



EXPLANATION OF SIGNIFICANT DIFFERENCES

ONONDAGA LAKE BOTTOM SUBSITE OF THE ONONDAGA LAKE SUPERFUND SITE

MODIFIED PROTECTIVE CAPS

**Towns of Geddes and Salina, Villages of Solvay and Liverpool, and City of Syracuse,
Onondaga County, New York**

Onondaga County

Site No. 734030

March 2018

1.0 INTRODUCTION

If the need for a significant change to a component of an action is identified after the selection of a remedy in a Record of Decision (ROD), Section 117(c) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), and Section 300.435(c)(2)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) require the publishing of an Explanation of Significant Differences (ESD) that sets forth the reasons such a change is necessary.

In July 2005, the New York State Department of Environmental Conservation (NYSDEC) and U.S. Environmental Protection Agency (EPA), in consultation with the New York State Department of Health (NYSDOH), issued a ROD that documented the selection of a remedy for the Onondaga Lake Bottom Subsite (Lake Bottom Subsite) of the Onondaga Lake Superfund Site (Site) (NYSDEC and EPA, 2005). A key component of that remedy is the dredging and capping of contaminated sediments/waste from portions of the littoral zone (water depth less than 30 feet) and monitored natural recovery (MNR) and thin-layer capping in portions of the profundal zone (water depth greater than 30 feet). The Onondaga Lake area is shown in Figure 1.

This is the third ESD issued for the Onondaga Lake Bottom Subsite since the ROD (prior ESDs were issued in 2006 and 2014). This ESD documents the basis for the design and construction of a modified erosion-resistant cap (MERC) in the vicinity of the Onondaga County Metropolitan Wastewater Treatment Plant (Metro) deep water outfall pipeline (Figure 2), as well as modified protective caps (MPCs) in portions of Remediation Areas (RAs) B, C, and D (Figures 3 through 8). These modified caps are the subject of this ESD, as they have minimum thicknesses less than the minimum cap layer thicknesses specified in the ROD (*i.e.*, the original remedy required a minimum of 12 inches for the chemical isolation layer and minimum of 12 inches for the habitat layer, not including the underlying “mixing” layer). As further discussed in Sections 3.1 and 3.2, below, the total area above and immediately adjacent to the Metro outfall pipeline that was not

dredged or capped to protect the integrity of the pipeline is approximately 1.9 acres, and the area where the MERC was placed in the vicinity of the outfall pipeline is approximately 4.3 acres.

As further discussed in Sections 3.3 and 3.4, below, revisions to the cap design were needed in portions of RAs B, C, and D where geotechnical investigations completed subsequent to the Final Design (Parsons and Anchor QEA, 2012) identified soft (low strength) sediment on relatively steep slopes. In addition, small areas of disturbances of the cap occurred in RA-C during cap construction in September 2012 and in RA-D in November 2014 (see Figure 3). These sediments are softer than what was identified during the pre-design investigation (PDI) and, therefore, design revisions were required in these and other areas (representing approximately 29 acres of the 418 acres of capped areas in the littoral zone¹). In addition, following the collection of data subsequent to the cap disturbances, thin-layer caps and amended caps were required in approximately 7 acres in the profundal zone (Sediment Management Unit [SMU] 8) adjacent to RA-C (where a thin-layer cap was not included in the Final Design) and 17 acres adjacent to RA-D. As further discussed in Section 3, the basis of the designs for these MPCs was to be protective for more than 1,000 years, consistent with the evaluation timeframe used in the Final Design (Parsons and Anchor QEA, 2012) and specified in the ROD. Design revisions were developed for five areas of the Lake as shown in Figure 3. These MPC design revisions were reviewed and approved by NYSDEC prior to construction of the MPCs in 2015 and 2016. Table 1 provides a summary of the MPC acreages in each of these areas.

As discussed in the Draft Onondaga Lake Monitoring and Maintenance Plan (OLMMP) (Parsons, 2017), monitoring and maintenance will be conducted in all capped areas, including the MERC and MPC areas addressed in this ESD, to ensure the effectiveness of the remedy in meeting the related goals specified in the 2005 ROD. NYSDEC and EPA believe that the design revisions in conjunction with the requirements for long-term monitoring and maintenance of the remedy complies with the remediation goals in the ROD.

This ESD provides the basis for the noted modifications to the remedy, and is a summary of what can be found in greater detail in the various design addendums and other supporting documents. This ESD and the supporting documents are available in the following repositories:

Onondaga County Public Library
Syracuse Branch at the Galleries
447 South Salina Street
Syracuse, NY 13202
Telephone: 315-435-1900

615 Erie Boulevard West
Syracuse, NY 13204
Telephone: 315-426-7400
Please call for an appointment

NYSDEC, Syracuse Office

Atlantic States Legal Foundation
658 West Onondaga Street

¹ The Final Design (Parsons and Anchor QEA, 2012) included an isolation cap in approximately 430 acres of the littoral zone of the Lake and select adjacent wetland areas as well as approximately 27 acres of thin-layer cap in SMU 8 (deep water area in the profundal zone). As discussed in the second ESD for the RA-E Shoreline Area and Nitrate Addition (NYSDEC and USEPA, 2014), approximately 10 acres of the near-shore area along the RA-E shoreline were not dredged or capped because of stability concerns for the shoreline and active railroad lines. In addition, as noted above, a cap was not placed in approximately 1.9 acres above and immediately adjacent to the Metro outfall pipeline. Therefore, an estimate of the area capped in the littoral zone is 418 acres.

Syracuse, NY 13204
Telephone: 315-475-1170
Please call for an appointment.

625 Broadway
Albany, NY 12233
Telephone: 518-402-9676
Please call for an appointment

Solvay Public Library
615 Woods Road
Solvay, NY 13209
Telephone: 315-468-2441

NYSDEC, Central Office

Information related to the Site can also be viewed electronically on the NYSDEC web site at <http://www.dec.ny.gov/chemical/37558.html>.

NYSDEC and EPA, in consultation with the New York State Department of Health (NYSDOH), have determined that these revisions do not constitute a fundamental change to the remedy selected in the 2005 ROD. The remedy, with these revisions, will be protective of human health and the environment and will comply with the federal and State requirements identified in the ROD.

2.0 SITE DESCRIPTION, ORIGINAL REMEDY, AND REMEDY MODIFICATIONS

On June 23, 1989, Onondaga Lake was added to the New York State Registry of Inactive Hazardous Waste Disposal Sites. On December 16, 1994, Onondaga Lake and tributaries and areas upland that contribute or have contributed contamination to the lake system were added to the EPA National Priorities List (NPL). The NPL listing means that the lake system is among the nation's highest priorities for investigation and response under CERCLA (more commonly known as Superfund) for sites where there has been a release of hazardous substances, pollutants, or contaminants. On July 1, 2005, NYSDEC and EPA issued a ROD documenting the selection of a remedy for the Lake Bottom Subsite. A key component of that selected remedy was the dredging of as much as an estimated 2,653,000 cubic yards (cy) of contaminated sediments/waste from the littoral zone in 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 reestablish the littoral zone habitat. The selected remedy, as specified in the ROD, also includes the placement of an isolation cap over an estimated 425 acres of SMUs 1 through 7 as well as a thin-layer cap over an estimated 154 acres of the profundal zone (SMU 8).

Following completion of a multiphase PDI and remedial design process, the Final Design for Capping, Dredging, Habitat, and Profundal Zone (Sediment Management Unit 8) was submitted in March 2012 (with revision of Appendix I in April 2012) and approved by NYSDEC in May 2012. The Final Design (Parsons and Anchor QEA, 2012) included dredging of approximately 2.2 million cy of sediments and placement of a full thickness cap (*i.e.*, with a mixing layer and minimum 12 inches chemical isolation layer and minimum 12-inch habitat/erosion protection layer) in approximately 430 acres of the littoral zone of the Lake and select adjacent wetland

areas as well as approximately 27 acres of thin-layer cap in SMU 8 (deep water area in the profundal zone).

An ESD was issued by NYSDEC and EPA in December 2006 to modify the 2005 ROD. Subsequent to the issuance of the ROD, the PDI was conducted to, among other things, identify the extent of pooled NAPLs near the shoreline adjacent to Interstate 690 (I-690) and to characterize the subsurface conditions. Based on these investigations, it was determined that the overall extent of pooled NAPLs beneath the Lake bottom in this area was significantly smaller than was anticipated. Based on the new data and stability evaluations, it was determined that the most appropriate manner in which to address NAPLs in the area was to locate the Willis/Semet Interim Remedial Measure (IRM) barrier wall off-shore immediately beyond the furthest extent of pooled NAPLs within the Lake and to install additional NAPLs recovery wells (to supplement the existing NAPL recovery system) between the barrier wall and the former shoreline. This response eliminated the need for deep dredging to address pooled NAPLs in this area and addressed the geotechnical stability concerns, while being protective of public health and the environment. The NAPLs are now completely isolated from the Lake. The additional NAPL recovery wells were installed behind the wall as part of the Willis/Semet IRM and on the northwestern area of the Wastebed B/Harbor Brook subsite to enhance the recovery of NAPLs present in the subsurface. Recovered NAPLs have been treated or disposed of off-Site. To compensate for the loss of aquatic habitat resulting from the placement of the barrier wall (approximately 2.3 acres), a pre-existing upland area along the Wastebeds 1 through 8 shoreline adjacent to Onondaga Lake has been converted to new aquatic habitat.

A second ESD was issued by NYSDEC and EPA in August 2014 related to the 2005 ROD. The remedy selected in the 2005 ROD was based largely on data collected as part of the remedial investigation for the Lake Bottom Subsite. Subsequent to the issuance of the ROD, and as part of the remedial design, a detailed geotechnical analysis was conducted at the south end of the Lake in Remediation Area E, immediately adjacent to the three active railroad lines (see Figure 3). The geotechnical analysis revealed that dredging in the vicinity of this shoreline area could result in shoreline and railroad line instability as a result of the potential shifting of the ground under the railroad lines during sediment removal. Placement of an isolation cap without prior dredging would not be an appropriate approach because it would result in the loss of Lake surface area because of the shallow water depths in this area (ranging from 0 to 3 feet). The 2014 ESD established a buffer zone where no dredging or capping occurred as the best means to prevent shoreline and railroad line instability. The buffer zone varies from 130 to 200 feet from the shoreline and encompasses an area of approximately 10 acres (approximately 2% of the total area which was to be dredged and/or capped as part of the overall remedy). Additional measures to improve habitat and promote natural recovery in this area were included in the revised approach. These measures included a wave damper along a portion of the buffer zone to reduce wave energy along the shoreline and active planting of, primarily, emergent wetland species in the buffer area. Following completion of a three-year pilot study, the 2014 ESD also documented the selection of nitrate addition in the deep Lake water instead of oxygenation in an effort to reduce the formation of methylmercury.

As documented in the Construction Completion Report (Anchor QEA and Parsons, 2017), 2.15 million cy of sediment were removed from the Lake across 215 acres from 2012 through 2014. In addition, approximately 3.1 million cy of cap material were placed across 475 acres of the Lake bottom from 2012 through 2016. Construction of the MERC and MPCs discussed in this ESD has been completed and documented in the Construction Completion Report.

3.0 DESCRIPTION OF SIGNIFICANT DIFFERENCES AND THE BASIS FOR THOSE DIFFERENCES

3.1 Metro Outfall Vicinity – New Information

The Metro outfall pipeline extends from the shoreline through the south corner of RA-E and into RA-D. It is a 60-inch inner diameter pipe of reinforced concrete construction with 6-inch thick walls for a total outer diameter of 72 inches. According to the 1922 design drawings for this outfall, approximately 1,350 feet of the pipeline lies within a channel that was dredged as part of the construction. The final 900 feet is supported with timber frames spaced every 20 feet which are pile-supported to an unknown depth. The current condition of the outfall is unknown. Most of the pipeline is buried beneath sediment that has accumulated since its construction.

To avoid having an adverse effect on the outfall, the Final Design (Parsons and Anchor QEA, 2012) included a dredging offset of 25 feet from the outfall and assumed a cap would be placed over the outfall pipeline. The Final Design also indicated that the remedial approach in the vicinity of this outfall would be re-evaluated based on additional consultation with Onondaga County. Based on discussions with Onondaga County subsequent to the Final Design, it was determined that the pipeline's integrity must remain intact, as this discharge is active during Metro high-flow conditions. Placing capping material on top of the pipeline could put stress on the pipe, as well as result in settlement of the underlying sediment, which could result in impacts to the pipeline. Therefore, a revised dredging and capping design was developed for this area.

3.2 Metro Outfall Vicinity – Remedy Modification and Comparison of Changes with the Original Remedy

Remedy Modification

A Design Addendum (Parson and Anchor QEA, 2014) for this area was submitted in October 2014 and approved by NYSDEC in October 2014. The revised remedial approach in the vicinity of the deep water outfall pipeline is shown in Figure 2 and includes the following:

- No dredging or capping above the 6-foot diameter pipeline and within 25 feet of the pipeline on each side (total width of 56 feet).
- A MERC in the zone between 25 feet and 100 feet of the pipeline in areas where there is minimal or no dredging prior to capping. This cap included 6 inches of gravely sand amended with granular activated carbon (GAC), which is the maximum cap thickness and coarsest substrate that can be applied in this area based on cap stability considerations (as documented in Attachment 1 of Parsons and Anchor QEA, 2014). This will help reduce scour and resuspension of underlying sediments because of wind/wave action, but it may not be coarse enough to meet the predicted erosive force of a 100-year storm event, which is the design basis for the surrounding area. Because of the reduced cap thickness, the cap surface elevation in this area will be approximately 2 feet lower than the surrounding cap elevation, which will reduce erosive forces in this area.

- Revised cap chemical isolation modeling. This modeling was completed based on a cap thickness of 6 inches, resulting in higher GAC application rates than for the full thickness cap specified in the Final Design (2012). The revised cap modeling in this area is summarized below and details of the modeling are provided in Attachment 2 of Parsons and Anchor QEA, 2014.
- Cap transitions from the modified cap to the full thickness cap in areas where the MERC was placed, between approximately 100 to 150 feet of the pipeline, with incremental increases in cap thickness to avoid significant differential cap loading in the transition zone.

Comparison of Changes with the Original Remedy

As noted above, cap stability and settlement evaluations led to the conclusion that a full thickness multi-layer cap (*i.e.*, with a mixing layer and minimum 12-inch chemical isolation layer and minimum 12-inch habitat/erosion protection layer) could not be placed in this area.

The total area adjacent to the pipeline that was not dredged or capped is approximately 1.9 acres. The area where the MERC was placed is approximately 4.3 acres.

For the full thickness multilayer caps included in the Final Design (Parsons and Anchor QEA, 2012), which include a habitat/erosion protection layer (sand, gravel, or topsoil substrate without GAC) above the chemical isolation layer (sand with, in most areas, GAC),² compliance with the cap performance criteria (*i.e.*, probable effects concentrations [PECs] for 23 chemical parameters of interest [CPOIs] and sediment screening criteria [SSCs] for benzene, toluene, and phenol) was assessed at the bottom of the minimum habitat layer (*i.e.*, 12 inches from the top of the cap and above the isolation layer) and the bottom of the bioturbation zone (*i.e.*, 6 inches from the top of the cap). These compliance points were used in the modeling in the Final Design (see Appendix B of Parsons and Anchor QEA, 2012) to determine final thickness and GAC dosages in each of the cap model areas.

As the MERC includes 6 inches of sand and GAC in a single layer (*i.e.*, an amended mono-layer cap) and does not include a dedicated (*i.e.*, separate) habitat layer above the amended layer, compliance with the cap performance criteria was assessed for modeling/design purposes at the midpoint of the amended cap layer because the compliance points used in the final design are not applicable for this configuration.

As the compliance point for this modified cap (described above) is within the GAC-amended sand layer, it is not appropriate to assess compliance based on solid-phase concentrations because that would include contaminants adsorbed to the GAC. To address this, PEC-equivalent porewater values corresponding to the solid-phase (dry weight) PEC values presented in the ROD and used as cap performance criteria in the Final Design were developed based on

² In portions of RA-A and in RAs B, C, and D, the full thickness caps included in the Final Design include a layer of siderite mixed with sand below the sand/GAC isolation layer. Siderite, a naturally-occurring mineral that neutralizes high pH, was included in the multi-layer caps in these areas where elevated pH in underlying sediments could impede long-term microbial degradation of contaminants within the isolation layer. In these areas, modeling was performed in the Final Design to determine siderite dosages. In RA-E, where the MERC is located, siderite was not included in the cap, as the pH levels of the sediments are not elevated.

chemical-specific partition coefficients and the habitat restoration layer total organic carbon (TOC) value of 4.6 percent used for these areas for the final design. Table 2 lists the PEC-equivalent porewater value for each chemical. For mercury, the values vary by model area given that partition coefficients for this chemical varied by area in the Final Design. This table also includes the porewater-based NYSDEC sediment screening criteria for benzene, toluene and phenol. These values were used as the cap performance criteria for both the MERC and mono-layer MPCs (further discussed below in Section 3.4).

The cap modeling approach and input parameters (*e.g.*, underlying porewater concentrations, groundwater upwelling velocities) used for this design addendum were consistent with the final design for the corresponding area. The GAC dosages within this 6-inch amended layer of the MERC were increased until the model-predicted porewater concentrations at the midpoint of the amended layer of the modified cap were all less than the PEC-equivalent porewater values for over 1,000 years. As noted above, the modeling of this 6-inch thick amended layer resulted in higher GAC application rates (ranging from 0.1 to 0.7 pounds per square foot [lb/sf]) than the rates specified in the Final Design for these areas (ranging from 0 to 0.3 lb/sf).

Construction quality assurance/quality control procedures were developed and implemented for the full thickness caps, as documented in the Construction Quality Assurance Plan (Anchor QEA and Parsons, 2012), as well as for the MERC and MPCs as documented in approved Field Change Forms (included in the Capping and Dredging Construction Completion Report) to ensure the various cap types were constructed consistent with the designs.

In addition, as presented in the Long-Term Cap Monitoring Work Plan included as Appendix D of the OLMMP (Parsons, 2017), post-construction physical and chemical monitoring will be conducted in all capped areas (monitoring began in 2017), including the MERC and MPC areas addressed in this ESD, to ensure the effectiveness of the remedy in meeting the related goals specified in the 2005 ROD.

3.3 Modified Protective Caps – New Information

As noted above in Section 2.0, the Final Design (Parsons and Anchor QEA, 2012) included placement of a full thickness (and ROD compliant) cap (*i.e.*, with a mixing layer and minimum 12-inch chemical isolation layer and minimum 12-inch habitat/erosion protection layer) in approximately 430 acres of the littoral zone of the Lake and select adjacent wetland areas as well as approximately 27 acres of thin-layer cap in SMU 8 (deep water area in the profundal zone). Revisions to the cap design were needed in portions of RAs B, C, and D where geotechnical investigations completed subsequent to the Final Design (Parsons and Anchor QEA, 2012) identified soft (low strength) sediment on relatively steep slopes. In addition, relatively small areas of disturbances of the cap occurred in RA-C during cap construction in September 2012 and in RA-D in November 2014. These sediments are softer than was identified during the PDI, and, therefore, design revisions were required in these areas.

The geotechnical investigations completed prior to the ROD and during the PDI, along with the associated laboratory testing results and bathymetric surveys, formed the basis for understanding the general site conditions to support the final 2012 cap design on a Lake-wide basis. The data available at the time of the Final Design indicated that a surficial layer of soft black silt was present in portions of the Site. Subsequent to the Final Design, additional investigations were conducted during the construction phase in many of the RAs to further refine the understanding

of the subsurface stratigraphy and geotechnical properties, with particular focus on the soft sediments. These investigations included the collection of sediment cores, in situ vane shear tests, cone penetration tests, full flow penetrometer tests, and laboratory index property tests.

As further discussed in the “Development of Geotechnical Design Parameters for Lakebed Sediments in Onondaga Lake Capping Areas” (Geosyntec, 2015), the additional investigations conducted during the construction phase defined the extent of the soft sediment. In addition, the engineering properties of the soft black sediment indicated a lower, undrained shear strength than measured during the PDI. It was concluded that the extent of soft sediments in portions of the remediation areas was sufficiently defined through these additional investigations, particularly in deep water areas, and that the slope stability modeling methods used for the modified protective cap designs would be appropriate.

In addition to the collection of geotechnical data, chemical characterization sampling of surface sediments was completed in 2014 and 2015 (Honeywell, 2015) subsequent to the cap disturbances in 2012 and 2014. Movement of the cap material and underlying and adjacent sediment in these small areas following cap placement necessitated development of a revised remedial approach for these areas. The sampling was conducted to better understand existing conditions in order to redefine the remedial extent and develop a revised remedial approach to be protective consistent with the intent of the ROD and Final Design.

Options were evaluated for maintaining the original cap thickness in select soft sediment areas. Engineering methods to improve stability, such as toe berms and keyways, were considered. However, the critical slip surfaces are related to multiple, localized surface irregularities and localized steep areas rather than a single large slip surface that could potentially be mitigated using methods such as toe berms and keyways. Therefore, implementation of these methods was determined to not be effective for these soft sediment areas. Other methods, such as additional dredging, slope redesign or fortification of the soft sediments (*e.g.*, in situ solidification/stabilization) in these areas were determined not to be feasible.

3.4 Modified Protective Caps – Remedy Modification and Comparison of Changes with the Original Remedy

Cap Requirements Based on 2005 ROD and 2012 Final Design

As noted above, the ROD specified minimum thicknesses of 12 inches for the chemical isolation layer and 12 inches for the habitat layer, as well as an underlying “mixing” layer. The chemical isolation layer component of the cap envisioned in the ROD was assumed to be sand only, and cap modeling conducted at that time (as documented in the Feasibility Study [FS] [Parsons, 2004]) resulted in an estimated cap thicknesses assuming biodegradation would occur within the cap. The estimated cap thicknesses presented in the “Technologies, Isolation Capping” section of the ROD were based on modeling conducted in the FS for each SMU. It was also noted in the ROD that “during the remedial design the actual thickness of the chemical isolation layer will be determined, based on additional sediment sampling and additional cap modeling.” Based on PDI data and biological degradation bench testing, it was determined during the design phase (post-ROD) that activated carbon should be mixed with the sand used for construction of the chemical isolation layer to improve sorption of contaminants within the cap and help ensure long-term effectiveness in certain areas. Site-specific bench-scale testing with GAC and subsequent modeling demonstrated that activated carbon will effectively adsorb the various dissolved organic contaminants, allowing development of a cap design to be effective for 1,000

years or longer. In addition, siderite, a naturally occurring mineral that neutralizes high pH, has been added in areas where elevated pH in underlying sediments could impede long-term microbial degradation of contaminants within the isolation layer.

Thus, with the inclusion of the siderite and GAC amendments in the isolation layer of the cap, which were not assumed in the ROD, the design criterion of a minimum 12-inch sand isolation layer is not needed to ensure that the isolation layer design achieves the cap performance criteria since the protectiveness is primarily driven by the GAC dosage. However, the caps in the Final Design included chemical isolation layers with a minimum thickness of 12 inches with the exception of portions of the caps in the 20 to 30-foot zone in RAs A and E with chemical isolation layers with a minimum thickness of 6 inches. The option of a chemical isolation layer less than 12 inches at these water depths was contemplated in the ROD.

The ROD also states that the habitat restoration layer above the chemical isolation layer in the littoral zone would be a minimum of 12 inches thick and that the specific thicknesses and types of substrate material to be used for the habitat layer would be determined in the comprehensive Lakewide habitat restoration plan. Based on this habitat plan, the required thickness of the habitat layer, as specified in the 2012 Final Design, ranges from 12 inches to 24 inches based on water depth.

Remedy Modifications

Design revisions were developed for the MPCs in five areas of the Lake as shown in Figure 3. These design revisions were reviewed and approved by NYSDEC prior to construction of the MPCs in 2015 and 2016. Table 1 provides a summary of the MPC acreages and cap types in each of these areas.

A summary of the design revisions for each of the five MPC areas is provided below.

- **RA-B-1:** As shown in Figure 4 and presented in Table 1, approximately 6 acres of the total MPC area in RA-B (11.3 acres) consist of a multi-layer cap with a minimum 12-inch habitat/erosion protection layer; approximately 5.1 acres of this area has a reduced thickness isolation layer as compared to the ROD minimum of 12 inches.³ An additional 0.7 acres consist of a multi-layer cap with a minimum 6-inch habitat/erosion protection layer and a reduced

³ For the Final Design (Parsons and Anchor QEA, 2012), the minimum requirement set forth in the ROD of 12 inches for the chemical isolation layer was addressed for these areas by inclusion of a minimum of 9 inches of sand/GAC above a 6-inch sand/siderite layer (of which the lower 3 inches was considered the mixing layer and not included in the model thickness and the upper 3 inches was considered part of the isolation layer and was included in the model thickness). Therefore, multi-layer MPCs that have a minimum of 9 inches of sand/GAC above a 6-inch sand/siderite layer are considered to be consistent with the Final Design and compliant with the ROD requirements for the inclusion of a mixing layer (at the bottom of the cap) and 12-inch minimum chemical isolation layer (above the mixing layer). This would include approximately 0.9 acres of the multi-layer MPCs in RA-B-1 (0.18 acres in RA-B-1D less than 4 ft water depth, 0.34 acres in RA-B-1E less than 4 ft water depth, and 0.4 acres in RA-B-1E in 4 to 10 ft water depth; see Figure 4) and approximately 0.3 acres of the multi-layer MPCs in RA-C-2 (0.26 acres in RA-C-2A less than 4 ft water depth; see Figure 6). These areas are considered to be MPCs as the revised minimum thickness of the habitat/erosion protection layer (12 inches) is less than the minimum thickness of the habitat/erosion protection layer for the corresponding area specified in the Final Design (*i.e.*, 24 inches in water depths of 0 to 3 feet, and 18 inches in water depths of 3 to 7 feet).

thickness isolation layer (less than the minimum of 12 inches). The remaining 4.6 acres consist of mono-layer amended caps of varying average thicknesses ranging from 2 to 10 inches.

- **RA-C-1:** As shown in Figure 5 and presented in Table 1, approximately 0.7 acres of the total MPC area in the littoral zone in this subarea (2.5 acres) consist of a multi-layer cap with a minimum 9-inch habitat/erosion protection layer and a reduced thickness isolation layer (less than the minimum of 12 inches). An additional 0.5 acres consist of a mono-layer amended cap overlain by a thin layer of sand as well as 1.3 acres of direct application of GAC placed with a minimal amount of sand in areas where some cap material had been placed in 2012. Note that sand was mixed with GAC in the areas designated as direct application of GAC to facilitate GAC placement. As noted in Section 3.3, the cap disturbance in 2012 in RA-C impacted the adjacent SMU-8 area. Based on additional data and stability analyses, the MPC approach for the SMU-8 area adjacent to RA-C consists of 0.7 acres of mono-layer amended cap as a transition from the cap in the littoral zone, 1.1 acres of direct application of GAC with a minimal amount of sand, and 5.6 acres of thin-layer sand (unamended) cap (4.5-inch average thickness), for a total of 7.4 acres of cap material in SMU 8 in this area.

- **RA-C-2:** As shown in Figure 6 and presented in Table 1, approximately 1.7 acres of the total MPC area in this subarea (3.7 acres) consist of a multi-layer cap with a minimum 12-inch habitat/erosion protection layer; approximately 1.4 acres of the 1.7-acre area has a reduced thickness isolation layer as compared to the ROD mandated minimum of 12 inches.⁴ An additional 0.5 acres consist of a multi-layer cap with a minimum 10-inch habitat/erosion protection layer and a reduced thickness isolation layer (less than minimum of 12 inches). Approximately 0.6 acres consist of mono-layer amended caps of varying average thicknesses. An additional 0.7 acres consist of a mono-layer amended cap (average 9 inches) overlain by a thin layer of sand, as well as 0.3 acres of direct application of GAC/siderite placed with a minimal amount of sand in the near-shore area.

- **RA-D-1:** As shown in Figure 7 and presented in Table 1, approximately 7.6 acres of the total MPC area in the deep part of the littoral zone (identified as the “Addendum Area” in the Final Design) in this subarea (8.8 acres) include a multi-layer cap with a minimum 12-inch habitat/erosion protection layer and a reduced thickness isolation layer (less than minimum of 12 inches). An additional 1.2 acres, upgradient of this multi-layer cap at the location of the cap disturbance in 2014, consist of a mono-layer amended cap with an average thickness of 4.5 inches. As noted in Section 3.3, the cap disturbance in 2014 in RA-D impacted the adjacent SMU-8 area. Based on additional data and stability analyses, the MPC approach for the SMU-8 area adjacent to RA-D consists of 16.8 acres of mono-layer amended caps with a 4.5-inch average thickness with varying GAC dosages.

- **RA-D-2:** As shown in Figure 8 and presented in Table 1, approximately 2.4 acres of this MPC area consist of a multi-layer cap with a minimum 10.5-inch habitat/erosion protection layer and a reduced thickness isolation layer (less than the minimum of 12 inches).

Similar to the cap modeling conducted to determine the GAC dosage and protectiveness of the MERC in the Metro outfall area, as discussed in Section 3.2, modeling was conducted for each of the five MPC design revisions for each of the MPC types (*i.e.*, reduced thickness multi-layer

⁴ See footnote 3.

caps and amended mono-layer caps in the littoral zone, and amended and unamended thin-layer caps in SMU 8). The revised cap modeling in these areas is summarized below, and details of the modeling are provided in Attachment 2 of each of the five MPC design revision documents (Parsons and Anchor QEA, 2015a, 2015b, 2016a, 2016b, 2016c).

Modeling conducted for the reduced thickness multi-layer MPCs was similar to modeling conducted for the full thickness caps in the Final Design (Parsons and Anchor QEA, 2012), except using the reduced thicknesses of the habitat and/or isolation layers. Compliance with the cap performance criteria (*i.e.*, PECs and SSCs) for multi-layer MPCs was assessed at the point of the maximum concentration within the habitat restoration layer to verify compliance throughout that layer, consistent with the final design. Multi-layer MPCs having a sand/siderite layer separate from and below the GAC-amended chemical isolation layer were evaluated incorporating biological degradation (which is expected to occur over the long term following porewater pH neutralization by siderite) in the chemical isolation layer, consistent with the final design. Biological degradation was conservatively not simulated for MPCs in which siderite and GAC are mixed with sand within the same layer. Although some biodegradation may occur because of the presence of siderite, biodegradation was conservatively excluded from the modeling for the determination of GAC dosages for these MPCs because the siderite is not a separate layer placed beneath the sand/GAC isolation layer and thus porewater from the underlying sediments may not be fully neutralized when in contact with GAC. Consistent with the final design, multi-layer MPCs were evaluated with the numerical cap model using deterministic simulations for a period of 1,000 years to determine the final GAC dosages in each area.

Mono-layer MPCs were simulated in a manner consistent with the MERC simulations conducted in the area of the Metro deep water outfall (as discussed in Section 3.2). All mono-layer caps, regardless of the placed thickness (ranging from approximately 2 to 10 inches), were represented in the model using a total 6-inch thickness for the purposes of defining a GAC application rate based on the thickness over which the GAC will be distributed over time by bioturbation (the littoral zone bioturbation depth used in the final design was 6 inches). For mono-layer caps less than 6 inches and direct application areas, it is anticipated that GAC will be mixed over a depth of 6 inches over time via bioturbation. Therefore, for the purposes of identifying a GAC application rate that would be protective for a 1,000-year model evaluation period, it is appropriate to simulate the GAC over a thickness of 6 inches. This assumption will be assessed as part of the long-term monitoring program as documented in the OLMMP and associated cap monitoring work plan (Parsons, 2017).

For mercury, the MPC protectiveness evaluations conservatively assumed that adsorption is not enhanced by the presence of GAC, consistent with the Final Design. Thus, in the MPC modeling approach, the thickness of the cap provides protectiveness for mercury by providing a layer over which sorption to sand and dispersion attenuate porewater concentrations. However, deposition of new material atop the cap could also provide an important attenuating mechanism for mercury in deeper water areas of the littoral zone. Therefore, where the mono-layer cap thickness is less than the bioturbation depth of 6 inches in the 20- to 30-foot portion of the littoral zone, mercury was evaluated with the MNR model.

For the unamended, thin-layer cap in the deep water zone (SMU 8) off of RA-C, the MNR model that was used for the 2012 final design for mercury was modified to include the organic CPOIs that have PECs, as further discussed in Attachment 2 of the MPC RA-D-1 Design Revision

(Parsons and Anchor QEA, 2015b). For the amended, thin-layer caps in SMU 8 off of RA-D, the cap model was used. For both the MNR and cap models for these SMU-8 areas, cap effectiveness was based on the SMU 8 criteria (mean PEC Quotient [PECQ] of 1 and mercury PEC of 2.2 [milligrams per kilogram] mg/kg) and compliance depth (top 4 centimeters).

In general, the cap modeling approach for MPC areas in the littoral zone and input parameters (*e.g.*, underlying porewater concentrations, groundwater upwelling velocities) used for these five design revisions were consistent with the 2012 final design for the corresponding area. For both the reduced thickness multi-layer MPCs and the mono-layer amended caps, the GAC dosages were increased until the model-predicted concentrations at the compliance points were all less than the cap performance criteria for over 1,000 years. For the mono-layer amended caps in the littoral zone, compliance was based on the PEC-equivalent porewater values at the approximate midpoint of the bioturbation zone similar to the approach used for the MERC in the Metro outfall area (as discussed in Section 3.2). For the thin-layer and amended caps in SMU 8, data collected in 2014 and 2015 subsequent to the cap disturbances (Honeywell, 2015) were used to refine the input to the MNR and cap models for these MPC areas.

In nearly all of the model subareas in each of the five MPC areas (including the amended caps in SMU 8), higher GAC application rates (ranging from 0.1 to 3.73 lb/sf) than the rates specified in the Final Design for these subareas (ranging from 0 to 1.33 lb/sf) were determined to be needed to be protective. In the mono-layer areas addressed in the MPC RA-B-1 Design Revision (Parsons and Anchor QEA, 2015a), the modified designs resulted in slightly lower GAC dosage (0.49 lb/sf) than the dosage specified in the Final Design (0.6 lb/sf). The revised GAC application rates for each of the MPC subareas are designed to ensure that the organic chemicals that are CPOIs meet the cap effectiveness criteria for more than 1,000 years.

As noted above, the MPC protectiveness evaluations for mercury conservatively assumed adsorption is not enhanced by the presence of GAC. For mono-layer MPCs (including direct application areas) where the placed cap thickness is less than the 6-inch modeled cap thickness in water depths greater than 20 feet, the MNR model was used to evaluate mercury. For a small subset of the areas with direct application (RA-C-1B [0.4 acres] and RA-C-2D [0.3 acres], representing less than 0.2 percent of the total cap area in the littoral zone), results of the MNR modeling and evaluations conducted for mercury indicate that mercury concentrations would not fall below the mercury PEC of 2.2 mg/kg for at least 15 years. However, mercury levels would be expected to be lowered in the amended areas that include siderite, which was found to significantly reduce mercury in porewater (Parsons and Anchor QEA, 2016b). As shown in the Long-Term Cap Monitoring Work Plan included as Appendix D of the OLMMP (Parsons, 2017), solid-phase samples for mercury analysis, in addition to porewater samples for the organics, will be collected from these areas to assess cap effectiveness and recovery. For all other areas, model-predicted mercury concentrations remain below the mercury PEC following placement of the MPC for the range of deposition rates evaluated.

Although a very small portion of the cap area (less than 0.2 percent) may initially exceed the mercury PEC of 2.2 mg/kg, it is expected that the bioaccumulation-based sediment quality value (BSQV) of 0.8 mg/kg for mercury would continue to be permanently achieved in this portion of the Lake (which is within the “South Corner” zone⁵) within 10 years following the remediation

⁵ As discussed in the Final Design (Parsons and Anchor QEA, 2012), the BSQV was applied over five subareas that together cover the entire surface area of the Lake. The five Lake subareas from north to

of upland sources, littoral sediments, and initial thin-layer capping in the profundal zone (as specified in the ROD). Also, these design revisions are not expected to have an impact on the time to achieve fish tissue goals or achievement of surface water quality standards.

Comparison of Changes with the Original Remedy

The 2005 ROD called for protective caps with a chemical isolation layer with a minimum thickness of 12 inches. For most of those limited areas where a 12-inch protective cap could not be placed because of stability concerns, NYSDEC and EPA determined that, in these limited areas, modified protective caps with increased GAC dosage (above what was specified in the Final Design) could be used so as to achieve the cap performance criteria, and thus the remediation goals, while allowing for a decreased thickness of the isolation layer to less than the prescribed 12 inches. Thus, these reduced cap thicknesses would not constitute a fundamental alteration of the remedy selected in the 2005 ROD.

The application of GAC to the surface as either a mono-layer cap mixed with sand or as a direct application mixed with a minimal amount of sand to facilitate placement was determined to be an appropriate remedial measure to address contamination in these limited areas where a multi-layer cap could not be placed. As discussed in EPA's 2013 guidance entitled, "Use of Amendments for In-Situ Remediation at Superfund Sediment Sites," the primary exposure pathway for hydrophobic and bioaccumulative pollutants often involves bioaccumulation in the benthic infauna and subsequent transfer into the aquatic food web. Direct amendment of surficial sediment with sorbents such as GAC can reduce pollutant bioavailability to the food chain and flux of pollutants into the water column (EPA, 2013; Patmont *et al.*, 2014). Laboratory testing and field-scale applications of activated carbon have demonstrated its effectiveness in reducing bioavailability. Using engineered black carbons such as activated carbon augments the native sequestration capacity of sediments, resulting in reduced in-situ bioavailability of organic contaminants. When activated carbon is applied at optimal, site-specific doses, the porewater concentrations and bioavailability can be reduced between 70% and 99% (Patmont *et al.*, 2014).

As noted above, for mono-layer caps less than 6 inches and direct application areas, it is anticipated that GAC will be mixed over a depth of 6 inches over time via bioturbation. Although GAC may not be fully mixed into the sediments by bioturbation for 1 to 2 years, the GAC is expected to be effective at reducing contaminant bioavailability to the food chain and flux into the water column in both the near term, where it may only be present at the sediment surface, as well as long-term as it is naturally mixed in the surficial sediments by bioturbation and deposition. To ensure that the specified GAC application rates are met, GAC addition rates in the mono-layer and direct application MPC areas were a minimum of 150 percent of the application rate specified in the design revision documents (*i.e.*, "over-dosing") that was otherwise determined to be protective based on cap modeling (as per Capping Field Change Form Number 061 included in the Construction Completion Report [Anchor QEA and Parsons, 2017]). The long-term stability and effectiveness of the GAC will be monitored.

As also noted above, the 2005 ROD states that the habitat restoration layer above the isolation layer in the littoral zone should be a minimum of 12 inches thick (per the approved March 2012 remedial design, the required thickness of the habitat layer ranges, based on water depth, from

south are called the North Basin, Ninemile Creek Outlet Area, Saddle, South Basin, and South Corner (see the BSQV analysis in Appendix N of the Final Design).

12 inches to 24 inches). For the modified protective caps where the minimum thicknesses (12 inches) of the isolation layer and the habitat layer could not be placed because of stability concerns, the approach for the revised designs in areas where a multi-layer cap could be placed was to maintain a separate habitat restoration layer at or near full thickness, to the extent feasible, while decreasing the thickness of the isolation layer and increasing the GAC dosage as noted above to maintain compliance with the cap performance criteria. As shown in Table 1, approximately 19.5 acres of the 33 acres of MPCs and MERCs in the littoral zone (approximately 60 percent) have a separate habitat layer above the isolation layer (15.3 acres with a minimum of 12 inches of habitat/erosion protection layer and 4.2 acres with a minimum of 6 inches).

Although there are portions of the MPC areas where a reduced thickness multi-layer cap could not be placed, these areas without a dedicated habitat layer (above the sand/GAC layer) where a mono-layer cap (sand/GAC) or direct application of GAC is specified in the MPC designs represent a very small portion of the overall capped area. Of the approximately 33 acres with MPCs and MERCs within the littoral zone, approximately 13.5 acres of all MPC and MERC areas do not have a dedicated habitat layer. As this represents only approximately 3 percent of the total 418-acre cap area in the littoral zone, these revised cap designs are not expected to impact achievement of the habitat restoration goals. In addition, none of these areas that would not have a dedicated habitat layer were included in the Final Design as areas slated for plantings.

Conclusions

NYSDEC and EPA believe that these design revisions comport with the applicable remediation goals in the 2005 Onondaga Lake Bottom ROD. The designs for the modified protective caps indicate that predicted concentrations of all chemicals of interest would be less than the PECs and applicable NYSDEC sediment criteria in all areas of the littoral zone with the exception of approximately 0.7 acres, where mercury may not achieve its PEC for approximately 15 to 30 years. As this area represents less than 0.2 percent of the total isolation cap area in the littoral zone, these design revisions would not have a detrimental impact on the ability of the remedy to achieve the goal of the protection of the benthic community. Also, the design revisions for the adjacent SMU-8 area indicate that all contaminant concentration objectives established in the ROD would be met.

In addition, it is expected that the BSQV of 0.8 mg/kg for mercury would continue to be achieved in this portion of the Lake within 10 years following the remediation of upland sources, littoral sediments, and initial thin-layer capping in the profundal zone (as specified in the 2005 ROD). Also, these design revisions are not expected to have an impact on the time to achieve fish tissue goals or achievement of surface water quality standards. Both fish tissue monitoring and surface water monitoring will be conducted in accordance with the Onondaga Lake Long-Term Monitoring and Maintenance Plan to assess the remedy effectiveness.

Given the relatively small size of these areas relative to the remaining areas of the Lake with a full thickness cap, as well as the increased GAC dosages applied in these MPC and MERC areas to ensure cap effectiveness, the modifications will not affect remedial timeframes, degree of protectiveness of the overall remedy, remedial costs, or the extent of institutional controls needed. As noted in the OLMMP (Parsons, 2017), post-construction physical and chemical monitoring will be conducted in all capped areas (beginning in 2017), including the MERC and MPC areas addressed in this ESD, to ensure the effectiveness of the remedy in meeting the related goals specified in the 2005 ROD. The monitoring also includes macrobenthic community sampling in the various cap areas, including the MPC areas.

4.0 STATE AND EPA ACCEPTANCE

NYSDEC is the lead agency for this Subsite and has prepared this ESD. EPA has determined that this modified remedy meets the requirements for a remedial action as set forth in CERCLA Section 121, 42 U.S.C. § 9621. As such, NYSDEC, on behalf of New York State, supports this modification. The New York State Department of Health also concurs with this modification.

5.0 FIVE-YEAR REVIEWS

Because hazardous substances, pollutants, or contaminants will remain at the Subsite which do not allow for unlimited use or unrestricted exposure, in accordance with 40 CFR 300.430(f)(4)(ii), the remedy for this Subsite, as modified, must be reviewed no less often than every five years. The first five-year review for this Subsite was completed on September 25, 2015. The next five-year review will be conducted on or before September 2020.

6.0 AFFIRMATION OF STATUTORY DETERMINATIONS

Considering the new information that was developed and the changes that have been made to the selected remedy, NYSDEC and EPA believe that the 2005 remedy, as revised, remains protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to this remedial action, and is cost effective. The modified remedy satisfies Section 121 of CERCLA.

7.0 PUBLIC PARTICIPATION ACTIVITIES

NYSDEC and EPA are making this ESD and supporting information available to the public. Should there be any questions regarding this ESD, please contact:

Timothy Larson, P.E., Project Manager
New York State Department of Environmental Conservation
625 Broadway, Albany, NY 12233-7013
Phone: (518) 402-9676
E-Mail: tim.larson@dec.ny.gov

or

Robert Nunes, Remedial Project Manager
United States Environmental Protection Agency, Region 2
290 Broadway, New York, NY 10007-1866
Phone: (212) 637-4254
E-Mail: nunes.robert@epa.gov

Project health-related questions should be directed to:

Mark Sergott, P.G., Project Manager
New York State Department of Health

Bureau of Environmental Exposure Investigation
Empire State Plaza - Corning Tower, Room 1787
Albany, NY 12237
Phone: (518) 402-7860
E-Mail: bee@health.ny.gov

With the publication of this ESD, the public participation requirements set out in §300.4–35(c)(2)(i) of the NCP have been met.

8.0 REFERENCES

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3/29/2018

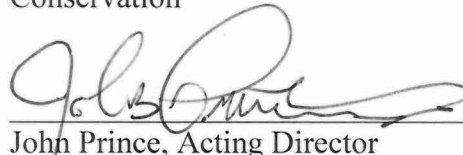
Date

3/28/2018

Date



Michael J. Ryan, P.E., Director
Division of Environmental Remediation
New York State Department of Environmental
Conservation



John Prince, Acting Director
Emergency and Remedial Response Division
U.S. Environmental Protection Agency

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Figure 6. Modified Protective Cap RA-C-2

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Table 1. Onondaga Lake Modified Cap Designs, Summary of Cap Types and Thicknesses

Table 2. PEC-Equivalent Porewater Concentrations Used for Cap Performance Criteria

LIST OF ACRONYMS AND ABBREVIATIONS

ac	acre
avg	average
BSQV	bioaccumulation-based sediment quality value
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
CPOI	chemical parameter of interest
DOT	New York State Department of Transportation
elev	elevation
EPA	Environmental Protection Agency
ESD	Explanation of Significant Differences
ESF	Environmental Science and Forestry (SUNY)
FS	feasibility study
ft	feet/foot
GAC	granular activated carbon
in	inches
IRM	interim remedial measure
lb/sf	pounds per square foot
MERC	Modified Erosion-Resistant Cap
Metro	Metropolitan Syracuse Sewage Treatment Plant
mg/kg	milligrams per kilogram
min	minimum
MNR	monitored natural recovery
MPC	Modified Protective Cap
NAPL	non-aqueous-phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OLMMP	Onondaga Lake Monitoring and Maintenance Plan
OSWER	Office of Solid Waste and Emergency Response
PDI	Pre-Design Investigation
PEC	probable effect concentration
PECQ	probable effect concentration quotient

RA	Remediation Area
ROD	Record of Decision
SETAC	Society of Environmental Toxicology and Chemistry
SMU	sediment management unit
SSC	NYSDEC Sediment Screening Criteria
TOC	total organic carbon
UFI	Upstate Freshwater Institute
ug/kg	micrograms per kilogram
ug/L	micrograms per liter
USC	US Code

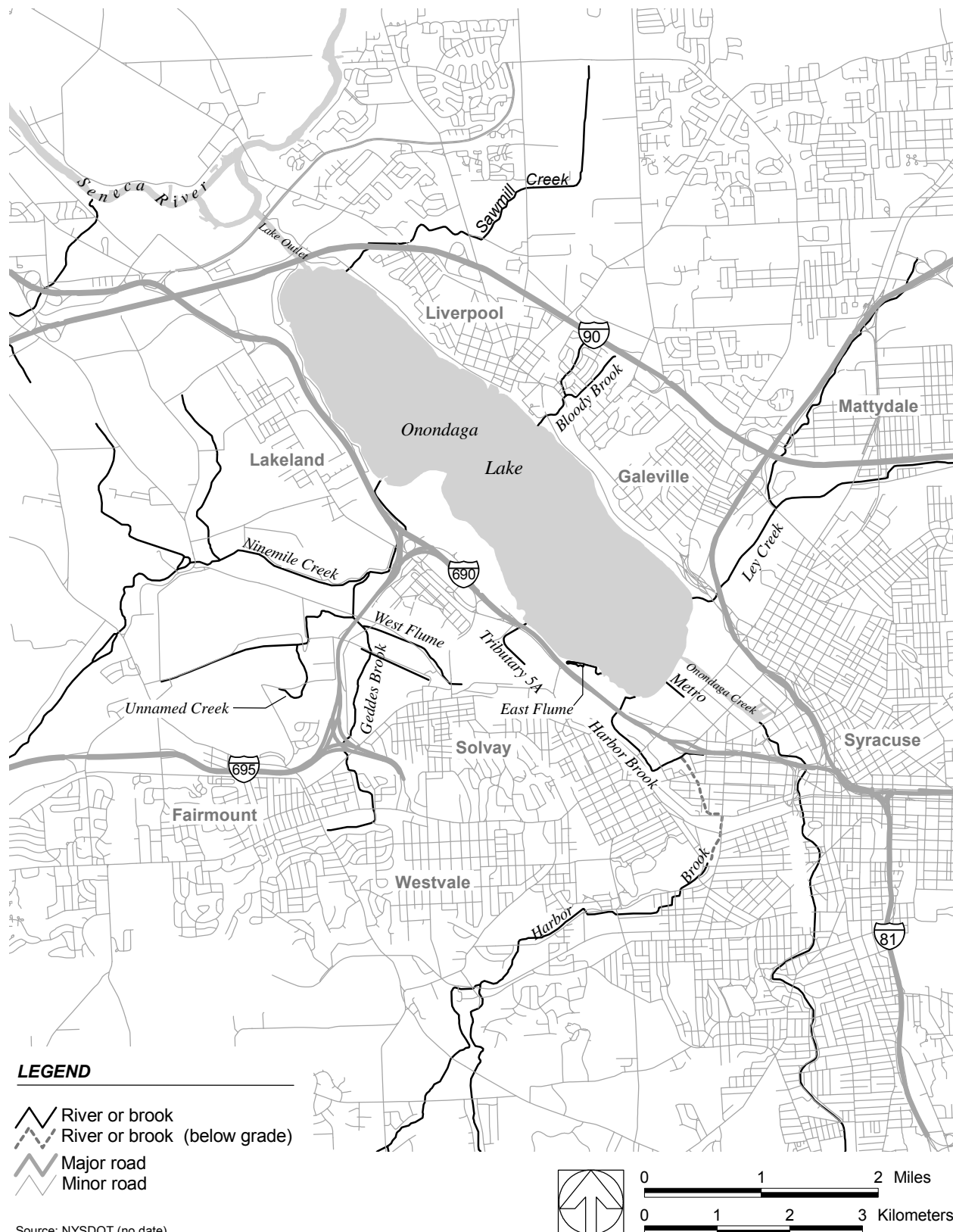


Figure 1 Onondaga Lake Area

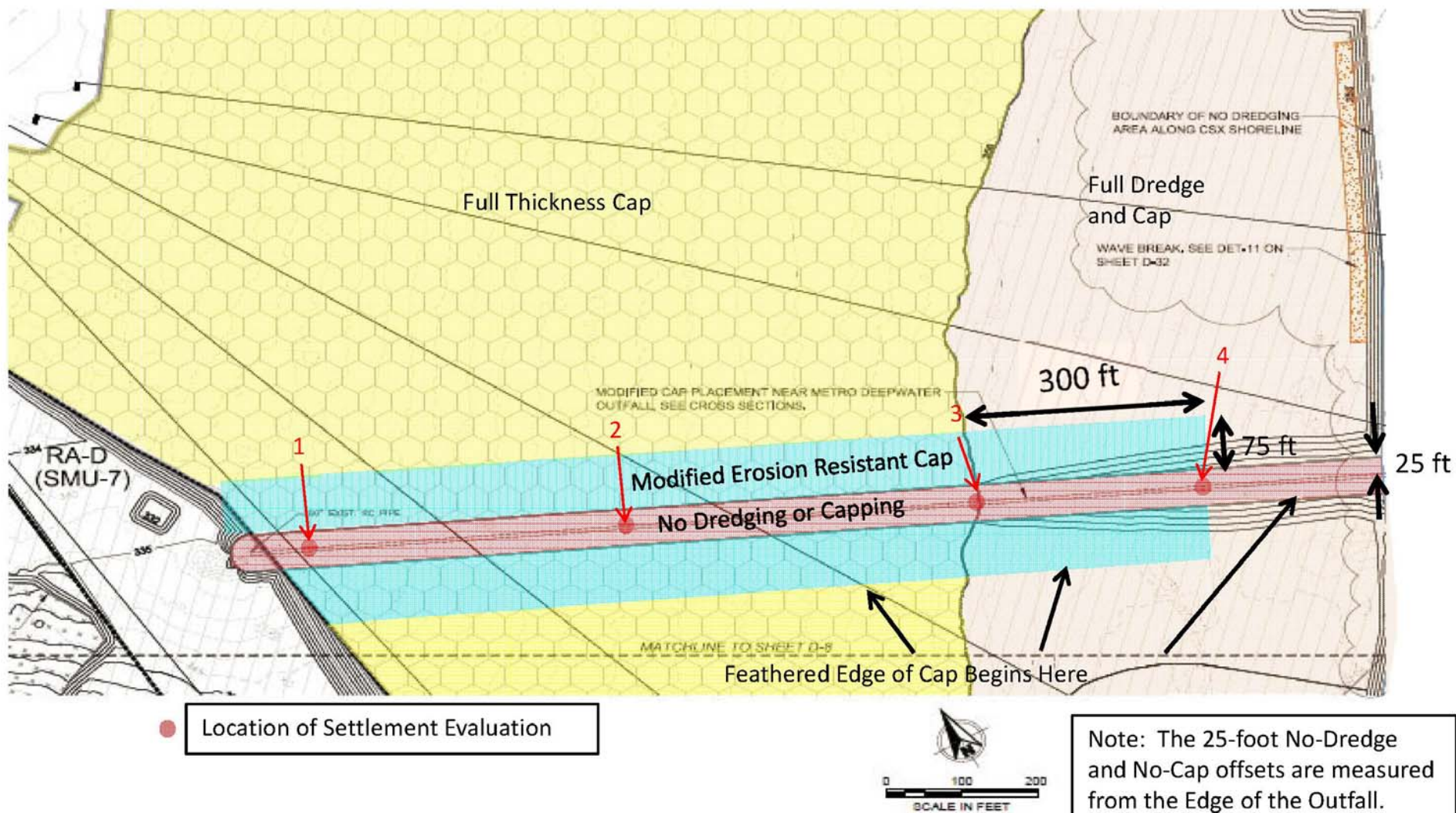
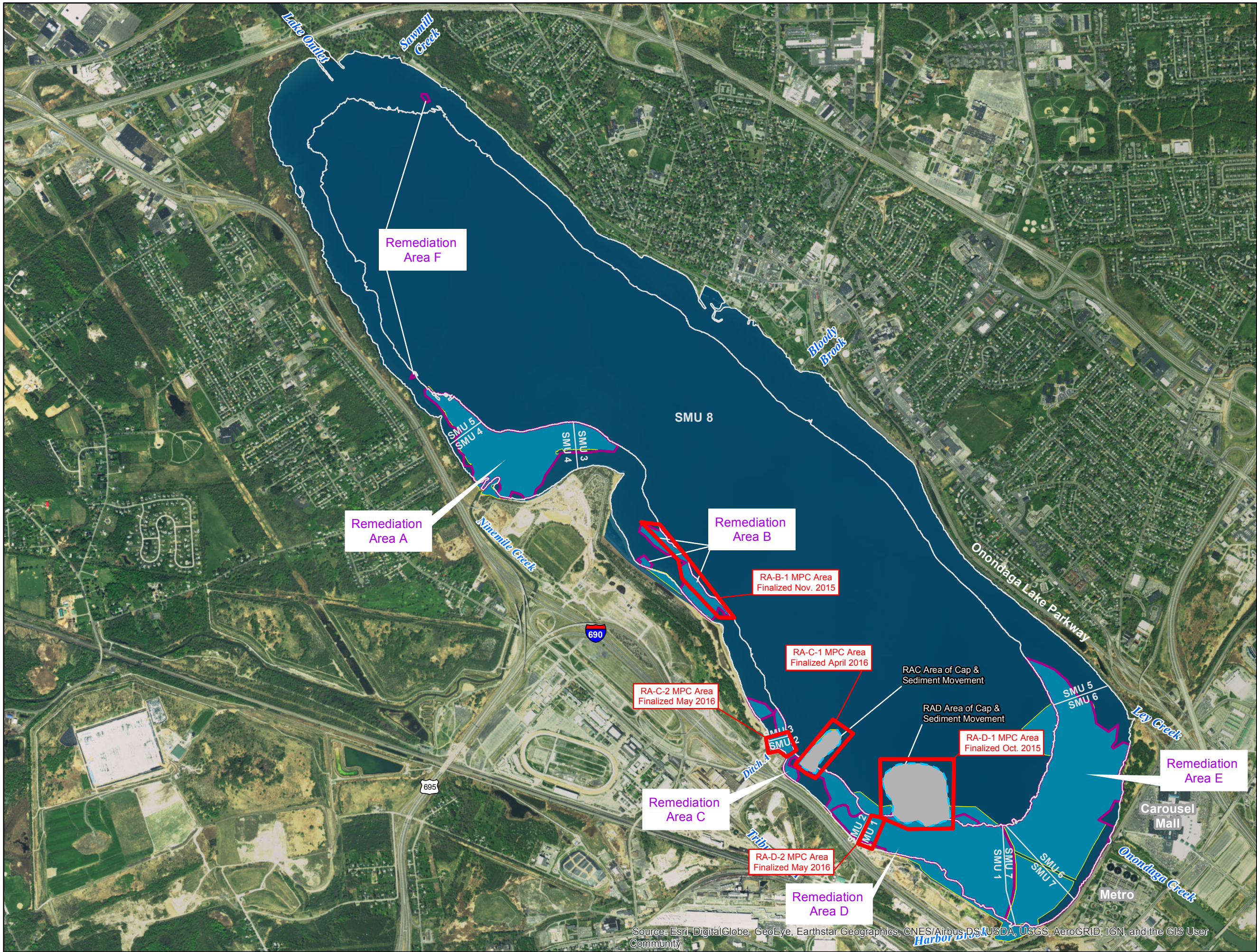


Figure 2
Modified Erosion Resistant Cap
Metro Deep Water Outfall



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

- Remediation Area Boundary
- Sediment Management Unit (SMU) Boundary
- Capped Area
- Area of Cap and Sediment Movement
- Approximate Area of Modified Protective Caps (see Figures 4 through 8) and Date of Design Revision



FIGURE 3

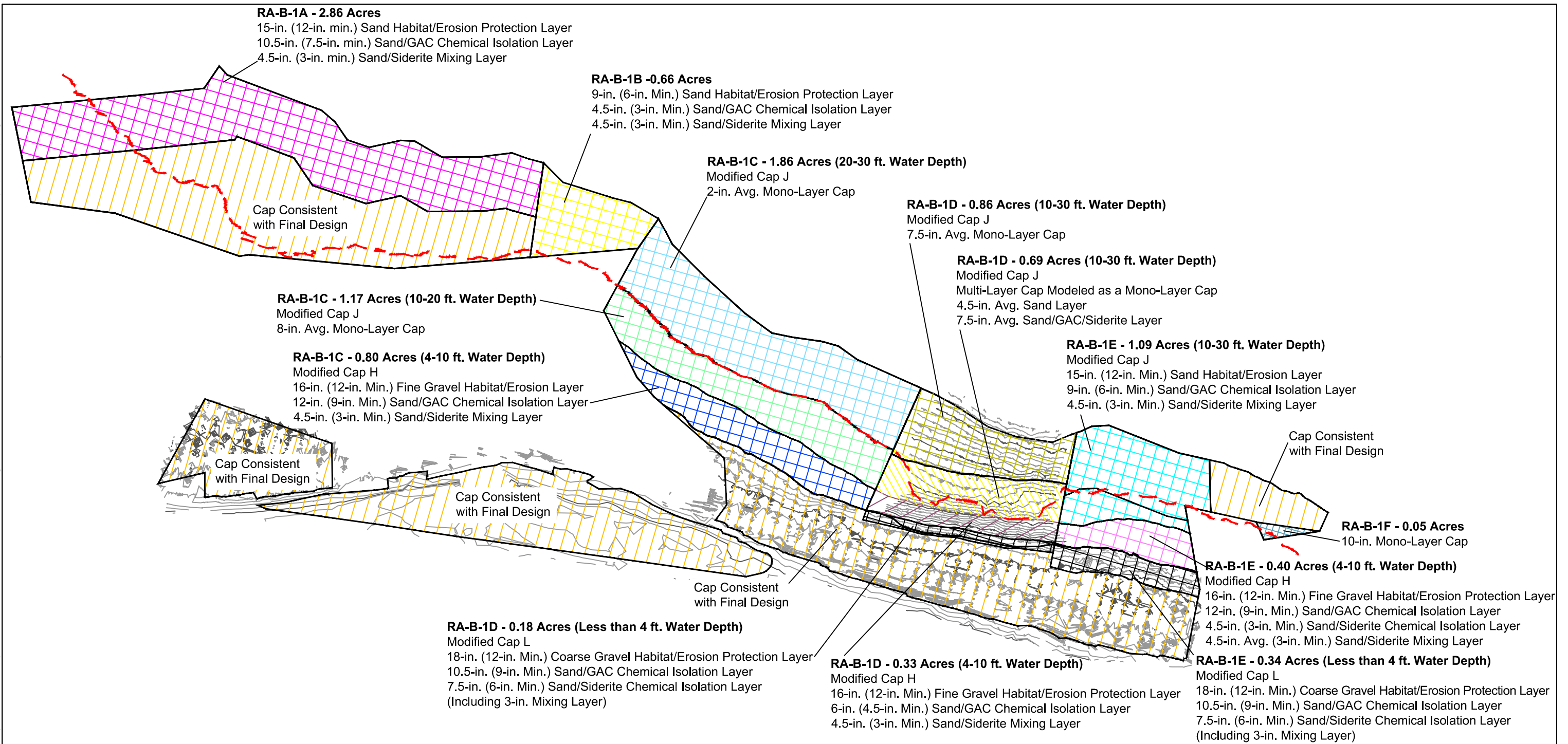
Honeywell Onondaga Lake
Syracuse, New York

ESD AREAS OF INTEREST



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

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SOURCE: Exg-Lake, RAB Severson Pre-Final
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North American Datum 1983 (NAD83), U.S. Feet
VERTICAL DATUM: North American Vertical Datum 1988 (NAVD88)

LEGEND:  Shoreline (elev. 362.5')
 20-foot Post Dredge Depth Contour (elev. 342.5')

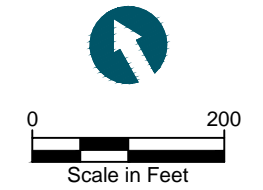
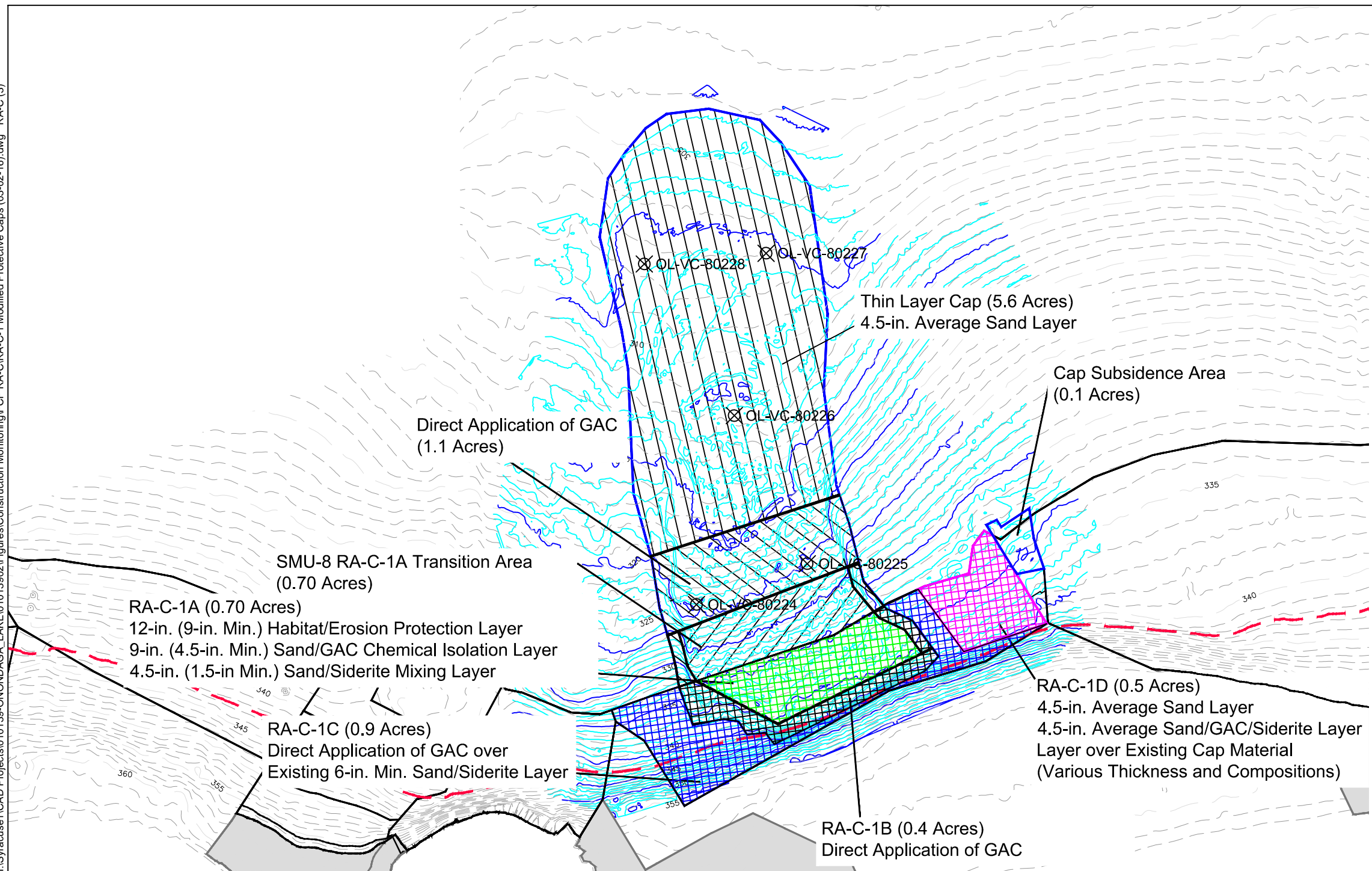


Figure 4
Modified Protective Caps
Remediation Area B
Onondaga Lake

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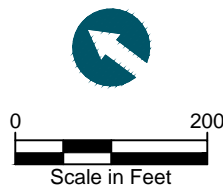
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The Depicted Contours Have
Been Simplified and
Smoothed For Clarity

SOURCE: CR Environmental Post-Disturbance Surveys
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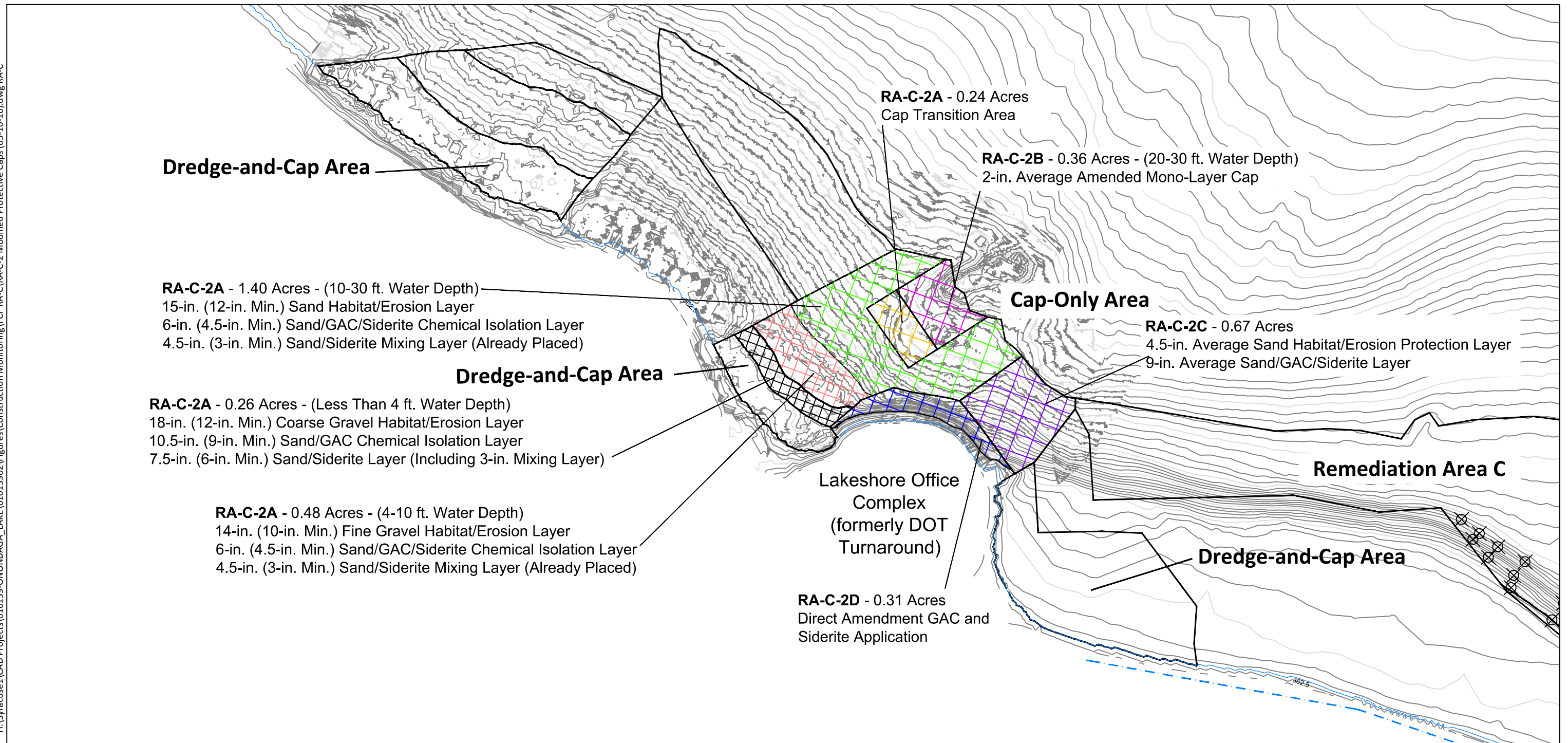
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- 20-foot (6 Meter) Depth Contour (elev. 342.5')
- Area of Movement Based on Bathymetric Survey
- Approximate Limits of Dredge and Cap Area
- Post-Movement Bathy (2015)
- OL-VC-80228 Sediment Samples Collected in 2014 (Post Cap Movement)

- Area RA-C-1A
- Area RA-C-1B
- Area RA-C-1C
- Area RA-C-1D



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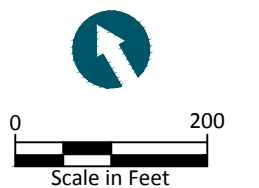
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VERTICAL DATUM: North American Vertical Datum 1988 (NAVD88)

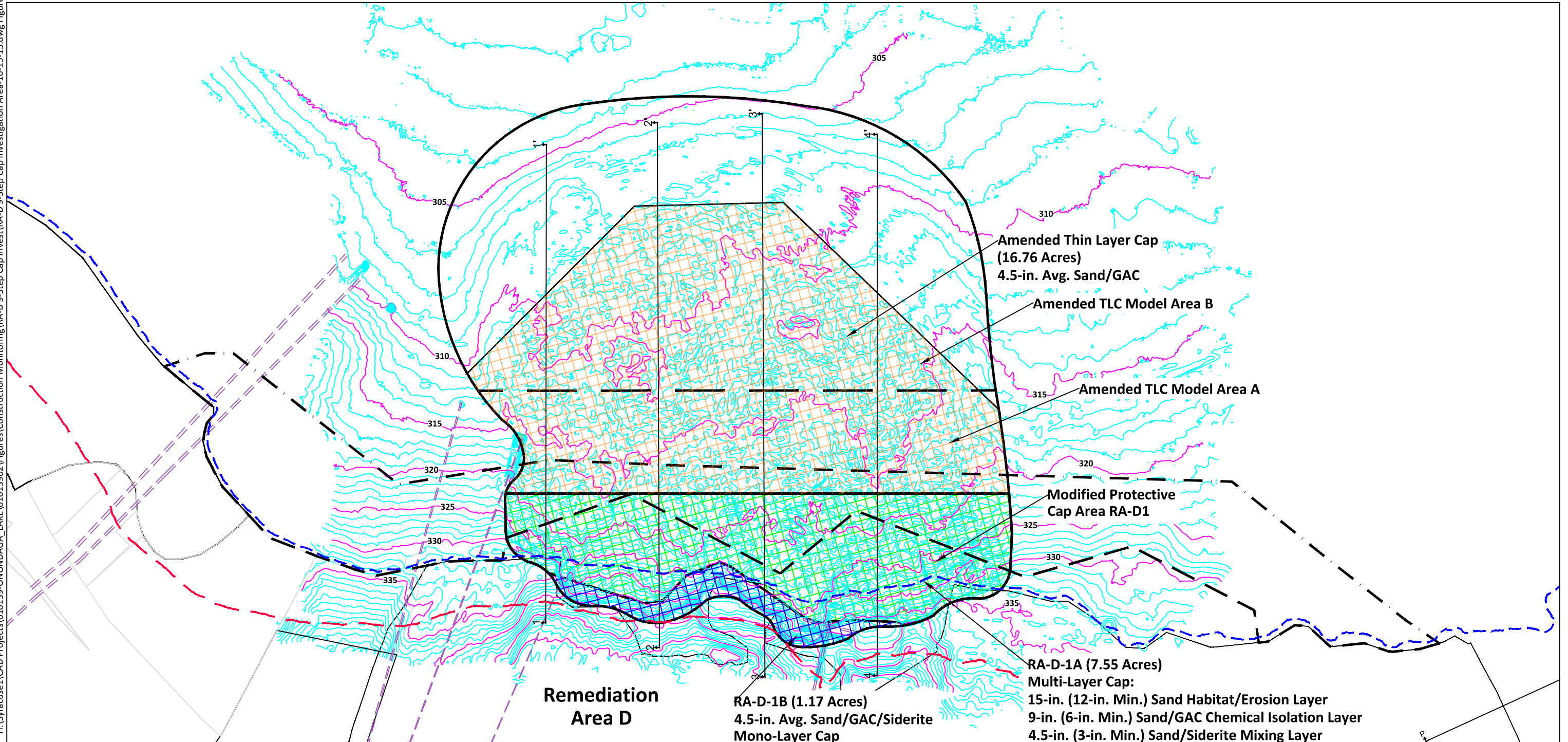
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Shoreline (elev. 362.5')
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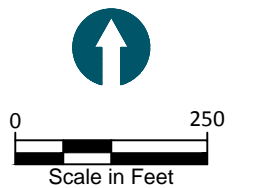


SOURCE: Rem D Disturbance Bathy (Parsons)
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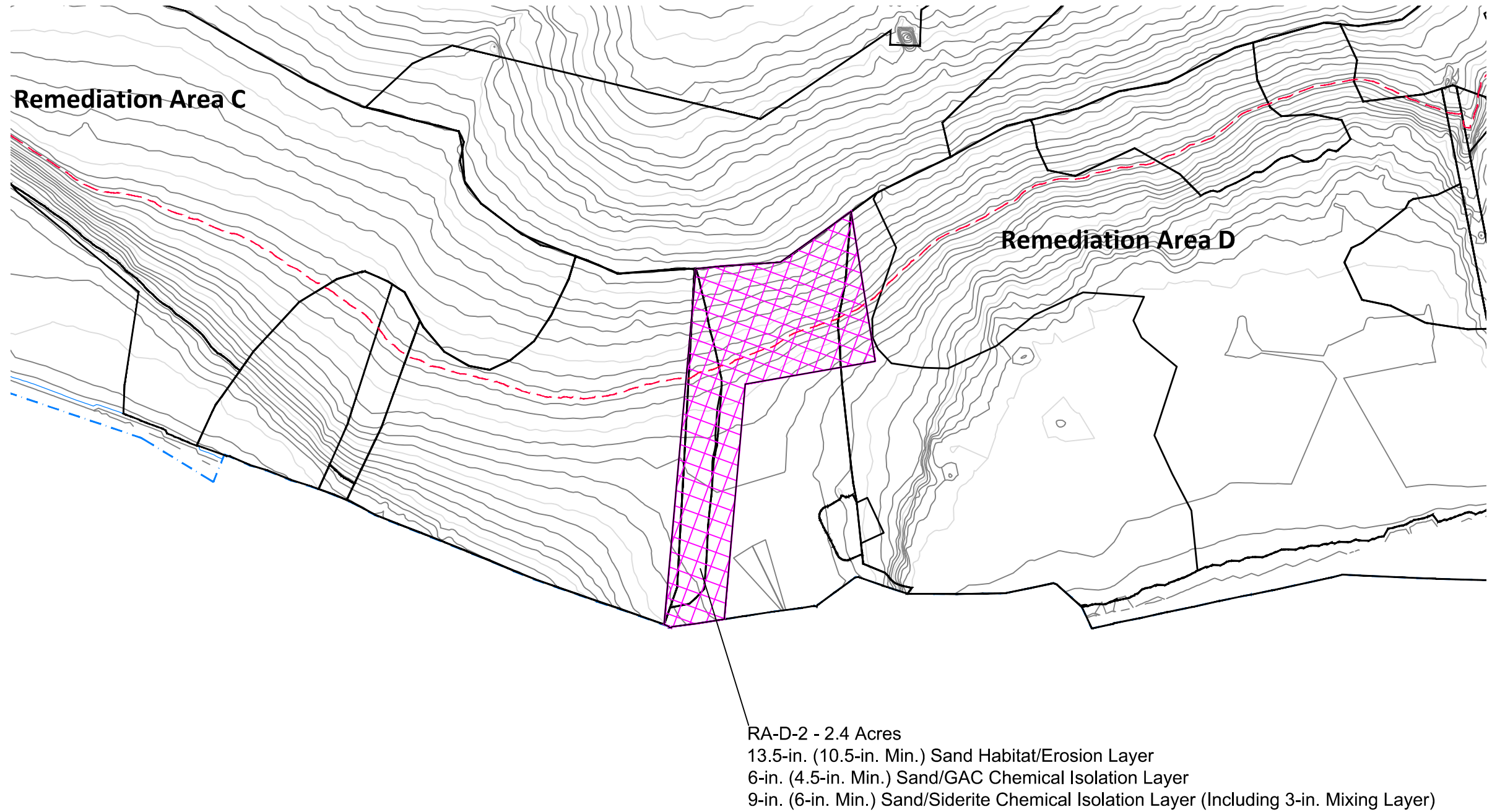
- Approximate Limits of Cap and/or Sediment Movement
- Post-Disturbance Bathymetry
- - - Original Capped Area Boundary
- - - Original Thin Layer Cap Area

- 20-foot (6 Meter) Depth Contour (elev. 342.5')
- 30-foot (9 Meter) Depth Contour (elev. 332.5')



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VERTICAL DATUM: North American Vertical Datum 1988 (NAVD88)

Table 1. Onondaga Lake Modified Cap Designs, Summary of Cap Types and Thicknesses

Type of Modified Protective Cap (acres)	RA-B-1	RA-C-1		RA-C-2	RA-D-1		RA-D-2	RA-E	TOTALS	
	Littoral Zone	Littoral Zone ¹	SMU 8	Littoral Zone ²	Littoral Zone and Addendum Area	SMU 8	Littoral Zone	Metro Outfall Area ³	Littoral Zone and Addendum Area	SMU 8
Multi-Layer Cap with 12" Minimum Habitat/Erosion Layer	6.0			1.7	7.6				15.3	
Multi-Layer Cap with 6" to 10.5" Minimum Habitat/Erosion Layer	0.7	0.7		0.5			2.4		4.2	
Mono-Layer Amended Cap (Varying Thicknesses)	4.6	0.5	0.7	1.3	1.2			4.3	11.9	0.7
Amended Thin-Layer Cap						16.8				16.8
Thin-Layer Cap			5.6							5.6
Direct Application of Amendment		1.3	1.1	0.3					1.6	1.1
TOTALS	11.3	2.5	7.4	3.7	8.8	16.8	2.4	4.3	33.0	24.2

Notes:

1. Includes direct amendment in 0.4-ac steep slope disturbance area (RA-C-1B) and 0.9 ac in adjacent areas where at least sand/siderite lift had been placed (RA-C-1C).
2. Cap Transition Area (0.24 ac) from RA-C-2A (multi-layer cap) to RA-C-2B (single lift mono-layer cap) contains one to four amended lifts and included in table above as a mono-layer cap.
3. Metro Outfall Area modified erosion resistant cap (MERC) included in table above as a mono-layer cap.

Table 2. PEC-Equivalent Porewater Concentrations Used as Cap Performance Criteria

Chemical	PEC (ug/kg)	PEC-Equivalent Porewater Concentration (ug/L)
Benzene ¹	NA	760
Toluene ¹	NA	480
Phenol ¹	NA	250
Chlorobenzene	428	50.4
Dichlorobenzenes	239	12
Ethylbenzene	176	9.92
Naphthalene	917	68.1
Xylene	561	36.3
Trichlorobenzene	347	6.78
Total PCBs	295	0.005
Fluorene	264	0.383
Phenanthrene	543	0.423
Acenaphthene	861	0.883
Acenaphthylene	1,301	3.28
Anthracene	207	0.161
Pyrene	344	0.036
Benzo(a)anthracene	192	0.01
Benzo(b)fluoranthene	908	0.018
Benzo(k)fluoranthene	203	0.004
Chrysene	253	0.005
Fluoranthene	1,436	0.203
Benzo(a)pyrene	146	0.003
Dibenz(a,h)anthracene	157	0.001
Indeno(1,2,3-cd)pyrene	183	0.004
Benzo(g,h,i)perylene	780	0.003
Mercury (RA-B, RA-C, RA-D) ²	2,200	1.63
Mercury (RA-E1) ²	2,200	1.08
Mercury (RA-E2) ²	2,200	0.367
Mercury (RA-E3) ²	2,200	1.3

Sources: Modified Protective Cap RA-D-1 Design Revision (Parsons and Anchor QEA, 2015b) and Metro Outfall Vicinity Design Addendum (Parsons and Anchor QEA, 2014)

Notes:

1. Values shown for benzene, toluene, and phenol are the NYSDEC sediment screening concentrations in ug/L.
2. Mercury PEC-equivalent Porewater Concentrations are based on the partition coefficients (Kd) for sand in model areas RA-B, RA-C, and RA-D, and the three subareas in RA-E (see Appendix B of the Final Design [Parsons and Anchor QEA, 2012]).
 µg/kg = micrograms per kilogram
 µg/L = micrograms per liter