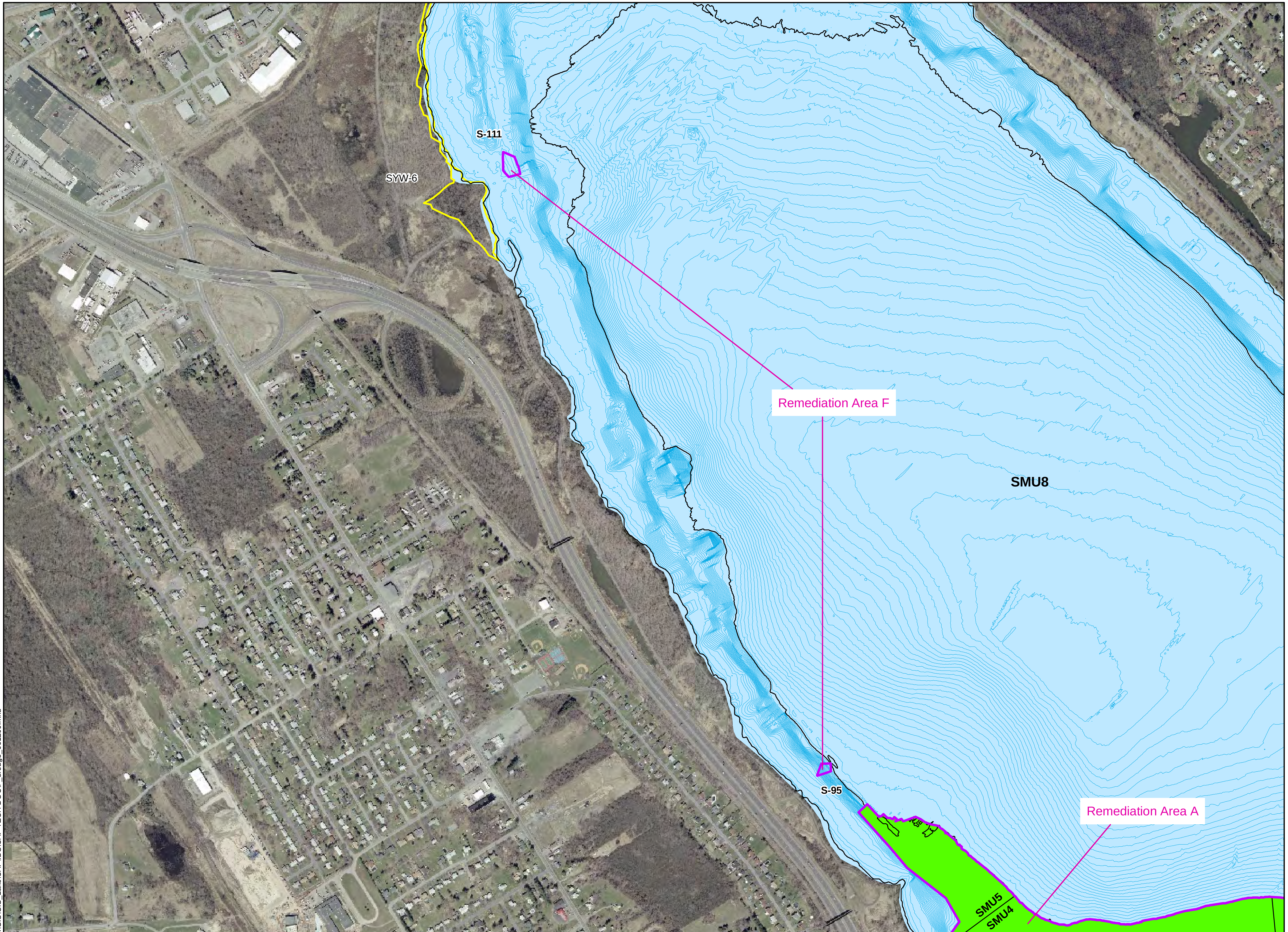
Onondaga Lake
Syracuse, New York

Remediation Areas C, D, & E
Preliminary Delineation

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Q:\GIS\GIS_Lake\CAP\MXD\Dredge_Cap\Dredge_Cap_Areas_120309-RAsC-E.mxd



Note: These areas will be modified as appropriate based on ongoing investigation and design activity.

- Remediation Area Boundary
- Delineated Wetland Boundaries
- Sediment Management Unit (SMU) Boundary

New York State Digital Orthoimagery from 2003

660 330 0 660
Feet

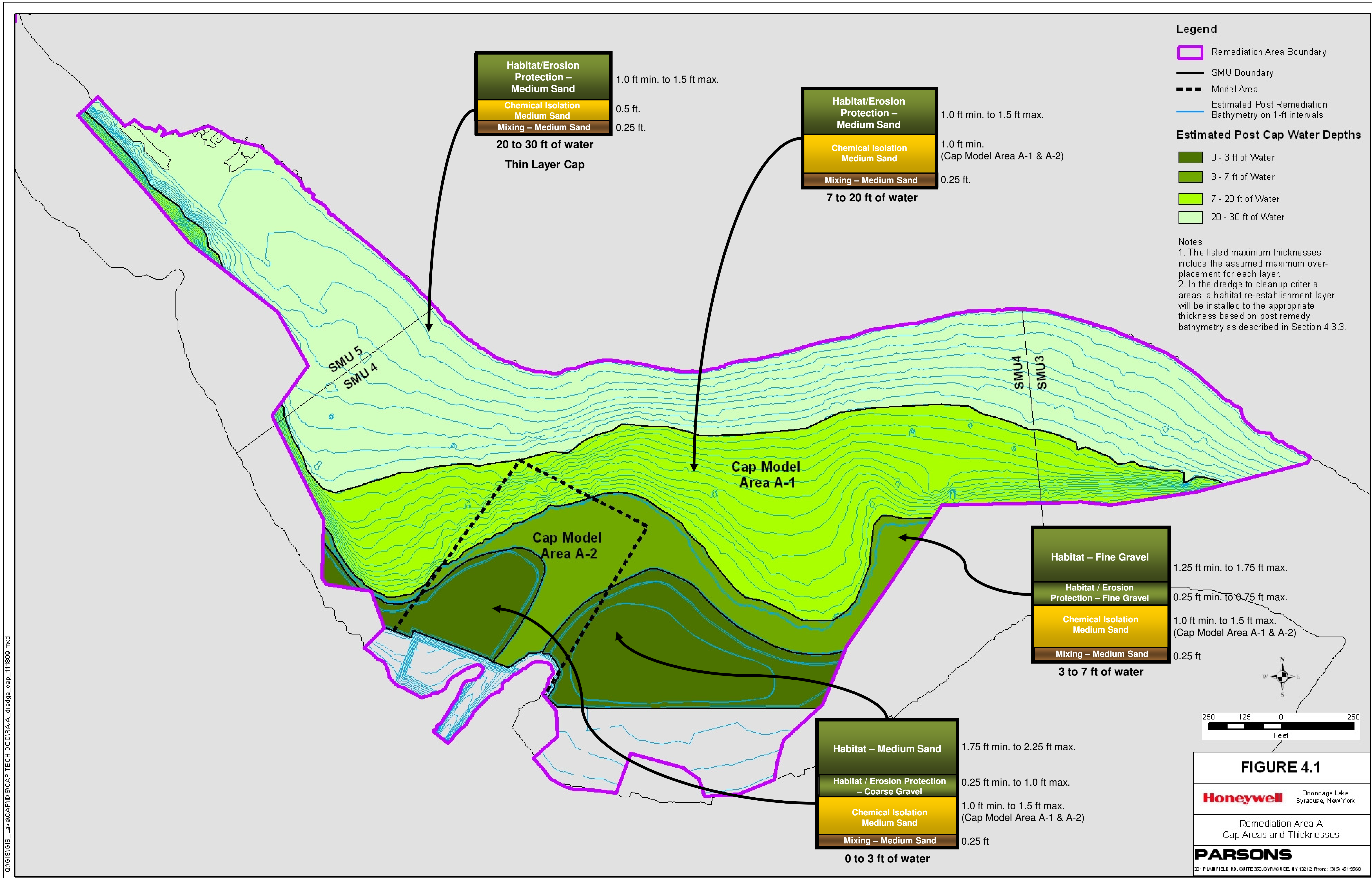
FIGURE 3.4

Honeywell — Onondaga Lake, Syracuse, New York

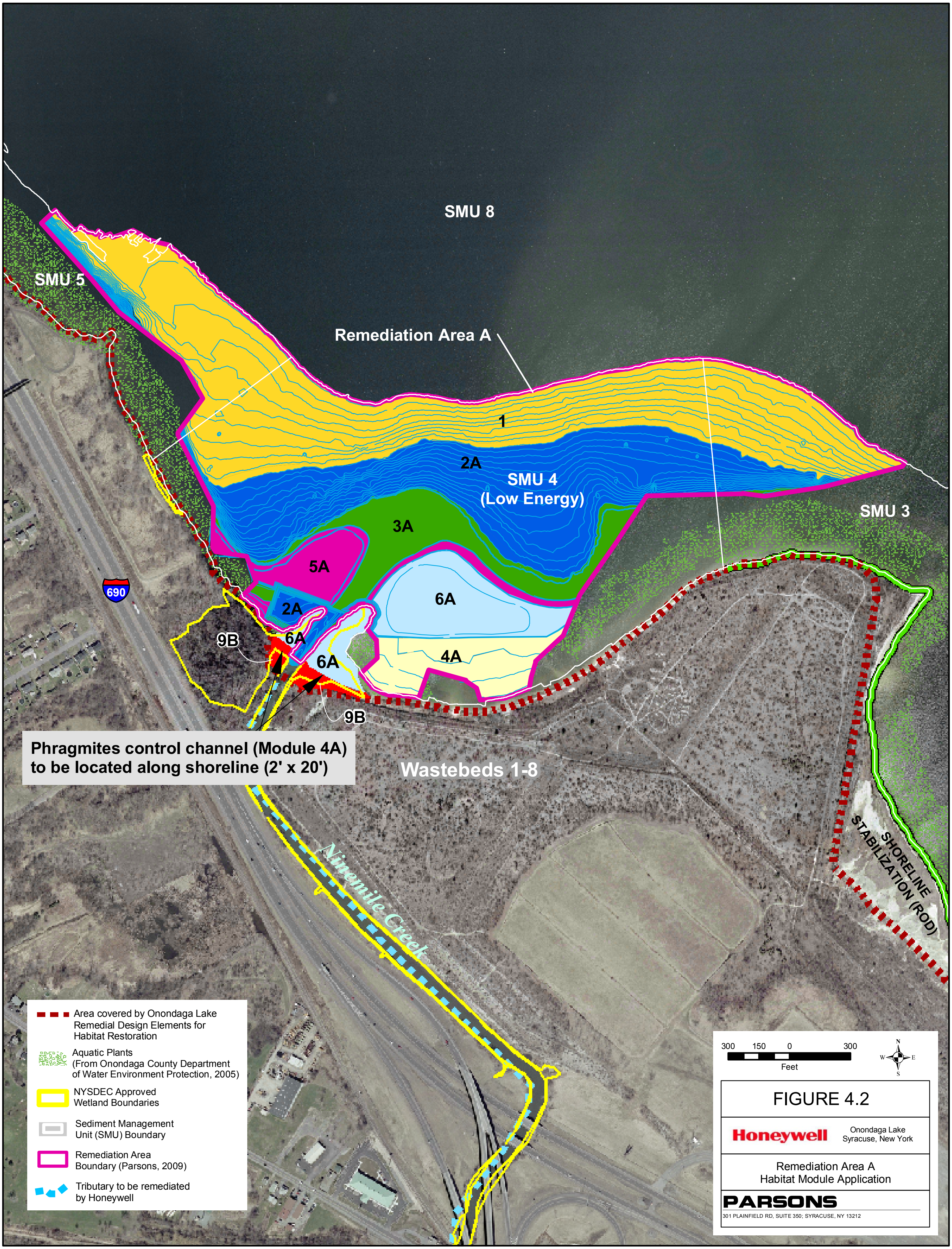
Remediation Area F Delineation

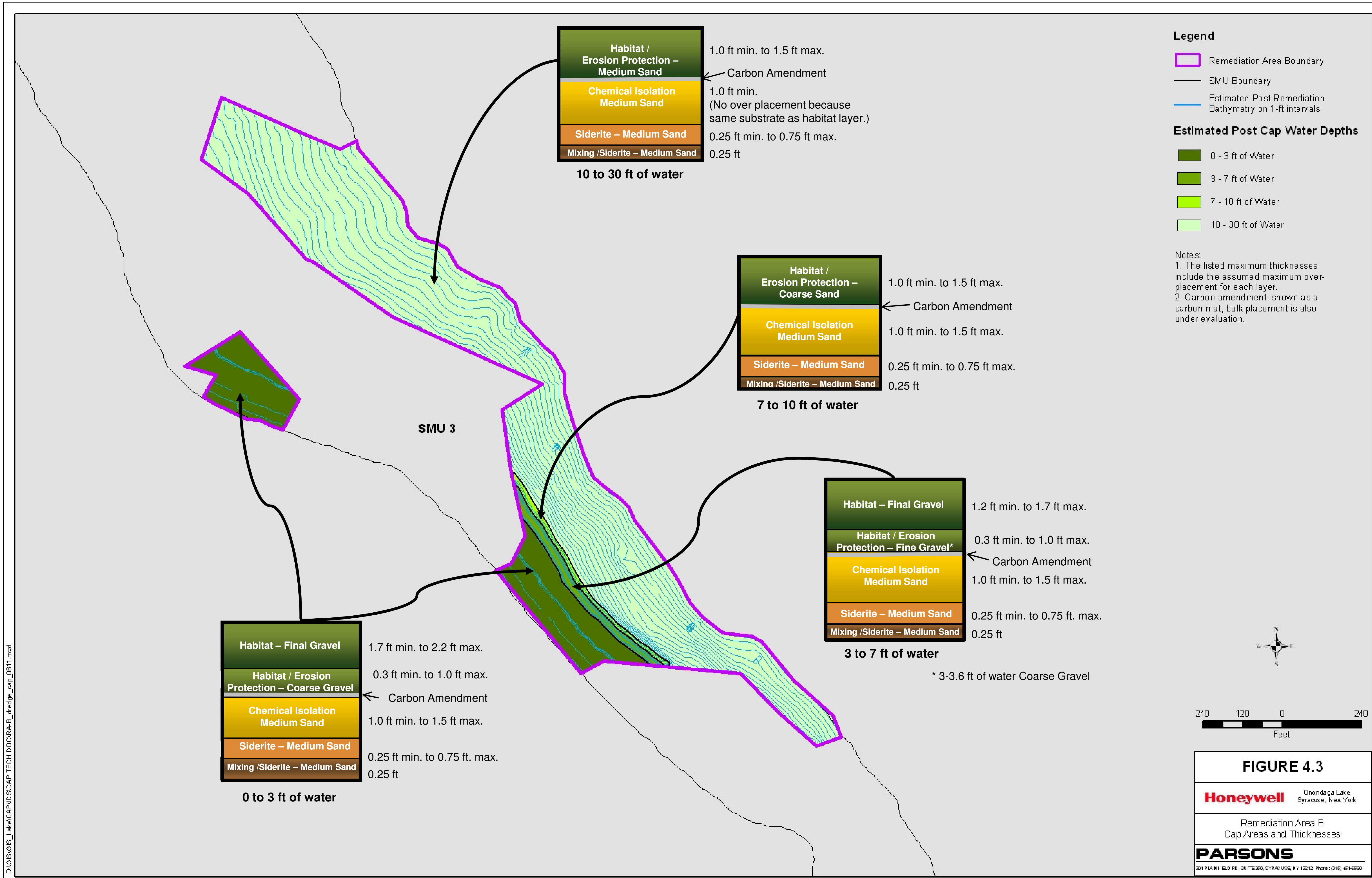
PARSONS
301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Q:\GIS\GIS_Lake\CAP\IDS\CAP TECH DOC\F_dredge_061209.mxd

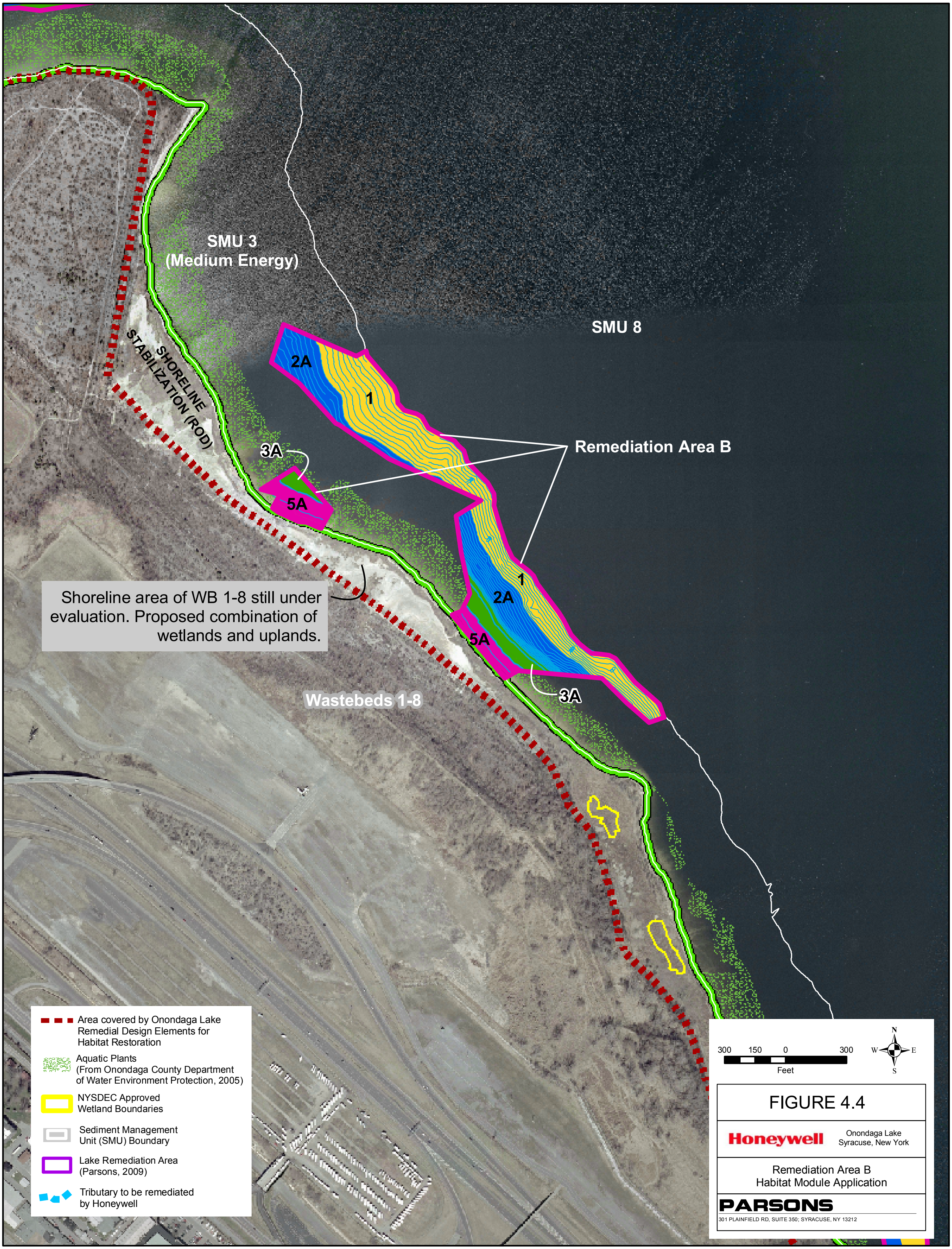


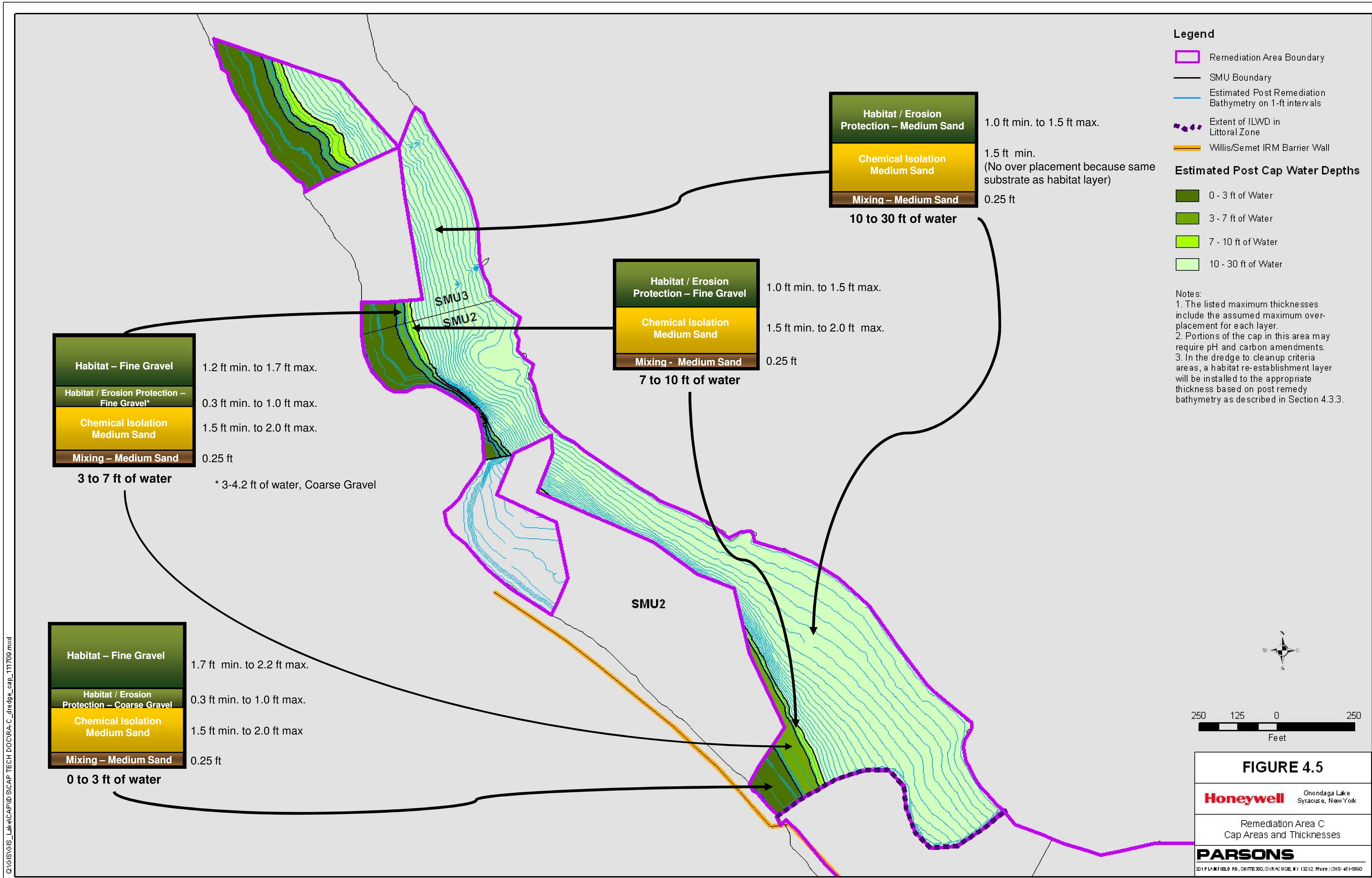
P:Hon-Syr\444576\09 Reports\9.1 Capping & Dredgng…\Figures\Figure 4.1-RA-A.ppt


SMU 8
SMU 5
Remediation Area A
1
2A
SMU 4
(Low Energy)
SMU 3
3A
5A
6A
2A
9B
6A
6A
4A
9B
690
Phragmites control channel (Module 4A)
to be located along shoreline (2' x 20')
Wastebeds 1-8
Ninemile Creek
SHORELINE
STABILIZATION (ROD)
Area covered by Onondaga Lake
Remedial Design Elements for
Habitat Restoration
Aquatic Plants
(From Onondaga County Department
of Water Environment Protection, 2005)
NYSDEC Approved
Wetland Boundaries
Sediment Management
Unit (SMU) Boundary
Remediation Area
Boundary (Parsons, 2009)
Tributary to be remediated
by Honeywell
300 150 0 300
Feet
FIGURE 4.2
Honeywell
Onondaga Lake
Syracuse, New York
Remediation Area A
Habitat Module Application
PARSONS
301 PLAINFIELD RD, SUITE 350; SYRACUSE, NY 13212



P:Hon-Syr\444576\09 Reports\9.1 Capping & Dredging…\Figures\Figure 4.3-RA-B.ppt


SMU 3
(Medium Energy)
SMU 8
SHORELINE
STABILIZATION (ROD)
2A
1
Remediation Area B
3A
5A
Shoreline area of WB 1-8 still under evaluation. Proposed combination of wetlands and uplands.
Wastebeds 1-8
Area covered by Onondaga Lake Remedial Design Elements for Habitat Restoration
Aquatic Plants (From Onondaga County Department of Water Environment Protection, 2005)
NYSDEC Approved Wetland Boundaries
Sediment Management Unit (SMU) Boundary
Lake Remediation Area (Parsons, 2009)
Tributary to be remediated by Honeywell
300 150 0 300
Feet
N
W
E
S
FIGURE 4.4
Honeywell
Onondaga Lake
Syracuse, New York
Remediation Area B
Habitat Module Application
PARSONS
301 PLAINFIELD RD, SUITE 350; SYRACUSE, NY 13212


Legend
Remediation Area Boundary
SMU Boundary
Estimated Post Remediation Bathymetry on 1-ft intervals
Extent of ILWD in Littoral Zone
Willis/Semet IRM Barrier Wall
Estimated Post Cap Water Depths
0 - 3 ft of Water
3 - 7 ft of Water
7 - 10 ft of Water
10 - 30 ft of Water
Notes:
1. The listed maximum thicknesses include the assumed maximum over-placement for each layer.
2. Portions of the cap in this area may require pH and carbon amendments.
3. In the dredge to cleanup criteria areas, a habitat re-establishment layer will be installed to the appropriate thickness based on post remedy bathymetry as described in Section 4.3.3.
Habitat / Erosion Protection – Medium Sand
1.0 ft min. to 1.5 ft max.
Chemical Isolation Medium Sand
1.5 ft min.
(No over placement because same substrate as habitat layer)
Mixing – Medium Sand
0.25 ft
10 to 30 ft of water
Habitat / Erosion Protection – Fine Gravel
1.0 ft min. to 1.5 ft max.
Chemical Isolation Medium Sand
1.5 ft min. to 2.0 ft max.
Mixing - Medium Sand
0.25 ft
7 to 10 ft of water
Habitat – Fine Gravel
1.2 ft min. to 1.7 ft max.
Habitat / Erosion Protection – Fine Gravel*
0.3 ft min. to 1.0 ft max.
Chemical Isolation Medium Sand
1.5 ft min. to 2.0 ft max.
Mixing – Medium Sand
0.25 ft
3 to 7 ft of water
* 3-4.2 ft of water, Coarse Gravel
Habitat – Fine Gravel
1.7 ft min. to 2.2 ft max.
Habitat / Erosion Protection – Coarse Gravel
0.3 ft min. to 1.0 ft max.
Chemical Isolation Medium Sand
1.5 ft min. to 2.0 ft max
Mixing – Medium Sand
0.25 ft
0 to 3 ft of water
SMU3
SMU2
SMU2
250 125 0 250
Feet
FIGURE 4.5
Honeywell
Onondaga Lake Syracuse, New York
Remediation Area C Cap Areas and Thicknesses
PARSONS
Q:\GIS\GIS_Lake\CAP\DS\CAP TECH DOC\RA-C_dredge_cap_111709.mxd

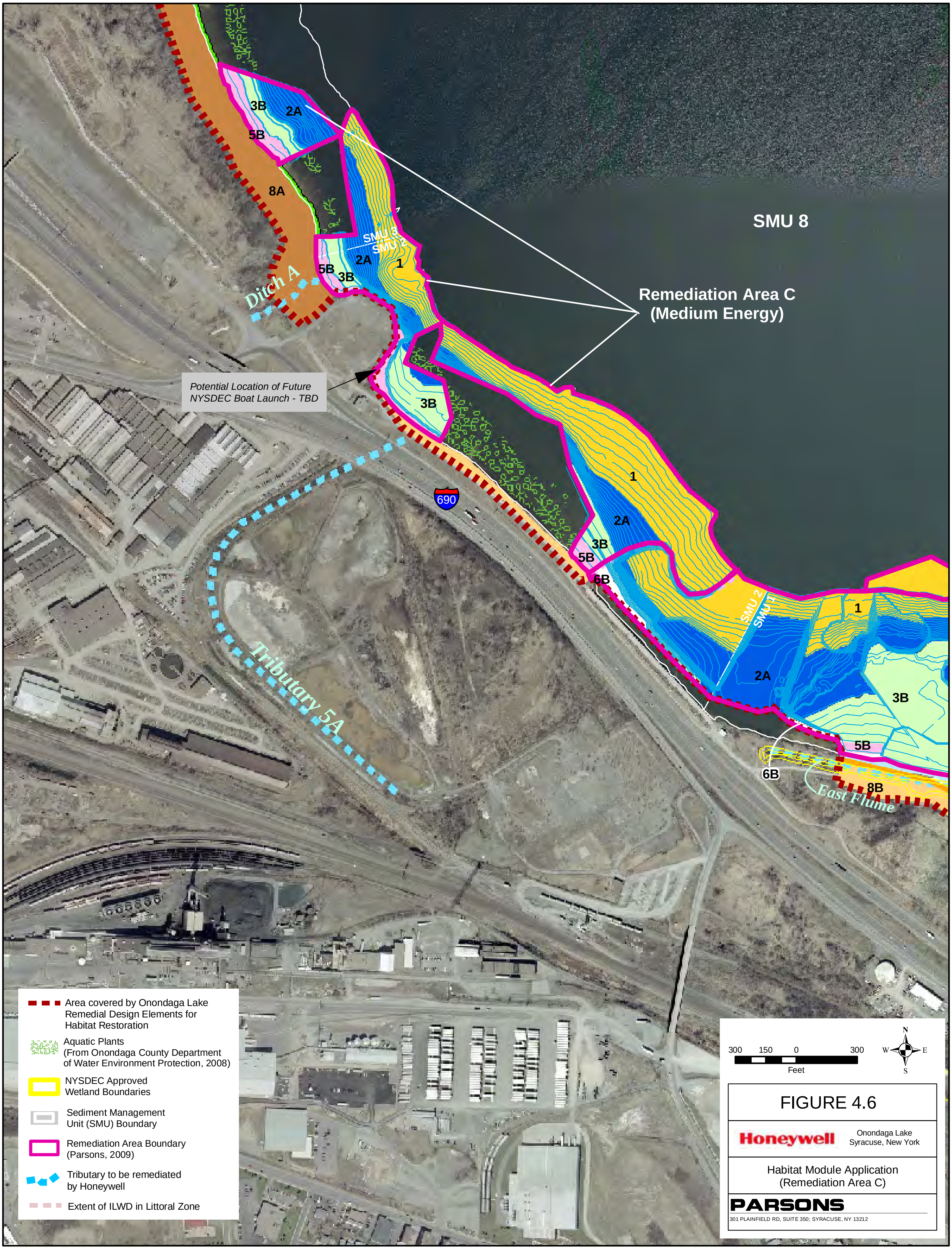
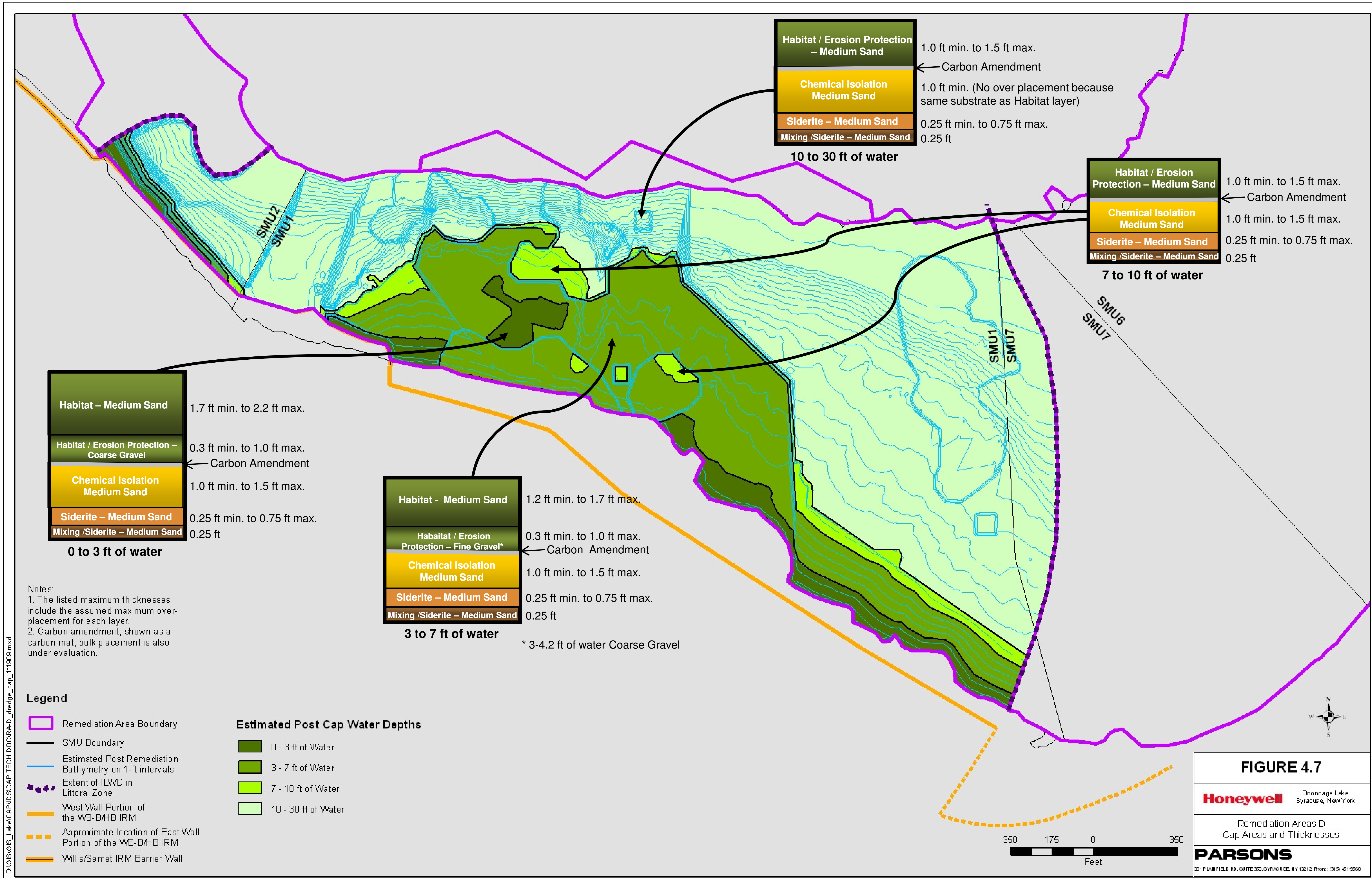
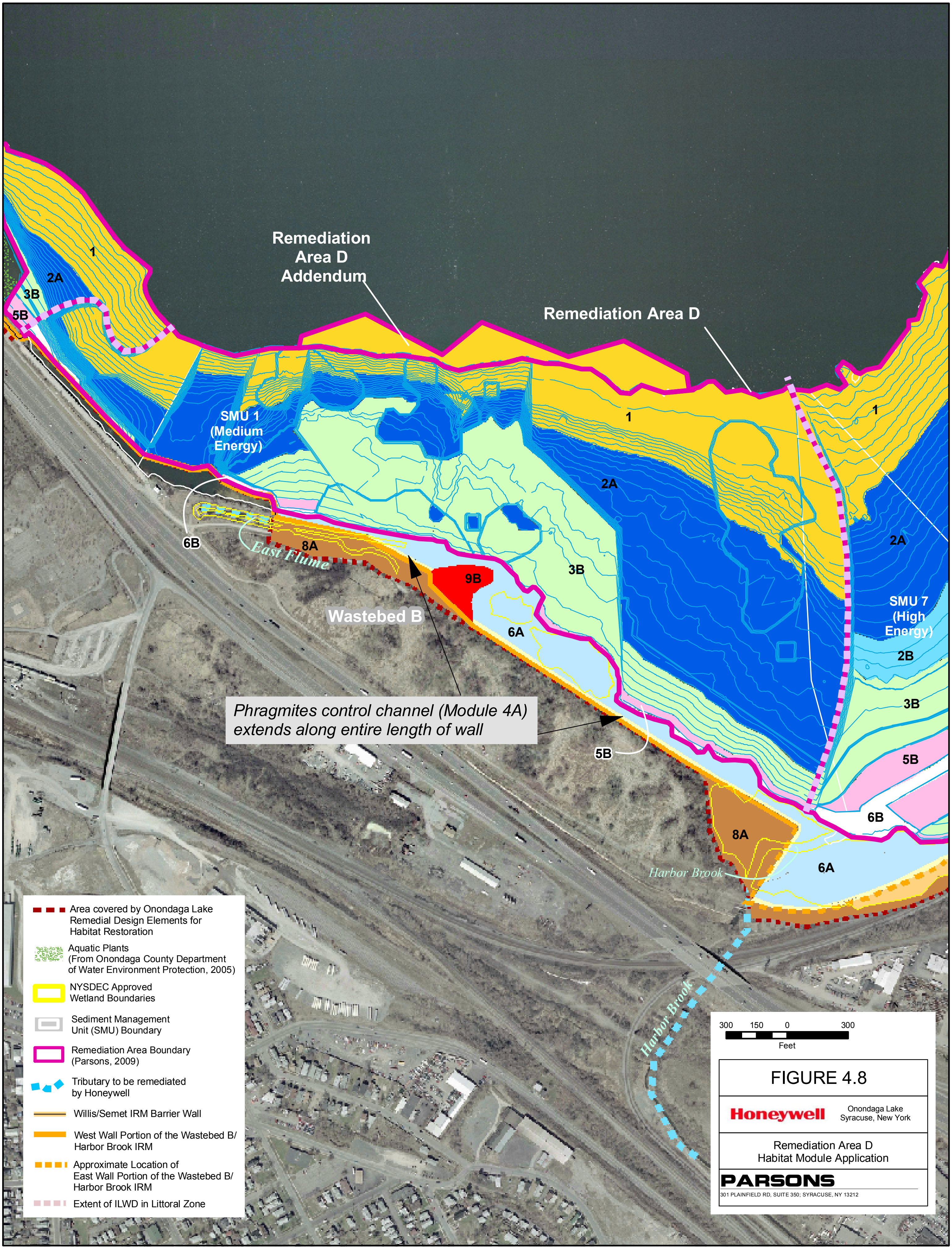


FIGURE 4.6

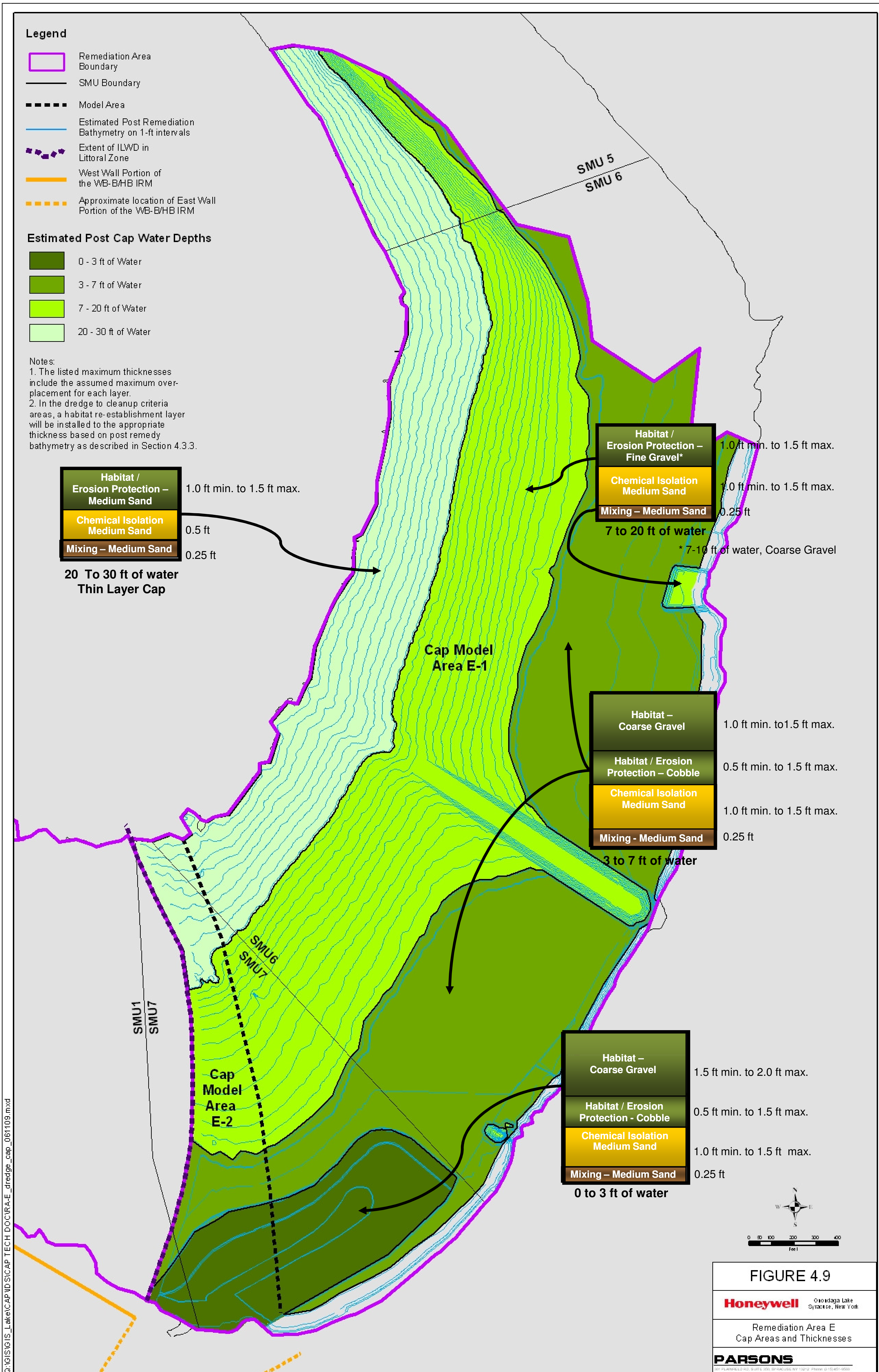
Habitat Module Application
(Remediation Area C)



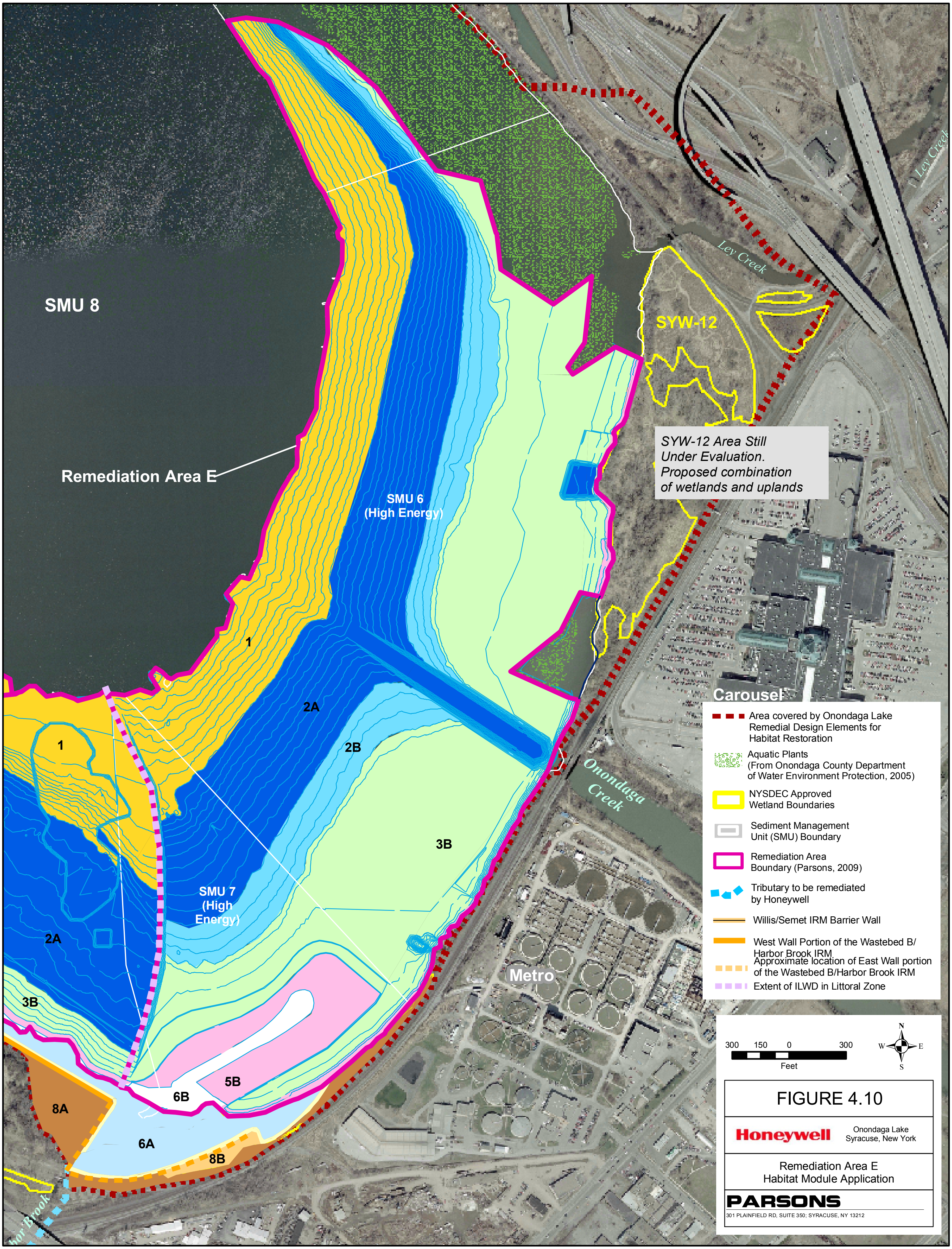
P:Hon-Syr\444576\09 Reports\9.1 Capping & Dredging…\Figures\Figure 4.7-RA-D.ppt

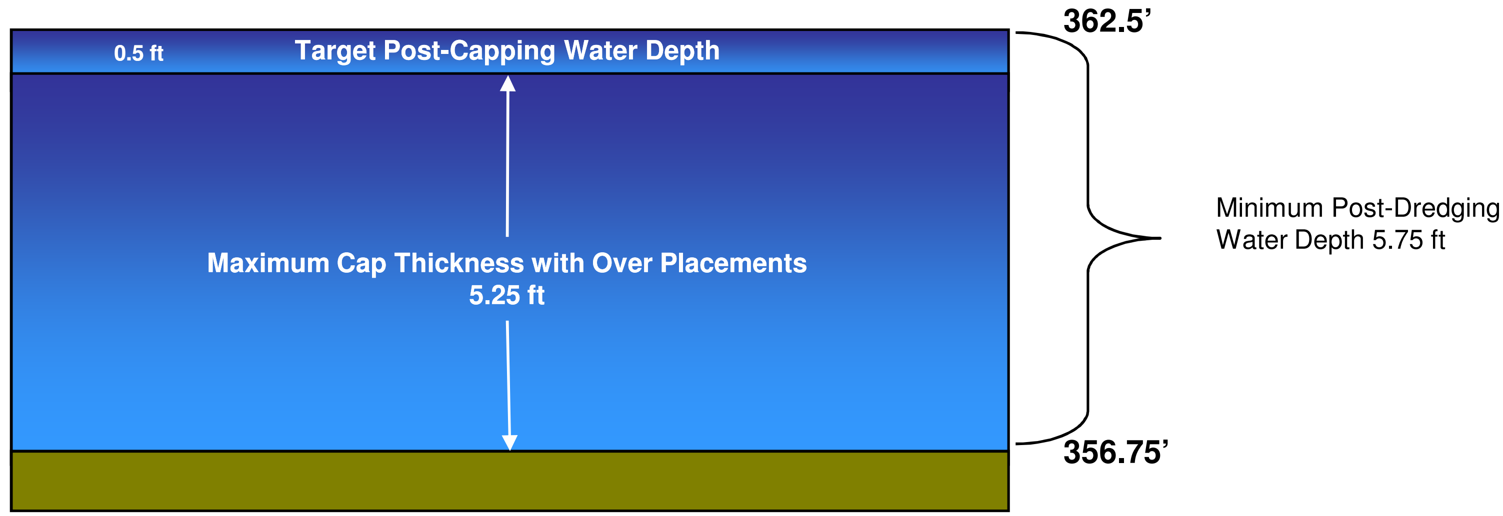


Remediation Area D Addendum
Remediation Area D
1
2A
3B
5B
SMU 1 (Medium Energy)
6B
8A
East Flume
9B
3B
Wastebed B
6A
2A
SMU 7 (High Energy)
2B
3B
5B
6B
8A
6A
Harbor Brook
Harbor Brook
Phragmites control channel (Module 4A) extends along entire length of wall
Area covered by Onondaga Lake Remedial Design Elements for Habitat Restoration
Aquatic Plants (From Onondaga County Department of Water Environment Protection, 2005)
NYSDEC Approved Wetland Boundaries
Sediment Management Unit (SMU) Boundary
Remediation Area Boundary (Parsons, 2009)
Tributary to be remediated by Honeywell
Willis/Semet IRM Barrier Wall
West Wall Portion of the Wastebed B/ Harbor Brook IRM
Approximate Location of East Wall Portion of the Wastebed B/ Harbor Brook IRM
Extent of ILWD in Littoral Zone
300 150 0 300
Feet
FIGURE 4.8
Honeywell
Onondaga Lake Syracuse, New York
Remediation Area D Habitat Module Application
PARSONS
301 PLAINFIELD RD, SUITE 350; SYRACUSE, NY 13212



P:Hon-Syr\444576\09 Reports\9.1 Capping & Dredging…\Figures\Figure 4.9-RA-E.ppt


SMU 8
Remediation Area E
SMU 6
(High Energy)
SMU 7
(High
Energy)
SYW-12
SYW-12 Area Still
Under Evaluation.
Proposed combination
of wetlands and uplands
Ley Creek
Onondaga
Creek
Carousel
Metro
1
1
2A
2A
2B
3B
3B
5B
6B
6A
8A
8B
Area covered by Onondaga Lake
Remedial Design Elements for
Habitat Restoration
Aquatic Plants
(From Onondaga County Department
of Water Environment Protection, 2005)
NYSDEC Approved
Wetland Boundaries
Sediment Management
Unit (SMU) Boundary
Remediation Area
Boundary (Parsons, 2009)
Tributary to be remediated
by Honeywell
Willis/Semet IRM Barrier Wall
West Wall Portion of the Wastebed B/
Harbor Brook IRM
Approximate location of East Wall portion
of the Wastebed B/Harbor Brook IRM
Extent of ILWD in Littoral Zone
300 150 0 300
Feet
N
W E
S
FIGURE 4.10
Honeywell
Onondaga Lake
Syracuse, New York
Remediation Area E
Habitat Module Application
PARSONS
301 PLAINFIELD RD, SUITE 350; SYRACUSE, NY 13212



Example: Remediation Area E
Habitat Module 5B (0.5-2 ft)

Cap Thickness

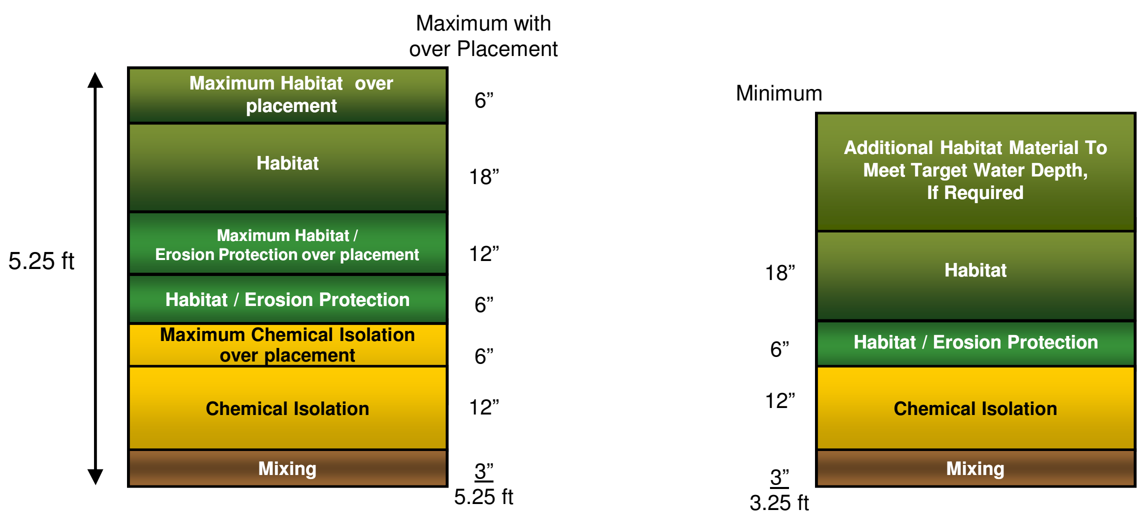


FIGURE 4.11

Honeywell — Onondaga Lake, Syracuse, New York

Example - Determination of Dredge Depth For Cap Areas In Habitat Modules 4A, 5A, 5B, 6A & 6B

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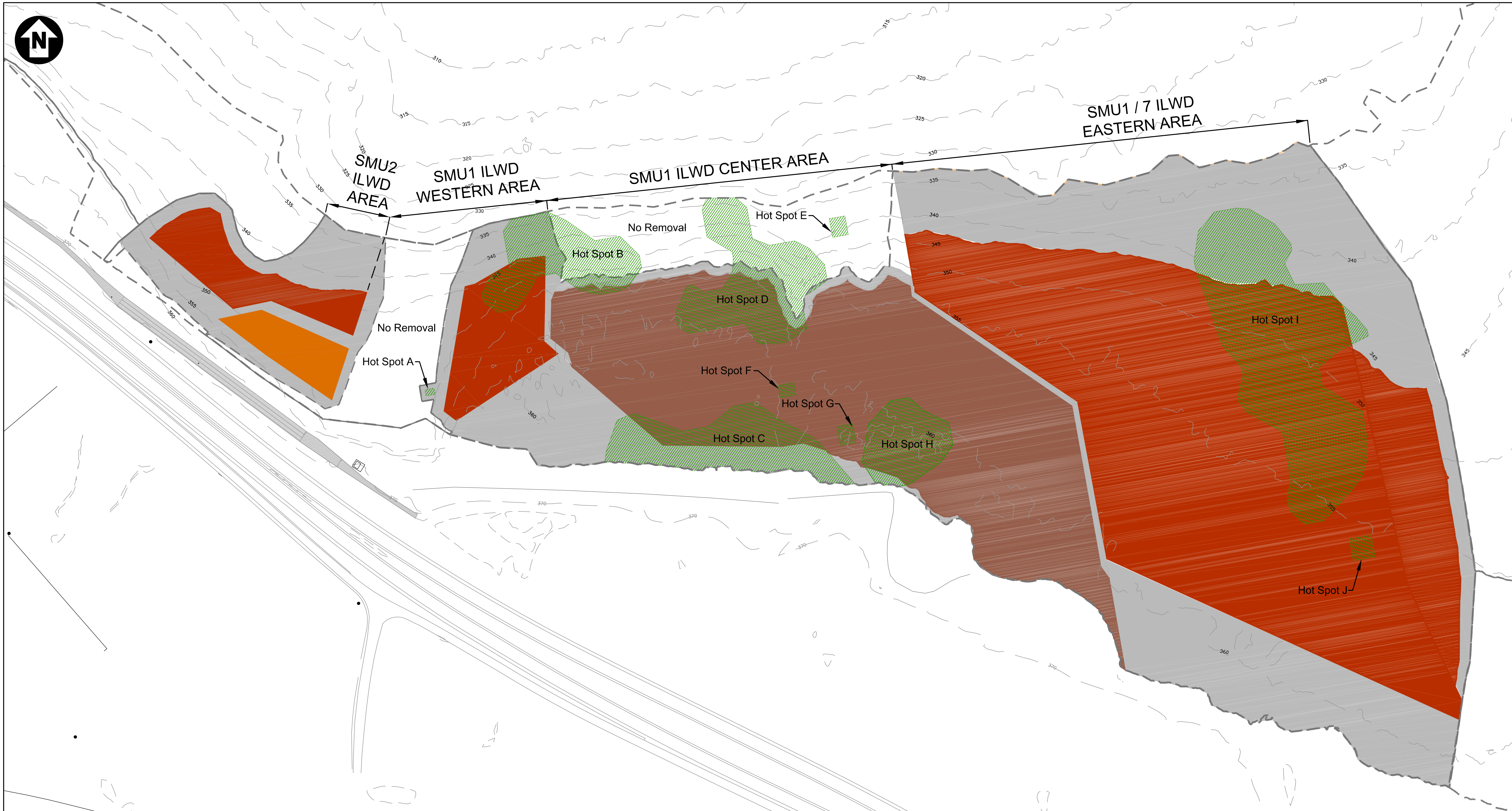
P:\Honeywell –SYR\444576\09\9.1\Figures\Figure 4.11.ppt



LEGEND:

- 2M REMOVAL DEPTH
- 3M REMOVAL DEPTH
- 5.5' REMOVAL DEPTH
- TRANSITION ZONE
- HOT SPOT

NOTES:

1. Areas designated as hot spots will be dredged one additional meter.

FIGURE 5.1

Honeywell

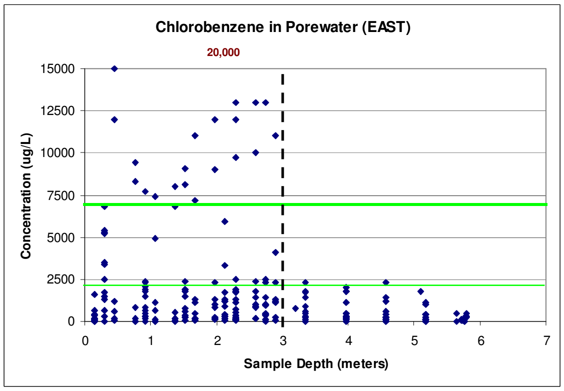
ONONDAGA LAKE
SYRACUSE, NEW YORK

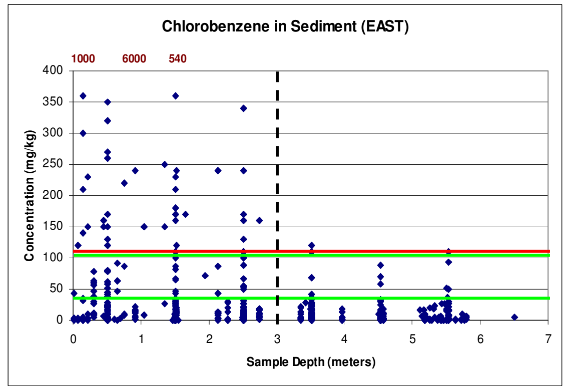
ILWD Removal Depths – 2 Meter Average Removal Plus Hot Spots

PARSONS
301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 PHONE: 315-451-9560

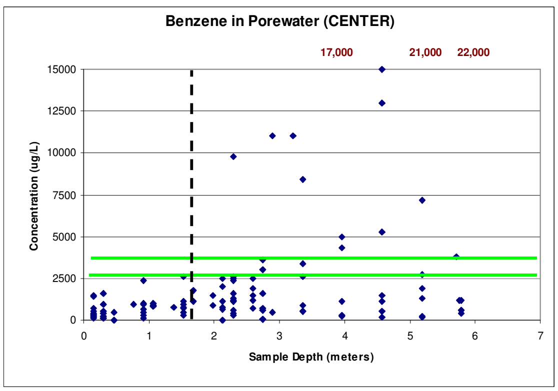
FILE NAME: P:\HONEYWELL -SYR\443582 - CAPPING\10 TECHNICAL CATEGORIES\10.1 CAD\ANCHOR\01013902-RP-02-12-4-09\FIGURE 5.1.DWG
PLOT DATE: 12/14/2009 1:01 PM PLOTTED BY: RUSSO, JILL

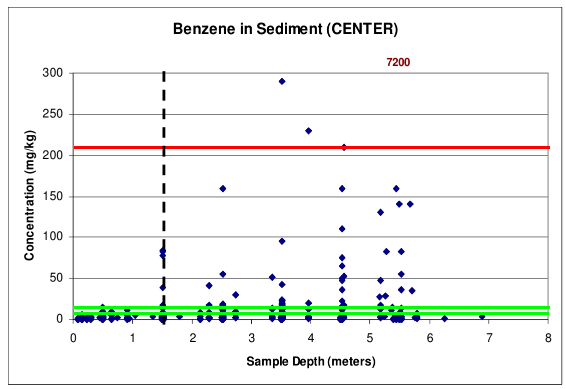
SMU1/SMU7 ILWD Eastern Area



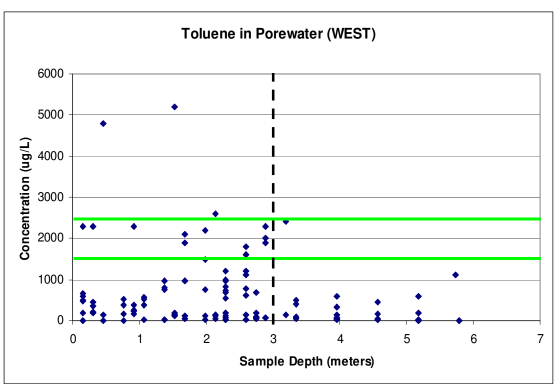


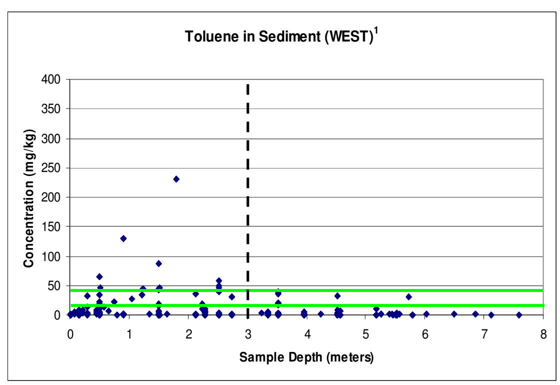
SMU1 ILWD Center Area





SMU1 ILWD Western Area





Data Presentation:

- Red lines indicate hot spot criteria for sediment as listed in the ROD.
- Dashed lines represent the proposed removal depth. This removal depth will not be achieved everywhere due to issues such as required sloping from shoreline down to the maximum removal depth. Therefore, not all data points shown above the removal depth will be removed.
- Green lines indicate 90th and 95th percentile concentrations.
- Numbers in red denote concentrations beyond the range of the scatterplots.

Notes: (1) Hot spot criteria for toluene above the range of plots.

FIGURE 5.2

Honeywell

Example ILWD Contaminant Concentration Versus Depth Plots

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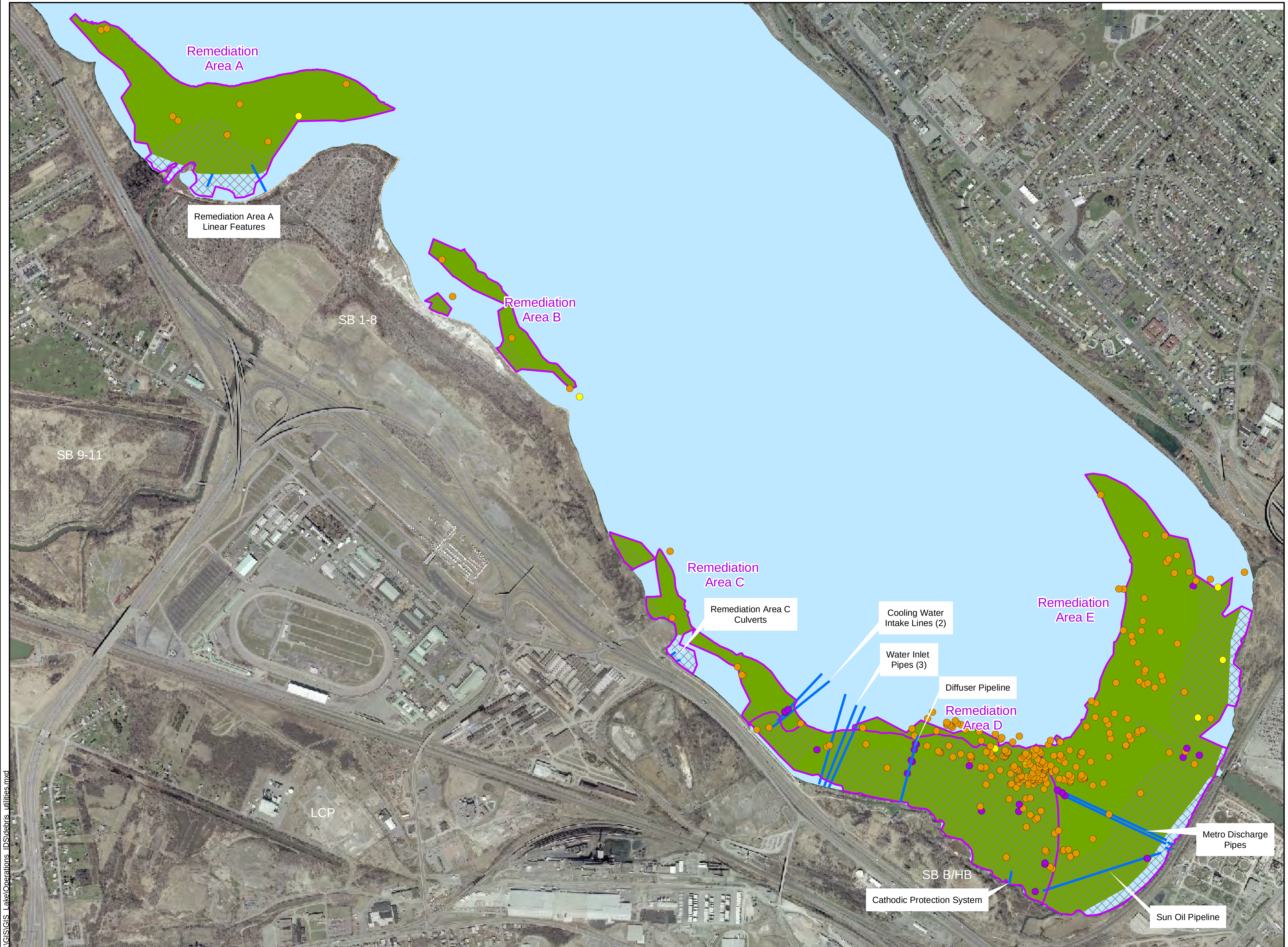

Remediation Area

Cap Area

Dredge Area

Side-scan Sonar Target

- Debris (greater than 5' in any dimension)
- Potential Wreck
- Structure

N W E S

970 485 0 970

Feet

FIGURE 6.1

Honeywell

Onondaga Lake
Syracuse, New York

Remediation Areas
Debris & Utilities

PARSONS

301 Plainfield Road, Suite 350; Syracuse, NY, 13212 Phone:(315)451-9560

APPENDIX A

REMEDIAL AREA DELINEATION

APPENDIX B

CAP MODELING

APPENDIX C

GROUNDWATER UPWELLING EVALUATION

APPENDIX D

EROSION PROTECTION LAYER / ARMOR LAYER DESIGN

APPENDIX E

CAP-INDUCED SETTLEMENT EVALUATION

E.1 CAP-INDUCED SETTLEMENT EVALUATION

E.2 CAP-INDUCED SETTLEMENT EVALUATION FOR REMEDIATION AREA D

E.1

CAP-INDUCED SETTLEMENT EVALUATION

E.2

CAP-INDUCED SETTLEMENT EVALUATION FOR REMEDIATION AREA D

APPENDIX F

DREDGING PLANS

APPENDIX G

ILWD DREDGE AREA AND DEPTH DEVELOPMENT

APPENDIX H

STABILITY EVALUATION OF REMEDIATION AREA D

H.1 SUMMARY OF SUBSURFACE STRATIGRAPHY AND MATERIAL PROPERTIES (DATA PACKAGE)

H.2 LIQUEFACTION POTENTIAL ANALYSES

H.3 STATIC SLOPE STABILITY ANALYSES

H.4 SEISMIC SLOPE STABILITY ANALYSES

H.1

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APPENDIX I

pH AMENDMENT EVALUATION

I.1

CAP pH MODEL MEMO

I.2

SIDERITE LEACHATE EVALUATION