FINAL SEDIMENT MANAGEMENT REMEDIAL DESIGN REPORT

ST. CLAIR RIVER AREA OF CONCERN SARNIA, ONTARIO

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Acronym	Definition / Description
AOC	Area of Concern
BMP	best management practices
BUI	beneficial use impairments
CD	Consent Decree
cm	centimeters
COA	Canada Ontario Agreement
CQA	Construction Quality Assurance
CQAP	Construction Quality Assurance Project Plan
CQC	Construction Quality Control
DFO	Ministry of Fisheries and Ocean Canada
DGPS	differential global positioning system
ERC	erosion-resistant cover
FFA	Federal Facility Agreements
GLWQA	Great Lakes Water Quality Agreement
GPS	Global Positioning System
IC	institutional controls
IDW	investigation-derived waste
km	kilometer
MECP	Ministry of the Environment, Conservation, and Parks
mg/kg	milligrams per kilograms
MNDMNRF	Ministry of Northern Development, Mines Natural Resources and Forestry
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PDI	pre-design investigation
RAO	Remedial Action Objective
RD	Remedial Design
RTK	real-time kinematic
SCRCA	St. Clair Region Conservation Authority
Shell	Shell Canada Limited
Suncor	Suncor Energy, Inc.
SWAC	surface weighted average concentration
TSS	total suspended solids
WQMP	Water Quality Monitoring Plan

1.0 INTRODUCTION

This Remedial Design (RD) Report presents the remediation strategy and detailed design for the three contaminated sediment priority areas within the St. Clair River Area of Concern in Sarnia, Ontario. The remedy includes placement of an erosion-resistant cover (ERC) consisting of fine gravel in portions of three separate areas designated as Priority Areas 1, 2 and 3 (**Figure 1**) to further reduce the impact from mercury within these historically contaminated areas. The design was developed considering numerous historical investigations as well the findings of the pre-design investigation (PDI) activities completed in 2019 and 2020.

1.1 Site History and Background

The St. Clair River flows 64 kilometer (km) from Lake Huron south to Lake St. Clair and forms the border between the state of Michigan and the province of Ontario. The St. Clair River was designated as an Area of Concern (AOC) under the 1987 Great Lakes Water Quality Agreement (GLWQA), based on several beneficial use impairments (BUIs). At that time, St. Clair River sediment was affected by nutrient loadings and elevated concentrations of organic contaminants and metals, such as mercury. Other metals present included copper, lead, and zinc. Organic compounds present included polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), octachlorostyrene, hexachlorobenzene, and hexachlorobutadiene. The conditions documented in 1985 reflected a long history of industrial development in Sarnia and along the eastern shore of the river.

As a result of effluent controls being instituted in 1985 to reduce the discharge of chlorinated solvents, and on-site remedial measures to achieve point source load reductions for chlorinated solvents and by-products, the length of the impacted area within the AOC had been reduced to approximately 9 km in river length by 1990. In 1996, chlorinated hydrocarbons were removed from a small area immediately downstream of the Cole Drain. Between 2002 and 2004, 13,370 m^3 of contaminated sediment was remediated by Dow Canada using hydraulic dredging and removed for disposal.

In 2008, the St. Clair River Sediment Technical Team initiated the Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment. The application of the Canada Ontario Agreement (COA) Framework focused on the 8.3 km reach of the St. Clair River located along the Canadian shoreline from the TransAlta property just upstream of the TransAlta/Suncor property line (easting 382177, northing 4754984), to the southern end of Stag Island (easting 380644, northing 4747565), in the St. Clair River.

The COA Framework uses an ecosystem approach to sediment assessment to evaluate effects on sediment-dwelling and aquatic organisms, as well as potential for contaminants to biomagnify in the food chain, in order to form a rational basis for making contaminated sediment management decisions.

At that time, the contaminants of concern in the St. Clair River included mercury and chlorinated organic compounds. A screening evaluation of the data indicated that most of the sediment concentrations of hexachlorobenzene and hexachlorobutadiene were well below the targets set by KAUSS (2001), 0.22 milligrams per kilogram (mg/kg) and 3.5 mg/kg, respectively. However, sediment concentrations of mercury and octachlorostyrene exceeded the target concentrations in many cases and thus the potential effects of mercury and octachlorostyrene were examined in the detailed risk analysis (ENVIRON 2009).

Four lines of evidence were used to evaluate sediment quality: (1) risk from biomagnification of mercury and octachlorostyrene, 2) sediment chemistry, 3) benthic invertebrate community structure, and 4) sediment toxicity. It was concluded that risk from biomagnification from mercury was the predominant line of evidence indicating risk. No risk based on benthic invertebrate community structure or sediment toxicity was identified.

Biomagnification is an important line of evidence because consumption of fish and other aquatic organisms by piscivorous fish and wildlife species may pose an ecological risk if chemical residues accumulate to toxic levels within the food chain. Priority areas for sediment management based on risks to fish from mercury were identified and mapped (ENVIRON 2009).

The report titled “Sediment Management Options for St Clair River Area of Interest” (Environ 2013) defined Priority Area boundaries and outlined different techniques that would be capable of addressing the contamination at the three priority areas. The report described and screened response actions for the management of mercury impacted sediment in the three priority areas; described remedial alternatives and evaluated these alternatives relative to refined selection criteria; and developed conceptual designs for the remedial alternatives.

The report concluded that isolation capping is a technically feasible means of reducing ecological risk by limiting biotic exposure to mercury and methylmercury in surface sediment. The principal benefits identified with capping included the provision of clean substrate for benthic invertebrates and sequestration of mercury below the biologically active zone of the sediment.

The report identified dredging as being a technically feasible means of achieving remedial goals and requiring less long-term monitoring and maintenance than capping. The report outlined how hydraulic dredging was not without risks and ecological effects, both during and after implementation. Residuals with elevated chemical concentration may remain after dredging due to either re-suspension of materials during dredging or exposure, or incomplete removal of buried sediment with elevated chemical concentrations. The report explained how the effectiveness of dredging could be improved through placement of a relatively thin backfill layer after dredging to cover residuals. Thin backfill layers can be engineered to maintain effectiveness under site-specific hydrodynamic conditions.

Based on data collected through 2016, the remedial objectives were refined using a science-based approach, as detailed in a document titled “Work Completed by the 2016 Sediment Management Technical Committee” (Anchor QEA 2016a) and related documents (Anchor QEA 2016b, 2016c, and 2016d). Based on these evaluations, the risk-based remedial goal is to achieve a surface weighted average concentration (SWAC) for mercury of 3 mg/kg or less within the top 15 centimeters (cm) in each of the Priority Areas. A SWAC, is a spatially averaged concentration that accounts not only for the sample concentrations, but also the area each datapoint represents. For instance, a sample that has a larger area surrounding it (i.e., greater distance to next datapoint), will contribute a larger proportion of the average concentration than samples that are collected closer together. The evaluation concluded that achievement of this goal would result in achievement of risk-based goals for protection of local fish based on mercury bioaccumulation considerations. Analysis based on historical data through 2016 indicated that addressing sediments that exceed 10 mg/kg of total mercury in the top 15 cm would result in achievement of the SWAC goal of 3 mg/kg in each Priority Area.

To support preparation of a dredging-based remedial design, extensive PDI activities were completed in 2019 and 2020, as detailed in Section 3. Based on the results from this investigation, the mercury concentrations in surface sediments are significantly lower than they were historically, likely as a result of deposition of cleaner sediment subsequent to remediation of upstream contaminated sediments in 2006 by Dow. Based on the new data, the SWAC goal of 3 mg/kg is currently met in all three Priority Areas. Additionally, the data indicate that the areas are net depositional and surface sediments are stable, and thus re-exposure of buried mercury is unlikely. Therefore, the revised remedial approach utilizes ERCs in the areas of highest surface sediment mercury concentrations to enhance erosion protection and further decrease mercury concentrations in surface sediment (**Figures 2 through 4**). Additional details regarding the results from the PDI and the basis for selecting ERCs and delineation of placement areas are provided in Section 3.

In addition to the Priority Areas, two areas with buried elevated mercury concentrations (Buried Deposits) were identified during historic sampling of the priority areas. One buried deposit is located between Priority Area 2 and 3, and the other buried deposit is located downriver of Priority Area 3 (**Figure 1**). Both deposits have low surface sediment and biota tissue concentrations, which indicate a low risk of causing biomagnification of methylmercury. Sediment stability evaluations indicate that both deposits are stable and are not at risk of re-exposing buried sediment characterized by elevated mercury concentrations. Additional details regarding the results from the PDI and the basis for concluding no action is required in these areas is provided in Section 3.

1.2 Site Description

The three Priority Areas are in shallow water areas directly adjacent to or near the river shoreline. Priority Areas 1 and 2 are in close proximity to steel dock structures and the navigational channel associated with active petroleum loading and unloading at the Suncor Energy Inc. (Suncor) and Shell Canada Limited (Shell) petroleum refineries (**Figures 2 and 3**). The southern cover area in Priority Area 1 is also directly adjacent to the Suncor cooling water intake. Priority Area 3 is adjacent to Guthrie Park (**Figure 4**).

The water depths where the ERCs will be placed range from shallow near the shoreline to approximately 5 m. Substrate composition within Priority Area 1 and Priority Area 3 is dominated by sand, with fines and some gravel. Priority Area 2 contains an even mix of sand and fine material with very little gravel. Numerous debris targets were identified historically in each of the three Priority Areas (Canadian Seabed Research 2011). The majority of debris targets identified within Priority Areas 1 and 3 were natural, such as logs and boulders. For Priority Area 2, the majority of debris targets related to anthropogenic debris such as old walkway pieces, tires, and steel pipes. As shown in **Figure 3**, there are a series of buried utility product lines in proximity to the ERC areas in Priority Area 2 and one buried stormwater discharge adjacent to ERC areas in Priority Area 3, as discussed in detail in Section 4.1.3.2.

1.3 Report Organization

This report is organized into the following sections:

- Section 1: Introduction
- Section 2: Remedial Objectives
- Section 3: Summary of PDI and Other Design Information and Basis for Remedial Approach
- Section 4: Design Elements
- Section 5: Construction Quality Assurance
- Section 6: Environmental Protection (Air, Water, Land)
- Section 7: Long-term Cover Integrity Considerations
- Section 8: References

Additional details and supporting information are included in the following Appendices:

- Appendix A – PDI Summary Report
- Appendix B – Drawings
- Appendix C – Specifications
- Appendix D – Water Quality and Sediment Resuspension Monitoring Plan
- Appendix E – Construction Quality Assurance Plan
- Appendix F – Sediment Stability Evaluation
- Appendix G - Mercury Surface-Weighted Average Concentration Calculations
- Appendix H – Preliminary Land Title Documentation Information

In addition to the design details included in this report, construction contractors will be required to submit for approval supporting information related to implementation details and means and methods of implementation. These supporting plans are referenced throughout this design and include:

- Cover Placement Plan
- Turbidity Barrier Plan
- Health and Safety Plan
- Environmental Protection Plan, which will include:
  - Erosion and Sediment Control Plan
  - Traffic Control Plan
  - Spill Control Plan
  - Non-Hazardous Solid Waste Disposal Plan
  - Air Pollution Control Plan
  - Contaminant Prevention Plan
  - Waste Water Management Plan

2.0 REMEDIAL OBJECTIVES

The Sediment Management Options Report (Environ 2013) developed remedial action objectives (RAOs) for the three Priority Areas. Regarding the Buried Deposits, Environ (2013) concluded that they both had low surface and tissue mercury concentrations, and the sediment stability evaluations indicated that both deposits are stable and are not at risk of re-exposure of buried sediment characterized by elevated mercury concentrations. The report also concluded that additional sediment stability and delineation testing at these two buried deposits would be conducted during detailed design phase.

As discussed in Section 1, subsequent to the 2013 Environ Report, the remedial objectives were refined using a science-based approach, resulting in a remedial goal to address mercury-contaminated sediment within the top 15 cm to achieve the risk-based goal of a SWAC of 3 mg/kg or less in each of the Priority Areas. As discussed in Section 1 and detailed in Section 3 below, the SWAC goal of 3 mg/kg is currently met in all three Priority Areas based on the new data collected during the PDI. Additionally, the data indicate that the areas are net depositional and surface sediments are stable, and thus re-exposure of buried mercury is unlikely. Therefore, the following remedial objectives have been developed for the project:

- Augment the local risk reduction already achieved by further reducing mercury concentrations in surface sediment; and
- Reduce the potential for erosion of surface sediment, and thus limit downstream transport of sediment with elevated mercury concentrations and the re-exposure of buried sediment with elevated mercury concentrations.

3.0 SUMMARY OF PDI AND OTHER DESIGN INFORMATION AND BASIS FOR REMEDIAL APPROACH

3.1 Pre-design Investigation Summary

There were numerous rounds of historical investigation activities completed consisting primarily of sediment sampling events from 2001 through 2016. To build on the extensive historical database of sediment mercury concentrations and other site information, three rounds of PDI activities were completed between 2019 and 2020 within Priority Areas 1 through 3 as detailed in the Work Plans (Parsons, Pollutech and Anchor QEA 2019, 2020a and 2020b). Comprehensive results from the PDI are provided in Appendix A. PDI data collection activities related to bathymetry, sediment stability, and sediment mercury concentrations are summarized below.

- **Phase 1 PDI, completed in November 2019 and summer of 2020:**
    - Collection and mercury analysis of samples from 27 locations in Priority Areas 1 through 3. Vertically-continuous sediment cores were collected to a target depth of one meter (or to clay), with mercury analysis conducted in 15 cm intervals. The primary purpose of this sampling was to better define the areas exceeding the target mercury concentration of 10 mg/kg.
    - Collection and mercury analysis of samples from five locations co-located with historical sample locations in Buried Deposits 1 and 2. Vertically-continuous sediment cores were collected to a target depth of one meter (or to clay), with mercury analysis conducted in 15 cm intervals. Grain size analysis was also completed at these locations on samples collected from 0 to 50 cm and 50 to 100 cm.
    - Measurement of water velocities at five transects proximate to locations of subsurface mercury concentrations greater than 10 mg/kg. The transects were located in Buried Deposit 1, Buried Deposit 2, Priority Area 1 and Priority Area 3. Short-term velocity measurements were made at three water depths at each of three locations along each transect.
    - Collection of surface sediment samples at locations adjacent to the water velocity transects with a ponar sampler for grain size analysis.
    - Completion of a bathymetric survey of Priority Areas 1 through 3 and Buried Deposits 1 and 2.
- **Phase 2 PDI, completed in the fall of 2020:**
    - Collection and mercury analysis of samples from 67 locations in Priority Areas 1 through 3. Many historical sample locations were resampled as part of this effort to better understand how mercury concentrations in surface sediment had changed over time. Samples were collected using a combination of cores and ponars. Vertically-continuous sediment cores were collected to a target depth of one meter (or to clay), with mercury analysis conducted in 15 cm intervals. Ponar sample depth varied based on field conditions. Estimating ponar sample depths is inherently less accurate than estimating sample depth intervals from cores. Based on field crew observations, ponar sampling depths ranged from approximately 4 to 20 cm and averaged approximately 10 cm.

Results and conclusions from these activities are discussed below in Sections 3.1.2 and 3.1.3. In addition, the PDI included the activities listed below. Detailed results are included in Appendix A.

- Select sediment samples were analyzed for VOCs, SVOCs, metals. PCBs, and cyanide. These were collected to facilitate development of the dredged sediment handling and disposal design that was anticipated during scoping of the PDI. Given that the remedy no longer involves dredging, these data are not relevant to the design.

- Select sediment samples were analyzed for geotechnical properties (moisture content, grain-size with hydrometer, Atterberg limits, specific gravity, and organic content). These data were collected to supplement the existing geotechnical data and verify the clay and overlying sediment geotechnical properties within the anticipated remedial area are consistent with areas previously characterized and evaluated. These data were used in the geotechnical stability assessment as discussed in Section 4.
- A bench scale study was completed on a fine grained sediment composite sample from Priority Areas 1, 2, and 3 to compare total suspended solids (TSS) to turbidity over a range of values to evaluate whether a strong relationship between TSS and turbidity can be developed. Results were used in the development of the Water Quality Monitoring Plan (WQMP) included as Appendix D.

3.2 Sediment Stability and Buried Deposits

As discussed in Section 1, two areas with buried elevated mercury concentrations (Buried Deposits) were identified during historic sampling of the priority areas. One buried deposit is located between Priority Area 2 and 3, and the other buried deposit is located downriver of Priority Area 3 (**Figure 1**). In addition, there are areas within the three Priority Areas where elevated mercury concentrations are present below the surface (0 to 15 cm) sediment layer. As detailed in Appendix F, sediment stability evaluations indicate that surface sediments within the Buried Deposit areas and Priority Areas are stable and are not at risk of erosion under the extreme events evaluated which would result in re-exposing buried sediment with elevated mercury concentrations. Key results and conclusions from the detailed analysis in Appendix F include:

- St Clair River flows exceeded the predicted 100-year flow on multiple events in late 2019 and early 2020.
- Measurements of near-shore velocities were performed during one of these high flow events in 2019.
- Velocities and computed bed shear stresses were very low.
- Surface sediments range from sands with gravels and fines in Priority Areas to sands and fines in the Buried Deposit areas.
- Results suggest that surface sediment transport potential is low in the Buried Deposits and Priority Areas, with bed armoring occurring in the surface layers.
- As shown in Table 1, comparison of historical and 2020 mercury sampling results in the Buried Deposits indicates that mercury concentrations greater than 10 mg/kg mercury are buried deeper now than they were historically, even after river flows that exceeded the 100-year flow, further verifying that buried mercury within the Buried Deposits is stable.
- Results suggest that surface sediment transport potential is low in the Buried Deposits and Priority Areas

Based on these results and conclusions, no further action is required for the Buried Deposits. These conclusions also support the current remedial approach in the Priority Areas, as discussed below in Section 3.1.3.

3.3 Priority Areas Basis for Remedial Approach

3.3.1 Priority Area Bathymetry

A comprehensive bathymetric survey was completed of the Priority Areas and Buried Deposits in 2020, exclusive of the areas behind areas totally enclosed by the Suncor docks that were not accessible. Results of this survey were compared to the results from the bathymetric survey completed in portions of the Priority Areas in 2011 (Pollutech 2012), as shown in **Figure 5**. In areas where the surveys overlapped, sediment surface elevations were generally higher in 2020 than 2011, even after the 100-year high flow events that occurred in 2019 and 2020. Results indicate that the Priority Areas are generally depositional and stable.

3.3.2 Priority Area Sampling Results and Revised SWAC Calculations

Sediment mercury results from the PDIs are shown in **Figures 6 through 10**. These figures also show results from prior investigations where the mercury concentration exceeded 10 mg/kg in any interval. Since bathymetric results indicate ongoing deposition, a significant goal of the Phase 2 PDI was to resample a subset of the historical sampling locations to obtain mercury data that are more reflective of current conditions for use in revised SWAC calculations in Priority Areas 1 through 3. A total of 26 historical sample locations were resampled. Based on global positioning system (GPS) measurements, 21 of the PDI locations were within 4 meters of the historical sample locations, and five were between 4 and 10 meters of the historical sample locations.

The revised surface sediment mercury SWAC analysis was performed using the same interpolation techniques as reported in the 2016 Anchor QEA Memorandum (Anchor QEA 2016c). SWAC analyses, using results from the top 15 cm of sediment, were performed for the following three data evaluation scenarios:

- Scenario 1: Data from 2001 through the Phase 2 PDI (i.e., 2020) were included in this analysis, except for the original data from all 26 historical sample locations that were revisited in 2020.
- Scenario 2: Data from 2001 through the Phase 2 PDI (i.e., 2020) were included in this analysis, except for the original data from the 21 historical sample locations that were revisited in 2020 and were within 4 meters of the historical sample locations.
- Scenario 3: All data from 2001 through the Phase 2 PDI (i.e., 2020) were included in this analysis.

The resultant SWACs, as well as the previously calculated SWACs based on data from 2001 through 2014 (Anchor QEA 2016c) are shown below. Details regarding the SWAC calculation, including figures showing the results of the Inverse Distance Weighting (IDW) used to calculate the SWACs for Scenarios 1 and 2, are provided in Appendix G.

Priority Area	Mercury SWAC (mg/kg) Based on Data from 2001 thru 2014	Mercury SWAC (mg/kg) Incorporating Current Sample Data		
		Scenario 1	Scenario 2	Scenario 3
PA 1	4.0	2.6	2.7	2.9
PA 2	4.1	2.4	3.1	3.2
PA 3	3.1	2.3	2.3	2.5

As shown above, inclusion of the 2020 data resulted in lower estimated SWACs in each of the Priority Areas. As documented in Table 1 in Appendix G, the average historical mercury concentration in surface sediment at locations that were resampled during the PDI was 19 mg/kg. The average mercury concentration in surface sediment at these locations from the 2020 PDI was 4 mg/kg. Consistent with the lower SWAC in 2020, these results indicate a decrease in mercury concentrations in surface sediment. Decreases are likely a result of natural attenuation processes, such as deposition of cleaner sediments over time.

3.3.3 Priority Area Remedial Approach

As detailed in the table above, mercury SWACs in surface sediment within Priority Areas 1 and 3 are below or essentially equivalent to the 3 mg/kg SWAC goal for all data evaluation scenarios. For Priority Area 2, the SWAC is less than 3 mg/kg for data evaluation scenario 1 and slightly above 3 mg/kg for scenarios 2 (3.1 mg/kg) and 3 (3.2 mg/kg). These results indicate that no further action is required to address potential risks presented by mercury in Priority Area sediments. Based on the bathymetry survey comparison showing these areas to be generally depositional, and the lower concentrations measured during the PDI, mercury concentrations in surface sediment are expected to continue to decrease over time.

Although the remedial goal has already been achieved in Priority Areas 1, 2 and 3, an ERC will be placed in areas with mercury concentrations greater than 10 mg/kg in surface sediment to enhance erosion protection and further decrease mercury concentrations in surface sediment. The ERC will provide a layer of clean substrate which will reduce potential exposure, and reduce the potential for transport of contaminated surface sediment or re-exposure of buried mercury because the ERC will consist of coarser-grained substrate than is currently present.

Areas where the ERC will be placed are shown in **Figures 2 through 4**. Details pertaining to development of the areas where the ERC will be placed are provided in Section 4. Acreages and estimated post-cover SWACs (mg/kg) are summarized below. SWAC calculations are documented in Attachment C.

Priority Area	Priority Area (Acres)	Priority Area Mercury SWAC (mg/kg) Following ERC Placement			
		ERC Area (acres)	Scenario 1	Scenario 2	Scenario 3
PA 1	6.5	0.6	2.2	2.2	2.3
PA 2	2.2	0.25	2.2	2.9	2.9
PA 3	8.1	1.9	1.8	1.8	1.8

3.3.4 River Elevation

For the purposes of the design, river water elevation data were collected from Dry Dock Station, a U.S. National Oceanic and Atmospheric Administration monitoring station, located in Port Huron, MI, approximately 1 km north of Priority Area 1. Data from this location are available on an average daily basis, and for the purposes of this analysis were collected for the period of January 1, 2015, through March 31, 2021. During this period, water levels of the St. Clair River fluctuated by up to roughly 1.2 meters, with water levels recorded as low as 175.91 meters (IGLD85) and as high as 177.09 meters (IGLD85) (**Figure 11**), and an average elevation of 176.5 meters (IGLD85). On average, elevated water conditions occur in late spring through summer, although timing and duration is heavily dependent on precipitation as well as various management practices of the river and surrounding bodies of water (**Figure 12**).

Consideration of river elevation will be important during construction based on consideration of being able to access the ERC areas with barge-based construction equipment. This is of particular significance in Priority Area 3 where two of the ERC areas are in shallow water directly adjacent to the shoreline, as shown in the design drawings included as Appendix B. Based on prior experience, it is anticipated that the placement barge should be able to operate in water depths of 0.75 meters and the placement equipment should be able to place materials up 12 meters from the edge of the barge. Therefore, placement using standard construction methods is anticipated to be achievable under average or higher water level elevations even in the shallow areas of Priority

Area 3. The contractor will be required to include details regarding placement methods and limitations for shallow water placement as part of their Cover Placement Plan.

3.3.5 Velocity

Water velocity may be a consideration for construction equipment anchoring and operating means and methods, and equipment and methods associated with fish barriers as discussed under Subsection 4.1.2, as well as for consideration of design and implementation of silt curtains, if required.

Water velocity was measured at five transects proximate to locations of subsurface mercury concentrations greater than 10 mg/kg as part of the PDI. Short-term velocity measurements were made at three water depths (0.2H, 0.6H, and 0.8H) at each of three or more locations along each transect. This included two transects within the Buried Deposit areas, one transect near the north end of Priority Area 1, one transect near the south end of Priority Area 1, and one transect near the middle of Priority Area 3. Depth-averaged velocities within Priority Area 1 ranged from 0.11 to 0.66 m/s. Depth-averaged velocities within Priority Area 3 ranged from 0.22 to 0.26 m/s. The velocity measurements were made during a high flow event where the river flow exceeded the predicted 100-year flow. Velocities during lower flow conditions would be expected to be lower. Complete details on velocity measurement locations and results are provided in Appendix A.

4.0 DESIGN ELEMENTS

As detailed in Section 3 above, remedial goals have been achieved in the Priority Areas, likely as a result of the natural deposition of sediment. To enhance erosion protection and further decrease mercury concentrations in surface sediment, an ERC will be placed in areas with the highest mercury concentrations in surface sediments. Provided below is a description of the design of the ERC as well as the other activities that will occur to facilitate the remediation.

4.1 General Site Work

Below are details on work that must occur before remedial activities can begin.

4.1.1 Notifications and Access

There are multiple property owners, license holders and lease holders of the areas of the river bottom where the ERCs will be placed, as detailed in Appendix H and summarized below.

Priority Area 1: The Priority Area 1 river bottom is Crown land. The northern ERC area is within a parcel for which TransAlta has a lease issued by Ministry of Northern Development, Mines, Natural Resources and Forestry (MNDMNRF). The southern ERC area is within a parcel for which Suncor has a license issued by MNDMNRF. Written consent from TransAlta and Suncor is required for any work that will be occurring within the leased/licensed areas, including placement of the ERC.

Suncor owns the land adjacent to the southern portion of Priority Area 1. Suncor will provide permission to access their property adjacent to Priority Area 1 to serve as a staging area and access point for the river, as shown on **Figure 13**. An access agreement with Suncor will be required before the commencement of equipment staging. Work crews will also be expected to undergo Suncor's safety training for work in this area and crew supervisors must undergo Safe Work Permit Receiver training. Construction operations must be coordinated with Suncor to ensure that usage of their docks is not interrupted.

TransAlta owns the land adjacent to the northern portion of Priority Area 1. They are currently evaluating potential redevelopment opportunities, including along the shoreline in the vicinity of the ERC adjacent to their property. TransAlta does not require additional permits or safety training, but operations in this area must be coordinated with TransAlta to ensure there are no impacts to any redevelopment activities.

Priority Area 2: The ERC in Priority Area 2 spans properties owned by Enbridge and Shell Canada Limited. Written consent from both companies is required for any work that will be occurring within the property boundaries, including placement of the ERC. The ERC placement area in Priority Area 2 is within proximity of docks owned by Shell. Shell does not require additional permits or safety training, but operations in this area must be coordinated with Shell so that Dock Security is aware of the work schedule in the event of an emergency. Shell owns the land adjacent to Priority Area 2. Shoreline access is not anticipated for Priority Areas 2 as access will be provided from the river.

As shown on **Figure 3**, Priority Area 2 also contains a number of buried utility lines immediately north of the ERC placement area. the closest of which is owned by Enbridge. Material will not be placed over the top of the buried utilities and a sufficient offset has been established, as discussed in Section 4.1.3.2, however an agreement document functionally similar to a Crossing Agreement will be required with Enbridge prior to the start of construction. No material will be placed directly over the pipelines therefore the Canadian Energy Regulator will not need to be involved with this project.

Priority Area 3: The Priority Area 3 river bottom is Crown land and is addressed in Section 4.1.2.2 below. The land adjacent to Priority Area 3 is a public park (Guthrie Park) and is owned by St. Clair Township. Shoreline access is not anticipated for Priority Area 3, as access will be provided from the river.

As shown in **Figure 4**, there is a buried stormwater discharge adjacent to ERC areas in Priority Area 3. It receives stormwater from the Alpenglow Rail facility owned by VIP Rail ULC. Material will not be placed over the top of the stormwater pipeline and a sufficient offset has been established, as discussed in Section 4.1.3.2, however VIP Rail should be notified prior to start of construction.

4.1.2 Permits and Regulatory Approvals

The required permits and regulatory approvals identified are discussed below.

Department of Fisheries and Oceans Canada (DFO). A Request for Review form detailing the proposed work was submitted to the DFO to ensure project compliance with the Fisheries Act. DFO identified two aquatic species at risk that could be negatively impacted during placement of the ERC: the Northern Madtom and the Channel Darter. DFO provided a Letter of Advice providing the recommended measures listed below to avoid and mitigate the potential for prohibited effects to fish and fish habitat, included in Appendix I. How these provisions are addressed within this design are included in italics and parenthesis.

- Complete the works outside of the restricted activity timing windows for spawning fish (i.e., no in-water works between March 15 – July 15) *(This provision has been incorporated into Specification 01 35 43 Environmental Procedures in Appendix C.)*;
- Complete work under calm conditions, where possible *(This provision has been incorporated into Specification 31 23 00 Erosion Resistant Cover in Appendix C.)*;
- Monitor turbidity, implement appropriate erosion and sediment control measures if necessary *(This provision is addressed by the Water Quality Monitoring Plan included as Appendix D)*;
- Minimize sediment resuspension by limiting propeller wash and mechanically placing fill as close to river bed as possible *(This provision has been incorporated into Specification 31 23 00 Erosion Resistant Cover in Appendix C.)*;
- Remove all non-biodegradable erosion and sediment control equipment upon completion of the project *(This provision has been incorporated into Specification 01 35 43 Environmental Procedures in Appendix C.)*;
- Develop and implement a response plan to avoid a spill of deleterious substances and report any spills of deleterious substance *(This provision has been incorporated into Specification 01 35 43 Environmental Procedures in Appendix C.)*; and
- Isolate each work area through the use of turbidity barriers or other means to exclude fish throughout duration of works, and relocate any trapped fish to outside of the work area by means of electrofishing and baited traps. *(This provision has been incorporated into Specification 01 35 43 Environmental Procedures in Appendix C.)*

The Letter of Advice will remain valid for a period of one year from the date of issuance. The party that takes responsibility for implementation of the work will still need to apply for a Species at Risk permit from DFO related to the catching, trapping and relocation of fish prior to implementation.

Ministry of the Environment, Conservation, and Parks (MECP). MECP is the lead for biota species potentially at risk, and a letter per Proponents Guide to Species at Risk Screening was submitted to them to gain an understanding if the proposed project is likely to impact Species at Risk or if the project is likely to trigger the need for an authorization under the Ontario Endangered Species Act. Resulting correspondence from the MECP Species at Risk Branch, included in Appendix I, noted the items listed below. How these provisions are addressed within this design are included in italics and parenthesis:

- While this review represents MECP's best currently available information, it is important to note that a lack of information for a site does not mean that SAR or their habitat are not present. There are many areas where the Government of Ontario does not currently have information, especially in areas not previously surveyed. On-site assessments will better verify site conditions, identify and confirm presence of species at risk and/or their habitats. *(The requirement for an on-site assessment has been incorporated into Specification 01 35 43 Environmental Procedures in Appendix C.)*
- If any vegetation removal must occur, then surveys for Butternut trees should be completed prior to the start of any vegetation removal. If butternut trees are detected and the proponent wishes to remove them, then Butternut Health Assessment must be completed on all trees which might be impacted by the proposed development prior to the removal of any vegetation and start of construction. *(This requirement has been incorporated into Specification 01 35 43 Environmental Procedures in Appendix C.)*
- No in-water work should be carried out from May 1st to June 30th to avoid potential negative impacts to Lake Sturgeon and/or its habitat. *(This provision is less restrictive than the seasonal restrictions provided by DFO, which have been incorporated into Specification 01 35 43 Environmental Procedures in Appendix C.)*
- DFO should be contacted to ensure federal legislation is adhered to and provided that DFO is the holder of the fish and mussel *observation* databases. *(DFO has been contacted, as detailed above.)*
- It is the responsibility *of* the proponent to ensure that SAR are not killed, harmed, or harassed, and that their habitat is not damaged or destroyed through the proposed activities to be carried out on the site. If the proposed activities can not avoid impacting protected species and their habitats, then the proponent will need to apply for an authorization under the ESA. *(Acknowledged.)*

The correspondence from MECP Species at Risk Branch also indicated that the electrofishing, trapping and relocation of fish species at risk may fit the eligibility criteria and qualify for regulatory exemption and thus only require online registration rather than permitting through MECP. Additional information on the determination and registration process are included in their correspondence included in Appendix I.

Special permits or approvals are not required from MECP for other aspects of the work. Although no permits or approvals were identified as being required from MECP related to water quality monitoring, staff from MECP's Southwest Region Technical Support Section and Environmental Monitoring and Reporting Branch were consulted on the proposed water quality monitoring program. Their comments were taken into consideration in developing the final WQMP included as Appendix D.

Whether or not an Individual Environmental Assessment will be required by MECP for the proposed work will need to be revisited once decisions have been made in regard to implementation.

Transport Canada. Individual applications will need to be submitted for each of the Priority Areas to ensure compliance with the Canadian Navigable Waters Act. Each approval package must at a minimum contain the following:

- A map showing the project location
- The legal site description and project coordinates
- Plan and profile view drawings with all related dimensions
- A general arrangement drawing
- A detailed project description

- Construction methodology
- The anticipated start and end dates

A 30-day public comment period will be required. It is not anticipated that this approval process will affect the Remedial Design. The submittal and approval process should be implemented subsequent to the Final Design and prior to the start of construction.

MNDMNRF. Based on communication with MNDMNRF, in order to provide a Letter of Authorization, they will require:

- Material description
- Construction Plans and Specifications
- Site photos
- Public Lands Act Applications 1 and 5
- Documentation of Indigenous consultation
- Written consent from property owners, license holders and lease holders of the ERC areas, as well as backshore/shoreline property owners, license holders or lease holders that may be impacted.

MNDMNRF should be contacted for idenfication of subject property owners, license holders and lease holders. Preliminary information on property owners, license holders and lease holders provided by MNDMNRF is provided in Appendix H and is also discussed in Section 4.1.1. It is not anticipated that this approval process will affect the Design. The submittal and approval process should be implemented subsequent to the Final Design and prior to the start of construction.

St. Clair Region Conservation Authority (SCRCA). – An Application for a Permit under O. Reg. 171/06 (St. Clair Region Conservation Authority: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses) would need to be submitted and a permit obtained prior to implementation of the work. The following is a link to the application form and a list of the information that would need to be submitted to accompany the application:

1. Application form: https://www.scrca.on.ca/wp-content/uploads/2018/11/FORMR1-SCRCA-Application-Form1.pdf [scrca.on.ca]
2. Site plans showing the dimensions and locations of the proposed works, in relation to other significant features of the property, such as watercourses, structures, property lines, roads, etc.
3. Profile (side view) drawing showing the approximate depth of the works and approximate slope gradients of the site before and after the completion of the works
4. Drawings showing the existing shoreline and the shoreline after the proposed works are completed (change in bottom elevations, alterations to banks, etc.)
5. Construction details including materials, methods, and equipment to complete the works
   a. Confirm how works will be completed (i.e., by land/barge)
   b. Works will be completed in low water/flow conditions
   c. What type of machinery will be used?
   d. The construction process – what is involved to complete the works
   e. Confirm you will maintain existing conditions (i.e., limit vegetation removal, no alterations to the river bottom, no changes to the channel of the river, etc.)
6. Proposed sediment and erosion control details
7. Timing of the works

It is not anticipated that this approval process will affect the Design. The submittal and approval process should be implemented subsequent to the Final Design and prior to the start of construction.

City of Sarnia. SCRCA confirmed with the City of Sarnia that no city permits will be required for the temporary staging area at the Suncor Refinery.

4.1.3 Site Preparation

Below are the details for site preparation and related work that must occur before remedial activities in the Priority Areas can begin.

4.1.3.1 Access and Staging Areas

As shown in **Figure 13**, a portion of the Suncor Energy Product Partnership – Sarnia Refinery property will be made available by Suncor for use as a staging area. This staging area is in the northwest portion of the facility along the bank of the St. Clair River, directly adjacent to Priority Area 1, and can be accessed on land by St. Clair Parkway. The available area is approximately 1.25 acres (5,400 m^2) and is split into two portions: secure and unsecure, as shown in **Figure 13**. The secure area is enclosed within Suncor's fencing at the facility and can be used to stage equipment and materials that will stay on-site overnight. The unsecure area is not enclosed and can be accessed directly from St. Clair Pkwy, therefore can only be used for gravel storage and vehicles and equipment that will not remain at the facility overnight.

Additional equipment will be staged on barges in the St. Clair River as appropriate. When not in use, these barges will be moored at a secure location to be determined by the Contractor.

Directly adjacent to the staging area in Priority Area 1 is one of the targeted placement areas for the ERC, which is enclosed within the Suncor dock. Due to the consistent use of the dock and utility lines that run along it, it is not possible to remove any of the sections to allow barges to pass through. Therefore, it will be necessary to place the construction barges and equipment required to place the ERC into the river in this area using a crane or other methods from the shoreline access area shown in **Figure 13**.

4.1.3.2 Utilities

As shown in **Figure 3**, there are a series of buried utility product lines in proximity to the ERC areas in Priority Area 2 and one buried stormwater discharge adjacent to ERC areas in Priority Area 3. Before work can commence, an Ontario One Call notification must be made so the buried utilities can be marked out along the shoreline. The utilities will also be entered into GPS equipment used by the contractor using the most accurate location data that has been made available. The utility owners will be notified prior to the start of work so that they may provide an on-site representative for the purpose of oversight while remedial activities are conduction in proximity to their respective utility lines.

To ensure there are no impacts to the buried utilities in Priority Area 2, no spudding, anchoring, cover placement or other activities that could disturb the sediment bed is allowed north of the second to last foundation pillar of the Shell dock, as requested by Enbridge (owner of closest pipeline) and shown in **Figure 3**. To ensure there are no impacts to the buried stormwater drain in Priority Area 2, no spudding, anchoring, cover placement or other activities that could disturb the sediment bed is allowed within 8 meters of the pipeline, as shown in **Figure 4**.

4.1.3.3 Pre-Condition Survey

A pre-construction condition survey will be completed to assess the condition of the existing structures adjacent to the ERCs. A similar post-construction condition survey will be completed to verify that ERC construction activities did not negatively impact the existing infrastructure. The pre- and post-condition surveys will be completed, at a minimum, on the following portions of the infrastructure adjacent to ERC placement areas:

Priority Area 1

- TransAlta dock
- Suncor docks
- Suncor water intake structure

- TransAlta and Suncor shoreline sheet pile walls

Priority Area 2

- Shell docks
- Shoreline sheetpile wall
- Free-standing sheetpile wall extending into the river

Details regarding the condition surveys are provided in Specification 01 71 00 in Appendix C.

4.2 Erosion-Resistant Cover

4.2.1 Design Criteria and Resultant Erosion-Resistant Cover Material

The primary purpose of the ERC is to provide increased erosion protection from high flow events.

The ERC substrate will be fine crushed gravel with stone size ranging from approximately 5 to 26 mm (0.2 inches to 1 inch) to provide enhanced erosion protection. As documented in the stability evaluation in Appendix F, this will provide a stable substrate even under river flow conditions exceeding a 100-year event, The gravel will be double washed to reduce turbidity during placement of the ERC. ERC material will meet the Ontario Provincial Standard Specifications for 19 mm Clear Stone (Type II), which has a gradation listed below. Complete specifications are provided in Specification 31 23 00 Erosion Resistant Cover in Appendix C.

Gradation for 19 mm Clear Stone (Type II)

Sieve Size	Percent Passing
26 mm	100%
19 mm	90 to 100%
16 mm	65 to 90%
9.5 mm	20 to 55%
4.75 mm	0 to 10%

The Canadian Remedial Action Plan Implementation Committee suggested that it would be beneficial if the ERCs were suitable habitat for Sturgeon, and suggested the Habitat Suitability Index Model for Lake Sturgeon (Adult and Juvenile) (Collier 2018) could be used as a basis for evaluating suitability. The habitat conditions of substrate, water velocity, water depth, and minimum size of the ERCs will be suitable for adult (spawning) and juvenile (nursery) sturgeon, as shown in Tables 2 and 3.

In addition to erosional forces due to river currents, other potential erosional forces that may act on the ERC include waves due to wind and boat wakes, propeller wash due to passing boats and ice scour. The ERC has not been specifically designed to resist these erosional processes. As discussed in Section 3.1, existing sediments in the areas where the ERCs are proposed have proven to be stable and are generally depositional even under current conditions which experience these forces, and the gravel substrate of the ERC will provide a significantly higher resistance to these forces than the current substrate. Nevertheless, there is a potential for localized movement of the ERC substrate due to these forces, particularly in shallow water and shoreline areas where these forces are the greatest. These localized impacts, if they occur, are expected to be minor and would not impact the overall effectiveness of the ERC given the current lack of measurable risk. The ERCs are not within the main shipping channel or within the Suncor or Shell docking areas, therefore potential erosion from large ship and barge propwash is not anticipated.

The ERC substrate will be fine crushed gravel with stone size ranging from approximately 5 to 26 mm (0.2 inches to 1 inch) to provide enhanced erosion protection. This is significantly larger than the current substrate in the Priority Areas, which consists primarily of sands. As detailed in Appendix F, the ERC materials could withstand river velocities up to at least 0.9 m/s. The 100-year modeled depth-averaged velocity within the PAs is approximately 0.78 m/s, and the depth-averaged velocity within the Priority Areas measured during a high flow event that was within 8% of the 100-year flow ranged from 0.045 m/s to 0.66 m/s and averaged 0.22 m/s. The cover material will provide significantly greater erosion resistance to river velocities than the native bed materials and provides a high degree of confidence that the ERC will not be disrupted due to river flow velocities.

The geotechnical stability of the existing slopes were checked taking into consideration the additional load that will be imposed on the slopes due to the ERC. The stability of the side slopes were analyzed using GeoStudios 2016 Slope/W computer program by Geo-Slope International. The Spencer (1967) method, which considers force and moment limit equilibrium to compute the Factor of Safety (FS) against slope failure, was used in the stability analyses. Only static slope stability analyses were performed since minimal impact on the static FS indicates minimal change to the seismic FS. The stability analysis verified that the ERC would have minimal impact on the stability of the existing slopes, and that the existing slopes have an adequate FS under the loading imposed by the ERC. However, as a precautionary measure to prevent potential localized failure in the soft river sediments during placement of the ERC, it is recommended that the ERC be placed from lower to higher elevations during construction.

4.2.2 Erosion-Resistant Cover Area

The ERCs are bounded by samples with mercury concentrations less than 10 mg/kg. ERC areas were developed using professional judgment considering:

- Historical and PDI surface (top 15 cm) sample locations with mercury concentrations greater than 10 mg/kg.
- Need to protect marine infrastructure, specifically buried utilities and loading docks and walkways.

ERC areas are shown in **Figures 2 through 4**, and acreages are summarized below.

	Area (hectares)	Area (acres)
Priority Area 1	0.24	0.6
Priority Area 2	0.10	0.25
Priority Area 3	0.76	1.9
Total	1.1	2.7

Additional discussion of the ERC area in each Priority Area is provided below.

<u>Priority Area 1</u>

In Priority Area 1 (**Figures 6 through 8**), the ERC area covers all areas associated with PDI locations and historical sample locations more than 4 meters from a resample location where mercury exceeded 10 mg/kg in the top 15 cm, with the exception of a single data point that is completely surrounded by active docking and petroleum loading infrastructure. The small area associated with PDI sample location SED-41 is surrounded by active loading pipelines and infrastructure and is directly adjacent to the active docking area, and accessing this area would be much more challenging, expensive, and disruptive to Suncor operations than the remaining ERC area.

Therefore, no ERC would be placed in this small area. Given that Priority Area 1 already meets the SWAC goal of 3 mg/kg, and placement of an ERC in the identified area would result in a further reduction in the SWAC to 2.2 from 2.3 mg/kg (depending on evaluation scenario), exclusion of this small area is appropriate.

Priority Area 2

In Priority Area 2 (**Figure 9**), the ERC area covers all areas associated with PDI locations and historical sample locations more than 4 meters from a resample location where mercury exceeded 10 mg/kg in the top 15 cm, with the exception of infrastructure offset areas and the small area over the buried pipeline in the vicinity of historic sample locations 249_2008 and T262-U-10. As discussed in Section 4.1.3.2 above and shown in **Figure 3**, there are numerous buried utilities within Priority Area 2. Although the ERC itself would not disturb the sediment or buried utilities, construction scows and barges used to place the ERC material would need to anchor and/or drive spuds into the sediment to maintain their position during ERC placement, which could potentially impact the buried utilities. The potential impacts of damaging a buried pipeline could be very significant financially and environmentally if the damage resulted in product loss from the pipelines. Therefore, it is typical on sediment remediation projects to create off-sets from pipelines. For example:

- Onondaga Lake – 25-foot (7.5-meter) offset established from deep water sewage treatment discharge pipe
- Fox River – numerous buried pipelines
  - Standard dredging and capping offset of 50 feet (15 meters)
  - Offset potentially reduced to 25 feet (7.5 meters) if horizontal and vertical position known within +/- 6 inches (15 centimeters) vertically and +/- 5 feet (1.5 meters) horizontally

Given the uncertainty associated with the position of the buried utilities in Priority Area 2 and the significant implications if a pipeline were to be damaged, an appropriate offset from the pipelines was established for the ERC area based on the recommendation of the closest utility owner (Enbridge) as detailed in Section 4.1.3.2. Historic sample locations 249_2008 and T262-U-10 are within the off-set area and therefore will not receive an ERC. Given that Priority Area 2 already meets the SWAC goal of 3 mg/kg (based on Scenario 1), and the ERC will result in a further reduction in the mercury surface-sediment SWAC to 2.2 mg/kg, exclusion of this small area is acceptable. In addition, multiple surface sediment samples were collected in 2020 in the vicinity of the pipelines, and the mercury concentrations were all less than 10 mg/kg.

Priority Area 3

In Priority Area 3 (**Figure 10**), the ERC area covers all areas associated with historical and PDI locations where mercury exceeded 10 mg/kg in the top 15 cm.

4.2.3 Thickness

The ERC will have a minimum thickness of 15 cm, with an anticipated average thickness of approximately 25 cm, providing a layer of clean substrate that reduces that potential exposure and transport of contaminated sediments. The clean substrate will consist of a coarser-grained material than what is currently present within the river, which will be resistant to reasonably anticipated erosive forces. The ERC will provide long term physical isolation of the underlying sediments and prevent exposure to fish and wildlife.

The actual thickness of the cover layer constructed in the field will exceed the minimum required design thickness due to operational considerations of how the ERC will be placed. To ensure that the minimum thickness of the layer is obtained, the construction contract will allow for over-placement beyond the minimum target thickness. The result will be that the final thickness will be equal to or greater than the minimum thickness in all areas. For design purposes based on experience at similar sites, it is assumed that the average ERC thickness will be approximately 25 cm.

4.2.4 Material Sourcing

Approximately 3500 m^3 of material will be imported to construct the ERCs. It is expected that most or all of the ERC material will be locally sourced. There are numerous potential material sources in the Sarnia area. For example, Southwestern Sales Corporation and LaFarge Aggregate are both located along the river in Sarnia, offer a variety of gravel types, and may be able to directly load on to barges for transport.

The ERC material specified was developed to facilitate local sourcing while meeting design requirements. The specified material is too large for chemical analysis, however it must consist of virgin gravel or stone from a permitted mine or quarry.

4.2.5 Placement Methods

To perform the placement of the ERC, is it expected that multiple pieces of equipment will be required. Placement activities within the Priority Areas are expected to be performed from the water using deck barge-supported excavator(s). Work boats will be used to position equipment and material barges. The ERC material placement buckets will be equipped with real-time kinematic (RTK) differential global positioning system (DGPS) with visualization ensure accurate placement of material.

Material placement will be conducted in a manner that minimizes disturbances of the sediment to reduce, to the extent possible, sediment resuspension that would create significant movement of contaminated sediment outside of the Priority Areas or exceed water quality criteria.

Operational controls and best management practices (BMPs) will be implemented to minimize sediment resuspension and maintain compliance with the surface water quality requirements. BMPs shall include, but are not limited to, the following:

- Place material at an appropriate rate and steadiness to minimize the movement of contaminated sediment.
- Release materials as close to the river bottom as feasible (target bottom of bucket elevation of 10 to 20 cm above the river bed) to minimize the resuspension of contaminated sediment.
- Conduct vessel operations in a manner to minimize potential resuspension due to propeller wash.
- Complete work under calm conditions to the extent practical.

All in-water work may be subject to seasonal timing restrictions, as detailed in Section 4.1.2.

4.2.6 Turbidity and Water Quality Controls

Turbidity and other water quality controls and monitoring to be implemented are detailed in Section 6.

4.3 Restoration

Below are details on work that must occur upon the completion of remedial activities.

4.3.1 Staging Areas

During the process of remedial work, the contractor will keep the staging area free from accumulation of waste materials, rubbish, and other debris resulting from the work. Upon the completion of work, contractor will remove and dispose of all waste materials, rubbish, and debris from and about the premise, as well as remove all tools, appliance, construction equipment and machinery, and surplus substrate material. The contractor will repair or replace all pavement, sidewalks, driveways, fences, shrubs, lawns, trees, and other public or private property that were damaged as a result of the work. All such replacement will be done in accordance with the applicable specifications. In all cases, replacement will be at least equal to the original conditions.

Additional details pertaining to the staging area requirements are provided in Specification 01 50 13 and Specification 01 35 43 in Appendix C, including requirements for secondary containment of all fueling operations and other measures to prevent unacceptable impacts to the staging areas.

4.3.2 Shoreline Areas

During the process of remedial work, it may be necessary to perform work directly along the shoreline of Priority Area 1 as part of shoreline staging activities. This would likely be primarily in the area where there is a shoreline sheetpile present. Upon completion of work, the contractor will complete shoreline restoration consistent with the staging area restoration activities detailed in Section 4.3.2.

It is not anticipated that work activities will be conducted above the water surface along the shorelines of Priority Areas 2 or 3. However, any damage as a result of work in ERC areas adjacent to the shoreline shall be repaired to conditions at least equal to the original.

5.0 CONSTRUCTION QUALITY ASSURANCE

In the context of this document, Construction Quality Control (CQC) and Construction Quality Assurance (CQA) are defined as:

- CQC - Those actions which provide a means to measure and regulate the characteristics of an item or service in relation to contractual and regulatory requirements. CQC refers to the actions taken by the Contractor, Manufacturers, or Installers to verify that the materials and the workmanship of the various components of the construction meet the requirements of the RD, including the construction drawings and the technical specifications.
- CQA - The planned and systematic means and actions designed to check with adequate confidence that the materials and/or services meet contractual and regulatory requirements and will perform satisfactorily in service. CQA refers to means and actions employed by the Implementing Parties and/or their representative to check conformity of the various components of the construction with the requirements of the RD, including the construction drawings and the technical specifications.

The Construction Quality Assurance Project Plan (CQAP) included as Appendix E details the CQC and construction quality assurance (CQA) activities to be implemented during construction of the remedy. The CQC/CQA program described therein will be implemented to verify that the remedy is constructed consistent with the project final RD. The objectives of the CQAP are to:

- describe the quality program to be implemented to verify that the project is constructed in accordance with the requirements of the design and industry standards;
- define the CQC and CQA teams, associated roles and responsibilities, and communication process;
- describe guidelines and procedures for inspection and testing of construction/operational activities; and
- describe the documentation and record keeping protocol to be followed for pre-, during, and post-construction activities, including specifying requirements for documenting any deficiencies or field changes.

The Contractor will also need to prepare and submit an ERC Placement Plan that will detail construction quality control procedures following Contractor selection and Notice to Proceed.

5.1 Confirmation of Cover Placement

The contractor will use multiple methods to verify that the minimum required thicknesses has been uniformly achieved over the entirety of each ERC area. Experience at other sites indicates that coring of gravel can result in estimates of material thickness that are biased low. Therefore, the following methods will be used to verify that the minimum thickness of 15 cm is uniformly achieved:

- Calculation of average thickness based on volume of material placed and the area of placement.
- Pre-placement and post-placement elevation measurements.
- Review of elevation data based on placement bucket measurements collected during construction.

Details are provided in Specification 31 23 00 and Specification 01 71 00 in Appendix C.

6.0 ENVIRONMENTAL PROTECTION (AIR, WATER, DUST, LAND)

Construction contractors will be required to submit an Environmental Protection Plan for approval prior to beginning construction, which will include:

- Erosion and Sediment Control Plan
- Traffic Control Plan
- Spill Control Plan
- Non-Hazardous Solid Waste Disposal Plan
- Air Pollution Control Plan
- Contaminant Prevention Plan
- Waste Water Management Plan

Details regarding the content of and requirements under these plans are detailed in Specification 01 35 04 in Appendix C.

Measures to protect surface waters will be implemented, including measures to control the release of turbidity and contamination resulting from placing the ERC in the Priority Areas. The BMPs listed in Section 4.2.5 and use of washed gravel will be the primary methods to minimize turbidity and maintain surface water goals during construction

Surface water will be monitored in real time in the field for turbidity to ensure compliance with water quality criteria throughout ERC placement activities, as detailed in the WQMP included as Appendix D. Water samples will also be collected for chemical analysis during placement of the first ERC area to verify there are no adverse water quality impacts. The first Canadian drinking water intake downstream of the Sarnia industrial zone is at the Walpole Island First Nation water treatment plant. The plant is located approximately 32 kilometers downstream of the PAs. Out of abundance of caution, and to provide added confidence that cover placement activities are not negatively impacting drinking water, it is proposed that water samples be collected for chemical analysis from the Walpole Island First Nation Water Plant during ERC placement. During material placement activities, turbidity barriers such as floating silt curtains may be deployed around the ERC areas as a response action if determined necessary to maintain water quality goals based on real-time monitoring of turbidity.

There may also be private water intakes located downstream of the cover placement areas on the Canadian side of the river that serve individual households/properties for potable water and/or non-potable water purposes. The local MECP office in Sarnia and MECP's Spills Action Centre have a list of water intakes, including private water intakes, for notification purposes. Prior to implementing the work, the MECP office in Sarnia should be contacted to evaluate whether private intakes exist and determine if notification procedures should be put in place.

7.0 EROSION-RESISTANT COVER LONG-TERM INTEGRITY CONSIDERATIONS

Potential mechanisms whereby the ERC could be disturbed following construction include erosion and disruption due to marine construction activities. Potential actions to monitor and control these mechanisms include long-term monitoring and institutional controls. Each of these are discussed below.

7.1 Long-Term Monitoring

Long-term monitoring is often a component of sediment remediation projects to verify that an engineered sediment cap or cover remains in place and is not eroded over time. However, given the lack of measurable risk under pre-remediation conditions, the strong evidence of sediment stability even in the absence of the ERC, and the high level of erosion protection that will be provided by the ERC, the need for long-term monitoring will be determined during the implementation stage by the agencies. Factors that will be taken into consideration are detailed below.

The ERC substrate will be fine crushed gravel with stone size ranging from approximately 5 to 26 mm (0.2 inches to 1 inch) to provide enhanced erosion protection. This is significantly larger than the current substrate in the Priority Areas, which consists primarily of sands. As detailed in Appendix F, the ERC materials could withstand river velocities up to at least 0.9 m/s. The 100-year modeled depth-averaged velocity within the PAs is approximately 0.78 m/s, and the depth-averaged velocity within the Priority Areas measured during a high flow event that was within 8% of the 100-year flow ranged from 0.045 m/s to 0.66 m/s and averaged 0.22 m/s. The cover material will provide significantly greater erosion resistance to river velocities than the native bed materials and provides a high degree of confidence that the ERC will not be disrupted due to river flow velocities.

As discussed in Section 4.2.1, the ERC has not been specifically designed to resist erosional processes associated with waves due to wind and boat wakes, propeller wash due to passing boats and ice scour. As discussed in Section 3.1, the area of the ERCs have proven to be stable and are generally depositional even under current conditions which experience these forces, and the gravel substrate of the ERC will provide a significantly higher resistance to these forces than the current substrate. Nevertheless, there is a potential for localized movement of the ERC substrate due to these forces, particularly in shallow water and shoreline areas where these forces are the greatest. These localized impacts, if they occur, are expected to be minor and would not impact the overall effectiveness of the ERC given the current lack of measurable risk. The ERCs are not within the main shipping channel or within the Suncor or Shell docking areas, therefore potential erosion from large ship and barge propwash is not anticipated.

7.2 Institutional Controls

Institutional controls (ICs) are non-engineered instruments, such as administrative and legal controls, that may be included as part of a remedial action to minimize the potential for human health or ecological exposure to sediment contamination and ensure the long-term integrity of the remedy. ICs can be divided into four categories: proprietary controls, governmental controls, enforcement and permit tools with IC components, and informational devices (USEPA 2012). Within each category, there are a variety of ICs that may be employed. A brief summary of each of these types of ICs is provided below, followed by a project-specific discussion of ICs.

Proprietary controls refer to controls on land use that are considered private in nature because they tend to affect a single parcel of property and are established by private agreement between the property owner and a second party who, in turn, can enforce the controls. Common examples include easements that restrict use (also known as negative easements) and restrictive covenants.

Governmental controls impose restrictions on land or resource use using the authority of a government entity. Typical examples of governmental controls include zoning; building codes; state, tribal, or local groundwater use regulations; and commercial fishing bans and sports/recreational fishing limits posed by federal, state and/or local resources and/or public health agencies.

Enforcement and permit tools with IC components are legal tools, such as administrative orders, permits, Federal Facility Agreements (FFAs), and Consent Decrees (CDs), that limit certain site activities or require the performance of specific activities (e.g., monitor and report on IC effectiveness). These legal tools may be issued unilaterally or negotiated.

Informational devices provide information or notification often as recorded notice in property records or as advisories to local communities, tourists, recreational users, or other interested persons that residual contamination remains on site. As such, informational devices generally do not provide enforceable restrictions. Typical informational devices include state registries of contaminated sites, notices in deeds, tracking systems, and fish/shellfish consumption advisories.

There is always the potential for another party to need to do work at some point in the future, along the St. Clair River shoreline, where mercury remains at depth and/or where the Erosion Resistant Cover has been applied. Work could be related to such activities as the addition, repair or replacement of infrastructure (e.g. pipelines, docks or walkways). It may be beneficial to have some form of legal or administrative measures in place to restrict future activities, and/or require they be done in a manner that is protective of the cover and minimizes the potential for resuspension and transport of mercury-impacted sediment. Discussions are underway with agencies and adjacent water lot owners to determine the best approach to achieve this goal.

8.0 REFERENCES

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TABLES

PARSONS

Table 1
Buried Deposit Historical Versus 2020 Core Mercury Profiles

Sample Location	Start Depth (cm)	End Depth (cm)	Total Hg ug/g	Year	Sample Location	Start Depth (cm)	End Depth (cm)	Total Hg mg/kg
Historical Results					2020 Results			
Buried Deposit 1								
T272-45_2001	0	5	1.3	2001	SED-26			
T272-45_2001	5	15	1.1	2001	SED-26	0	15	1.09
T272-45_2001	15	25	5	2001	SED-26	15	30	3.84
T272-45_2001	25	35	8.7	2001	SED-26			
T272-45_2001	35	45	5.6	2001	SED-26	30	45	2.76
T272-45_2001	45	55	11	2001	SED-26	45	60	3.83
T272-45_2001	55	65	48	2001	SED-26			
T272-45_2001	65	75	100	2001	SED-26	60	75	4.18
T272-45_2001	75	86	110	2001	SED-26	75	80	21.3
BD1-S2	0	10	0.934	2015	SED-25	0	15	0.399
BD1-S2	10	20	1.81	2015	SED-25			
BD1-S2	20	30	1.96	2015	SED-25	15	30	0.507
BD1-S2	30	40	7.07	2015	SED-25	30	45	0.65
BD1-S2	40	50	2.02	2015	SED-25			
BD1-S2	50	60	3.55	2015	SED-25	45	60	1.42
BD1-S2	60	70	8.68	2015	SED-25	60	75	7.37
BD1-S2	70	80	1.62	2015	SED-25			
BD1-S2	80	90	2.71	2015	SED-25	75	90	3.37
BD1-S2	90	100	4.12	2015	SED-25	90	105	2.67
BD1-S2	100	110	3.48	2015	SED-25			
BD1-S2	110	120	5.1	2015	SED-25	105	120	2.34
BD1-S2	120	130	25.1	2015	SED-25			
BD1-S3	0	10	2.53	2015	SED-27	0	15	2.22
BD1-S3	10	14	4.08	2015	SED-27			
BD1-S3	14	20	74.7	2015	SED-27			
BD1-S3	20	30	149	2015	SED-27	15	30	34.5
BD1-S3	30	40	86.6	2015	SED-27	30	37	49
BD1-S3	40	50	20.5	2015	SED-27			
BD1-S3	50	60	18.2	2015	SED-27			
BD1-S3	60	70	61.8	2015	SED-27			
BD1-S3	70	80	27.4	2015	SED-27			
BD1-S3	80	90	2.04	2015	SED-27			

PARSONS

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Buried Deposit Historical Versus 2020 Core Mercury Profiles

Sample Location	Start Depth (cm)	End Depth (cm)	Total Hg ug/g	Year	Sample Location	Start Depth (cm)	End Depth (cm)	Total Hg mg/kg
Historical Results					2020 Results			
Buried Deposit 2								
BD2-S1	0	10	12	2015	SED-29	0	15	0.587
BD2-S1	10	20	1.45	2015	SED-29			
BD2-S1	20	30	2.06	2015	SED-29	15	30	0.93
BD2-S1	30	40	1.35	2015	SED-29	30	45	1.39
BD2-S1	40	50	1.88	2015	SED-29			
BD2-S1	50	60	0.854	2015	SED-29	45	60	1.75
BD2-S1	60	70	1.7	2015	SED-29	60	75	1.27
BD2-S1	80	90	27.6	2015	SED-29	75	90	1.41
					SED-29	90	105	14.6
					SED-29	105	120	22.7
					SED-29	120	135	16.1
					SED-29	135	150	9.34
					SED-29	150	165	4.7
					SED-29	165	180	0.112
					SED-29	180	190	0.095
BD2-S2	0	6	0.63	2015	SED-28	0	15	0.394
BD2-S2	6	10	0.566	2015	SED-28			
BD2-S2	10	18	1.05	2015	SED-28			
BD2-S2	18	20	0.891	2015	SED-28			
BD2-S2	20	30	1.15	2015	SED-28	15	30	0.888
BD2-S2	30	40	0.874	2015	SED-28	30	45	1.05
BD2-S2	40	50	1.08	2015	SED-28			
BD2-S2	50	60	2.27	2015	SED-28	45	60	0.995
BD2-S2	60	70	3.31	2015	SED-28	60	75	1.37
BD2-S2	70	80	36.3	2015	SED-28			
BD2-S2	80	90	72.1	2015	SED-28	75	90	8.48
BD2-S2	90	100	75.6	2015	SED-28	90	105	49.9
BD2-S2	100	108	25.6	2015	SED-28			
BD2-S2	108	112	13.3	2015	SED-28			
BD2-S2	112	120	13.2	2015	SED-28	105	120	30.1
					SED-28	120	135	15.1
					SED-28	135	150	9.76
					SED-28	150	165	1.42
					SED-28	165	180	0.079
					SED-28	180	190	0.103

x.x Mercury concentration exceeds 10 mg/kg

PARSONS

Table 1
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BD1-S2	0	10	0.934	2015	SED-25	0	15	0.399
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BD1-S2	20	30	1.96	2015	SED-25	15	30	0.507
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BD1-S2	40	50	2.02	2015	SED-25			
BD1-S2	50	60	3.55	2015	SED-25	45	60	1.42
BD1-S2	60	70	8.68	2015	SED-25	60	75	7.37
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BD1-S2	80	90	2.71	2015	SED-25	75	90	3.37
BD1-S2	90	100	4.12	2015	SED-25	90	105	2.67
BD1-S2	100	110	3.48	2015	SED-25			
BD1-S2	110	120	5.1	2015	SED-25	105	120	2.34
BD1-S2	120	130	25.1	2015	SED-25			
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BD1-S3	10	14	4.08	2015	SED-27			
BD1-S3	14	20	74.7	2015	SED-27			
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BD1-S3	30	40	86.6	2015	SED-27	30	37	49
BD1-S3	40	50	20.5	2015	SED-27			
BD1-S3	50	60	18.2	2015	SED-27			
BD1-S3	60	70	61.8	2015	SED-27			
BD1-S3	70	80	27.4	2015	SED-27			
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Sample Location	Start Depth (cm)	End Depth (cm)	Total Hg ug/g	Year	Sample Location	Start Depth (cm)	End Depth (cm)	Total Hg mg/kg
Historical Results					2020 Results			
Buried Deposit 2								
BD2-S1	0	10	12	2015	SED-29	0	15	0.587
BD2-S1	10	20	1.45	2015	SED-29			
BD2-S1	20	30	2.06	2015	SED-29	15	30	0.93
BD2-S1	30	40	1.35	2015	SED-29	30	45	1.39
BD2-S1	40	50	1.88	2015	SED-29			
BD2-S1	50	60	0.854	2015	SED-29	45	60	1.75
BD2-S1	60	70	1.7	2015	SED-29	60	75	1.27
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BD2-S2	6	10	0.566	2015	SED-28			
BD2-S2	10	18	1.05	2015	SED-28			
BD2-S2	18	20	0.891	2015	SED-28			
BD2-S2	20	30	1.15	2015	SED-28	15	30	0.888
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BD2-S2	90	100	75.6	2015	SED-28	90	105	49.9
BD2-S2	100	108	25.6	2015	SED-28			
BD2-S2	108	112	13.3	2015	SED-28			
BD2-S2	112	120	13.2	2015	SED-28	105	120	30.1
					SED-28	120	135	15.1
					SED-28	135	150	9.76
					SED-28	150	165	1.42
					SED-28	165	180	0.079
					SED-28	180	190	0.103

x.x	Mercury concentration exceeds 10 mg/kg

PARSONS

TABLE 2
ADULT STURGEON (SPAWNING) HABITAT SUITABILITY INDEX

Parameter		Suitability Index Poor <0.30 Marginal 0.3-0.79 Suitable 0.8-1.0	Erosion-Resistant Cover Habitat Conditions
Substrate	**(mm)**		
	Clay	0	
	Silt	0	
	Sand (<2mm)	0.3	
	Gravel (2mm-80mm)	1	Gravel, 5 mm to 26 mm (0.2 to 1 inch)
	Cobble (80mm- 250mm)	1	
	Boulder (>250mm)	1	
	Bedrock	0.3	
Water Depth	**(m)**		
	0 – 0.3	0.1	
	0.3 – 3.0	1	0 to 5
	3.0 – 6.0	1	
	6.0 – 8.0	0.5	
	8.0 – 12.0	0.4	
	12.0 – 18.0	0.3	
	> 18.0	0.1	
Water Velocity	**(m/s)**		
	0	0.01	
	0.1	0.8	
	0.3 – 1.5	1	0.05 to 0.66 (Avg. 0.2)[1]
	1.5 – 1.77	0.8	
	> 1.77	0.01	
Total Spawning Area	**(m^2)**		
	<13 m^2 per female or <700 m^2 total	0.29	
	>13m^2 per female or > 700 m^2 total	1	11,000m^2

[1]Based on depth-averaged velocity measurements at multiple locations in PA1 and PA3 under high flow conditions, see Appendix A

Table compile by:

Collier, J. J. (2018). *Creating a Spatially-Explicit Habitat Suitability Index Model for Lake Sturgeon (Acipenser fulvescens) in the Maumee River, Ohio* (Doctoral dissertation, The University of Toledo, Toledo, Ohio USA).

TABLE 3
JUVENILE STURGEON (NURSERY) HABITAT SUITABILITY INDEX

Parameter		Suitability Index Poor <0.30 Marginal 0.3-0.79 Suitable 0.8-1.0	Erosion-Resistant Cover Habitat Conditions
Substrate	**(mm)**		
	Clay	0.4	
	Silt	1	
	Sand (<2mm)	1	
	Gravel (2mm-80mm)	1	Gravel, 5 mm to 26 mm (0.2 to 1 inch)
	Cobble (80mm- 250mm)	0.8	
	Boulder (>250mm)	0.5	
	Bedrock	0.2	
Water Depth	**(m)**		
	0 – 0.2	0.1	
	0.2 – 2.0	1	0 to 5
	2.0 – 8.0	1	
	8.0 – 12.0	0.7	
	>12.0	0.29	
Water Velocity	**(m/s)**		
	0 - 0.1	0.8	
	0.1 - 0.5	1	0.05 to 0.66 (Avg. 0.2)[1]
	0.5 - 0.7	0.7	
	> 0.7	0.1	

[1]Based on depth-averaged velocity measurements at multiple locations in PA1 and PA3 under high flow conditions, see Appendix A

Table compile by:

Collier, J. J. (2018). *Creating a Spatially-Explicit Habitat Suitability Index Model for Lake Sturgeon (Acipenser fulvescens) in the Maumee River, Ohio* (Doctoral dissertation, The University of Toledo, Toledo, Ohio USA).

FIGURES

Figure 1

St. Clair Conservation

Priority Areas 1, 2, and 3
Site Location

St. Clair River

PARSONS / ANCHOR QEA

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plot Date: 6/12/2020 Plotted By: CS

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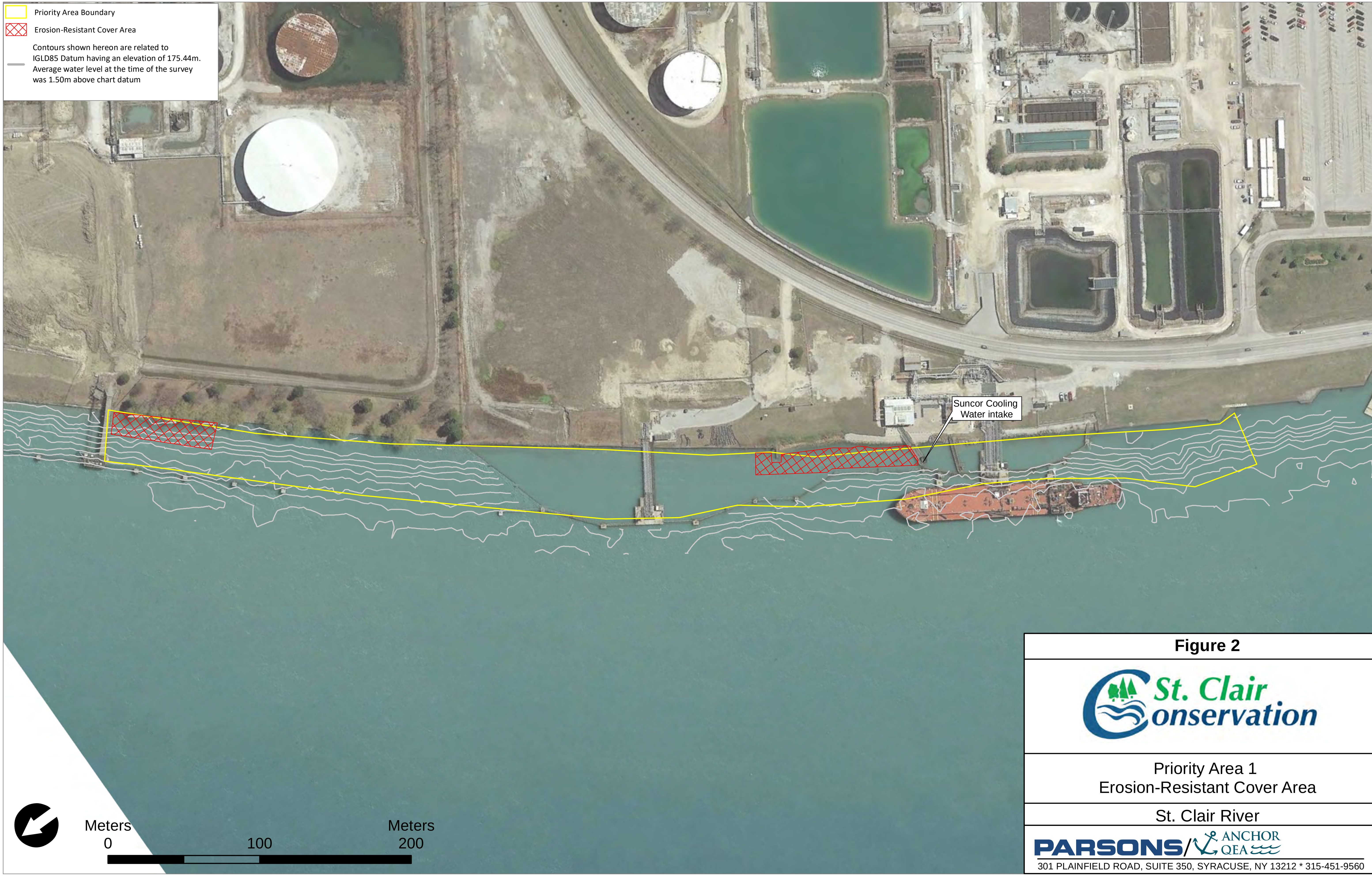

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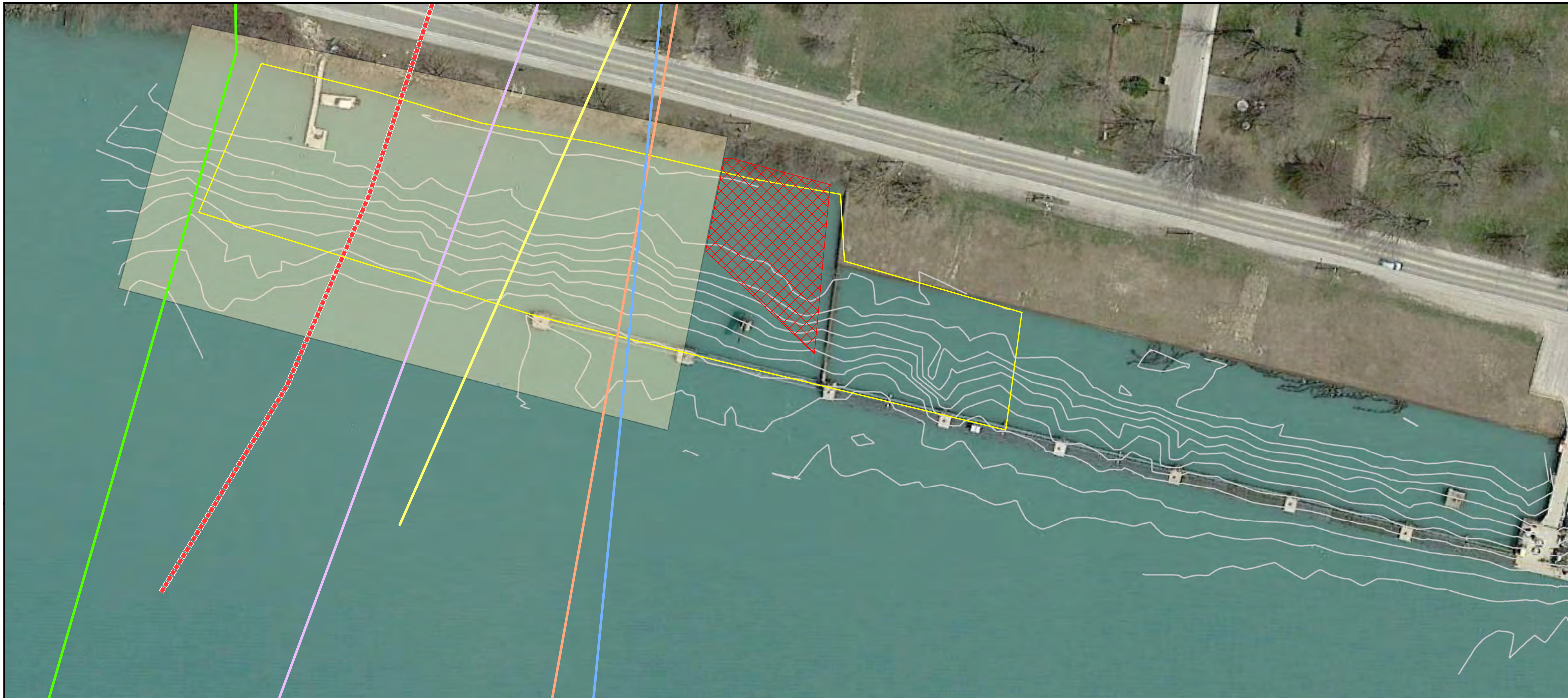


Priority Area Boundary

Erosion-Resistant Cover Area

Pipelines

20" Union Gas/Enbridge

8" Ethane line (Lamsar/Sunoco)

Genesis

New Enbridge

Old Enbridge

Shell

Contours shown hereon are in 1 meter intervals and are related to IGLD85 Datum having an elevation of 175.44m. Average water level at the time of the survey was 1.50m above chart datum

Pipeline Data referenced from:

Pg. 52, Geophysical Survey, St. Clair River AOI
St. Clair Region Conservation Authority
Prepared by: Canadian Seabed Research Ltd.

Genesis Pipeline Drawn from:
The 2018 Navigable Water Survey
Prepared by: Watech Services INC

20" Union Gas/Enbridge Drawn from:
Bluewater NPS 20" Pipeline As-Builts
Prepared by: Monteith & Sutherland Limited

*Note: pipeline locations are approximate and should not be used for planning of subsurface work.

No construction, spudding, or anchoring allowed due to buried pressurized product pipelines.

Figure 3

St. Clair Conservation

Priority Area 2
Erosion-Resistant Cover Area

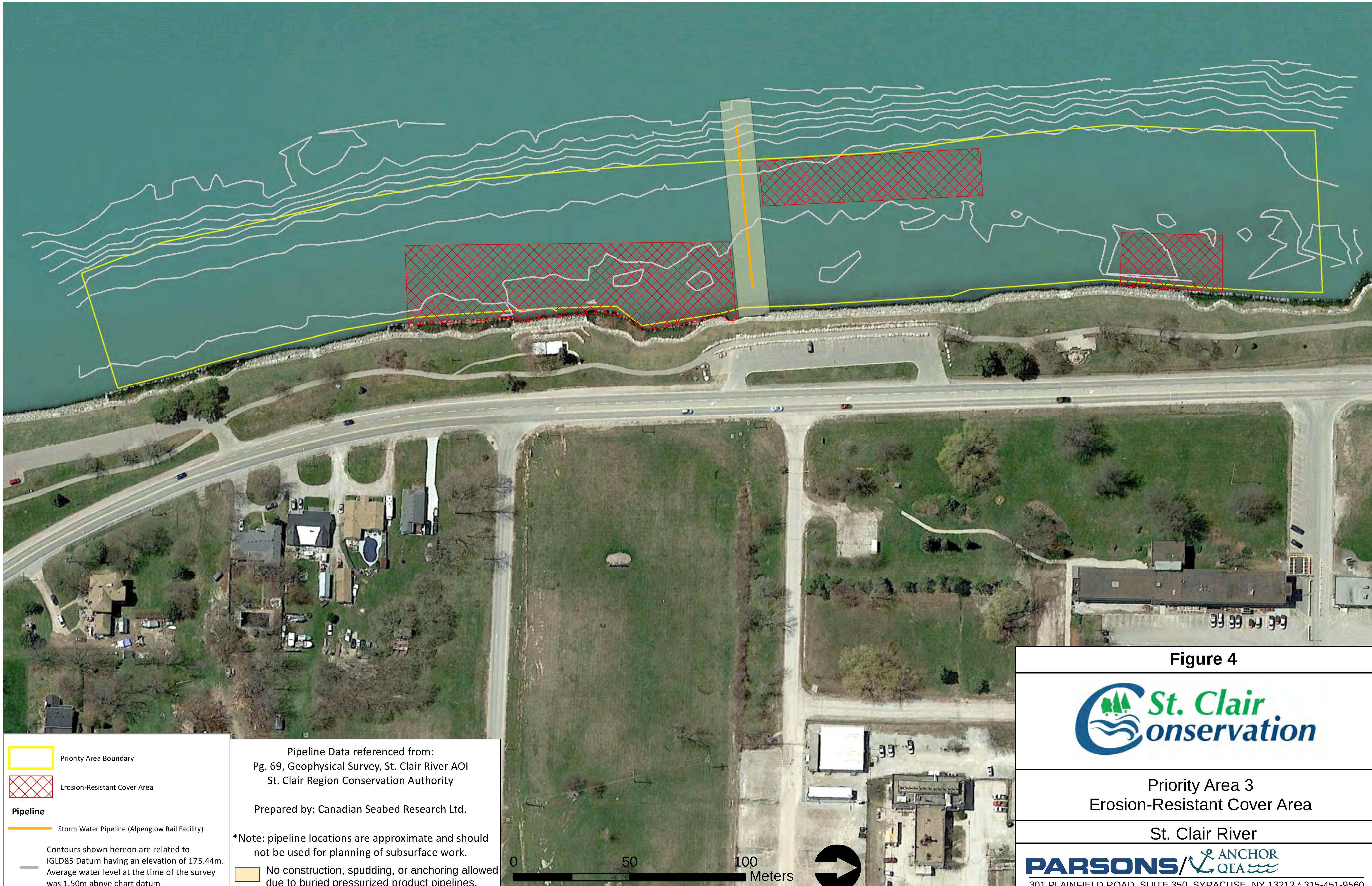
St. Clair River

PARSONS / ANCHOR QEA

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plot Date: 7/20/2021 Plotted By: CS

Document Path: Q:\GIS\St Clair\MXDs\Priority Area 2 Cover Area.mxd



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Plot Date: 8/16/2019

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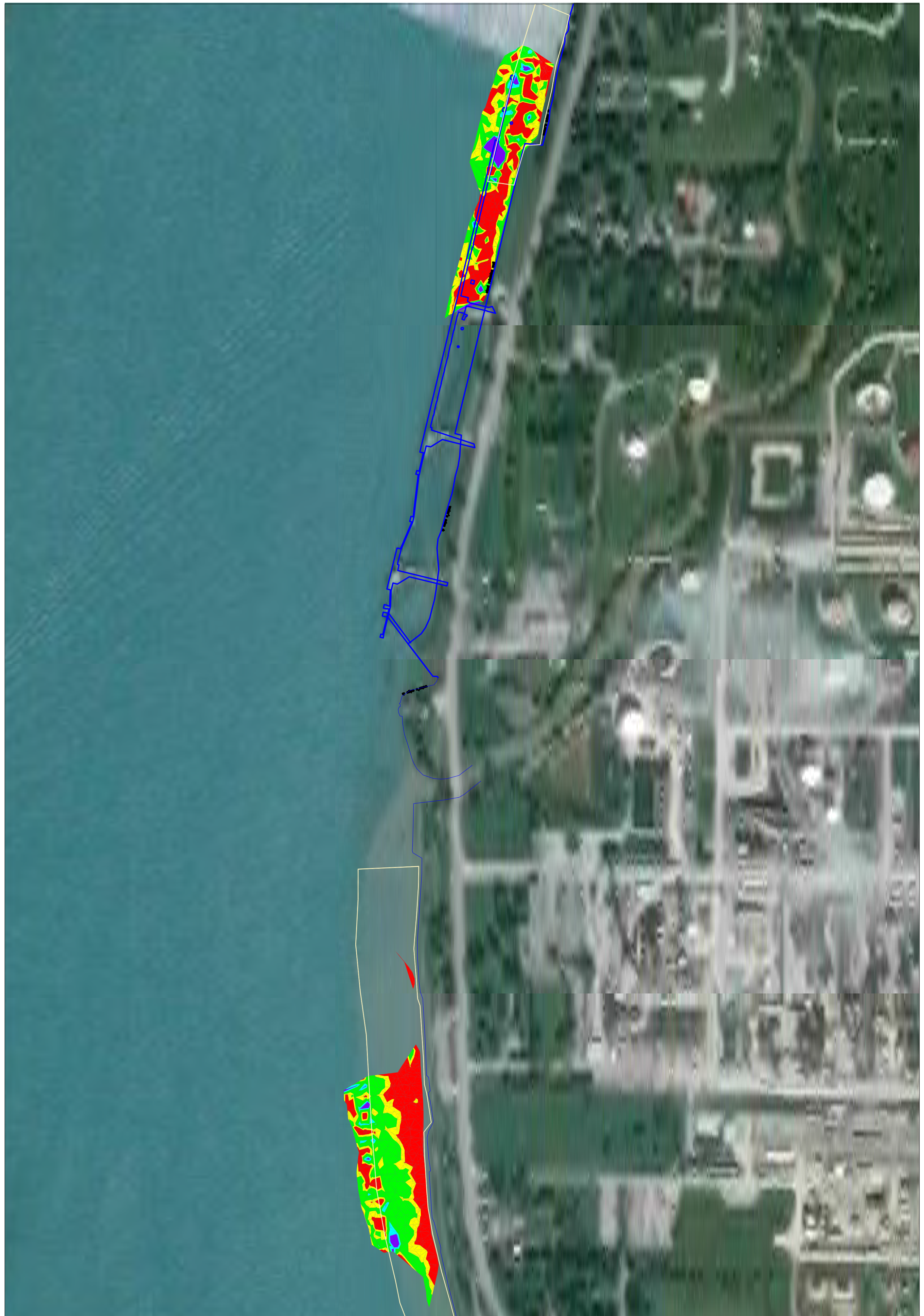
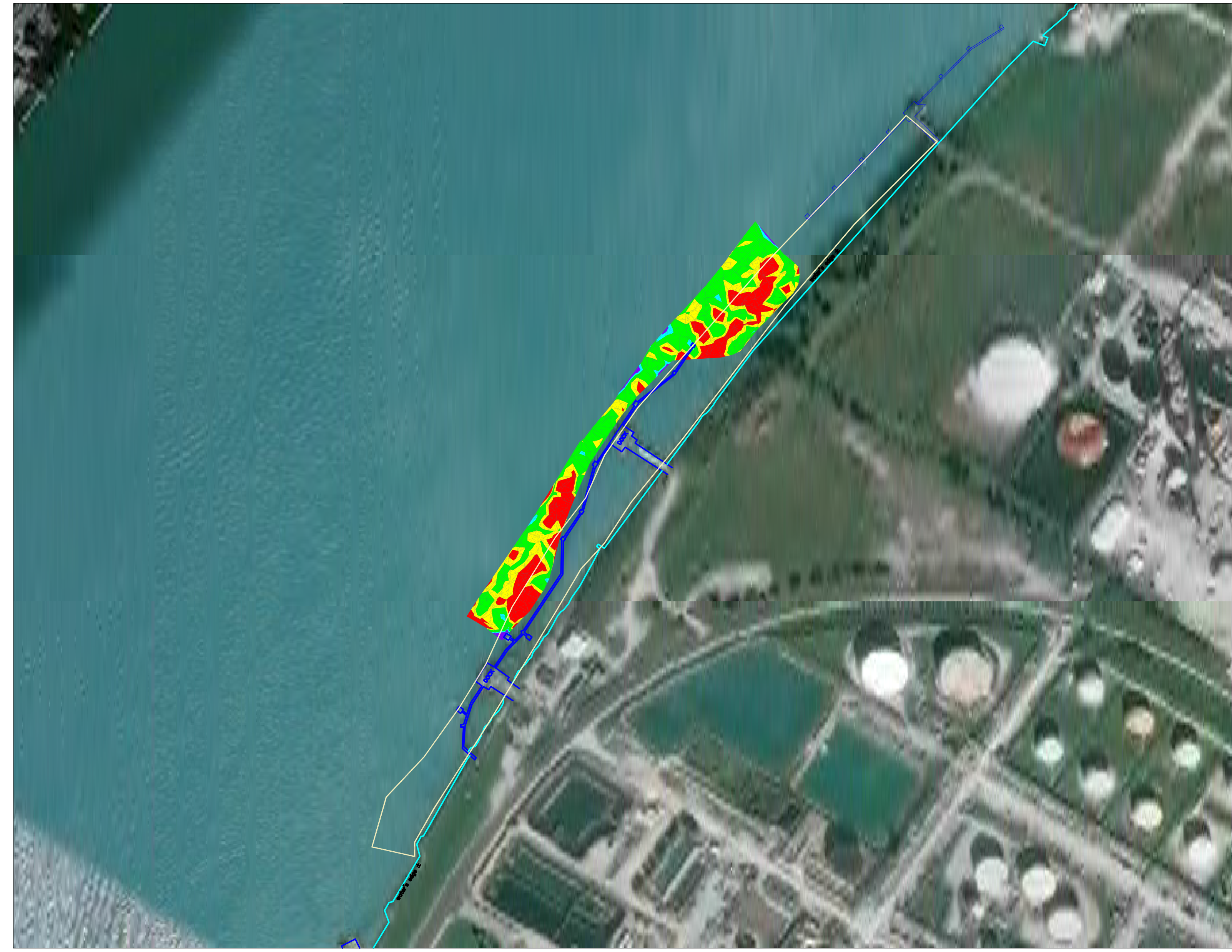




Legend

Red	2020 Survey > 0.4m Above 2011 Survey
Yellow	2020 Survey 0.2m – 0.4m Above 2011 Survey
Green	2020 Survey Within 0.2m of 2011 Survey
Cyan	2020 Survey 0.2m – 0.4m Below 2011 Survey
Purple	2020 Survey > 0.4m Below 2011 Survey

Figure 5

St. Clair Conservation

2020 vs 2011 Bathymetric Survey Comparison

St. Clair River

PARSONS

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212

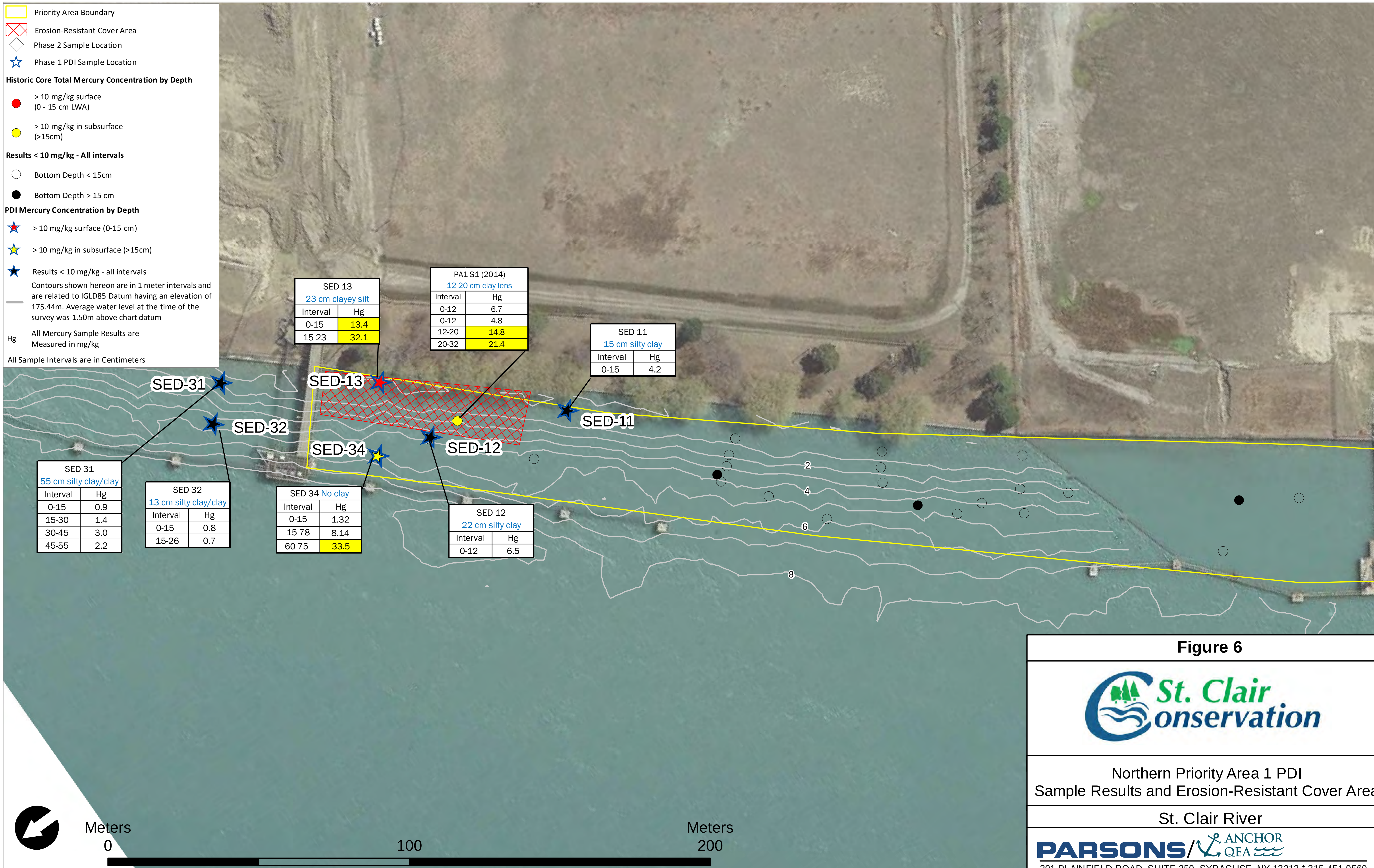


Figure 6

St. Clair Conservation

Northern Priority Area 1 PDI
Sample Results and Erosion-Resistant Cover Area

St. Clair River

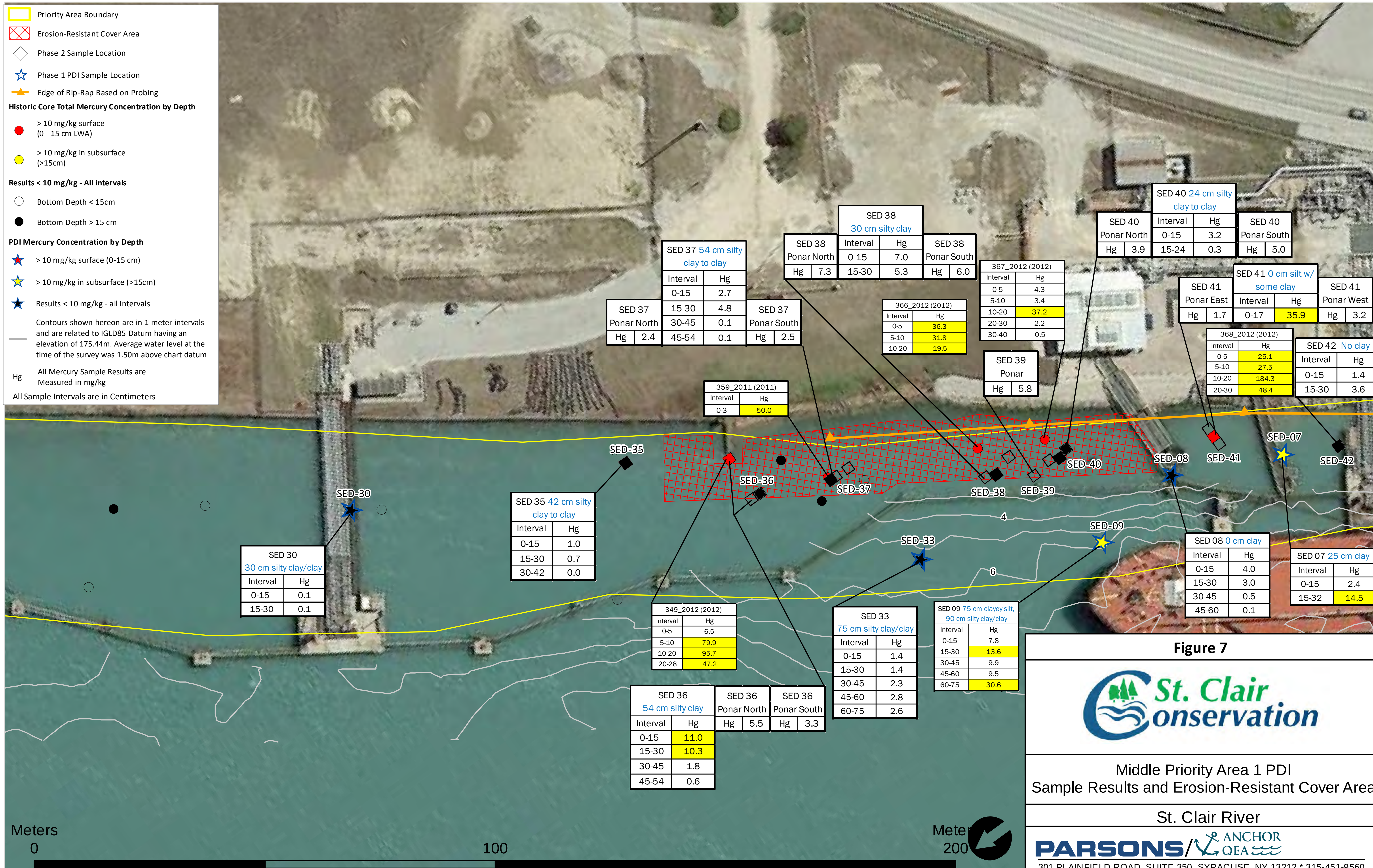
PARSONS/ANCHOR QEA

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plotted By: CS

Plot Date: 7/14/2021

Document Path: Q:\GIS\St Clair\MXDs\North Priority Area 1 Phase 2 Cover Area.mxd



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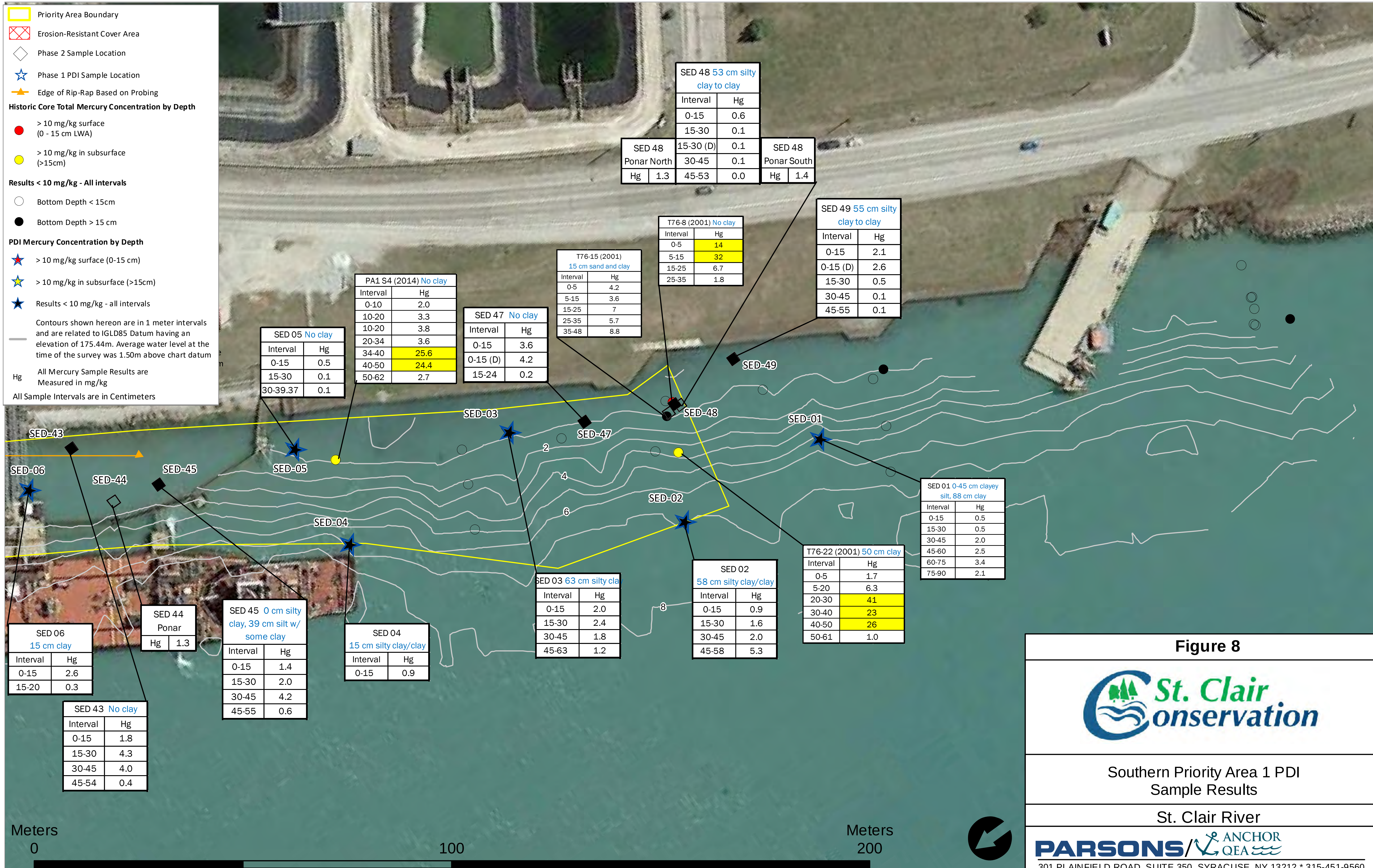


SED 48 53 cm silty clay to clay	
Interval	Hg
0-15	0.6
15-30	0.1
15-30 (D)	0.1
30-45	0.1
45-53	0.0

SED 48 Ponar North	
Hg	1.3

SED 48 Ponar South	
Hg	1.4

T76-8 (2001) No clay	
Interval	Hg
0-5	14
5-15	32
15-25	6.7
25-35	1.8

SED 49 55 cm silty clay to clay	
Interval	Hg
0-15	2.1
0-15 (D)	2.6
15-30	0.5
30-45	0.1
45-55	0.1

T76-15 (2001) 15 cm sand and clay	
Interval	Hg
0-5	4.2
5-15	3.6
15-25	7
25-35	5.7
35-48	8.8

PA1 S4 (2014) No clay	
Interval	Hg
0-10	2.0
10-20	3.3
10-20	3.8
20-34	3.6
34-40	25.6
40-50	24.4
50-62	2.7

SED 47 No clay	
Interval	Hg
0-15	3.6
0-15 (D)	4.2
15-24	0.2

SED 05 No clay	
Interval	Hg
0-15	0.5
15-30	0.1
30-39.37	0.1

SED 01 0-45 cm clayey silt, 88 cm clay	
Interval	Hg
0-15	0.5
15-30	0.5
30-45	2.0
45-60	2.5
60-75	3.4
75-90	2.1

T76-22 (2001) 50 cm clay	
Interval	Hg
0-5	1.7
5-20	6.3
20-30	41
30-40	23
40-50	26
50-61	1.0

SED 02 58 cm silty clay/clay	
Interval	Hg
0-15	0.9
15-30	1.6
30-45	2.0
45-58	5.3

SED 03 63 cm silty cla	
Interval	Hg
0-15	2.0
15-30	2.4
30-45	1.8
45-63	1.2

SED 04 15 cm silty clay/clay	
Interval	Hg
0-15	0.9

SED 45 0 cm silty clay, 39 cm silt w/ some clay	
Interval	Hg
0-15	1.4
15-30	2.0
30-45	4.2
45-55	0.6

SED 44 Ponar	
Hg	1.3

SED 06 15 cm clay	
Interval	Hg
0-15	2.6
15-20	0.3

SED 43 No clay	
Interval	Hg
0-15	1.8
15-30	4.3
30-45	4.0
45-54	0.4

Figure 8

St. Clair Conservation

Southern Priority Area 1 PDI Sample Results

St. Clair River

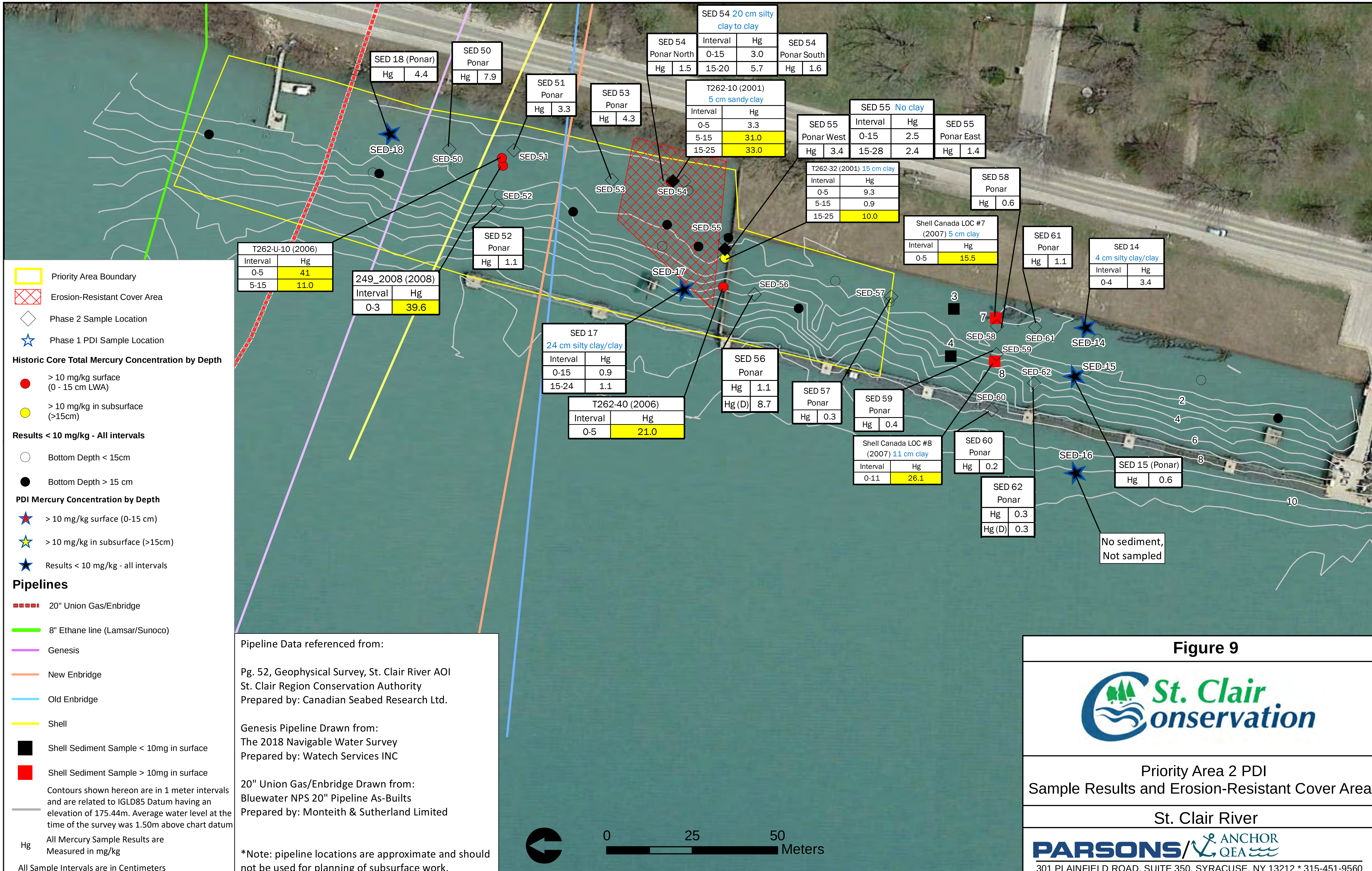
PARSONS / ANCHOR QEA

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plotted By: CS

Plot Date: 7/20/2021

Document Path: Q:\GIS\St Clair\MXDs\Southern Priority Area 1 Phase 2 Cover Area.mxd



Pipeline Data referenced from:

Pg. 52, Geophysical Survey, St. Clair River AOI
St. Clair Region Conservation Authority
Prepared by: Canadian Seabed Research Ltd.

Genesis Pipeline Drawn from:
The 2018 Navigable Water Survey
Prepared by: Watech Services INC

20" Union Gas/Enbridge Drawn from:
Bluewater NPS 20" Pipeline As-Builts
Prepared by: Monteith & Sutherland Limited

*Note: pipeline locations are approximate and should not be used for planning of subsurface work.

Figure 9

St. Clair Conservation

Priority Area 2 PDI
Sample Results and Erosion-Resistant Cover Areas

St. Clair River

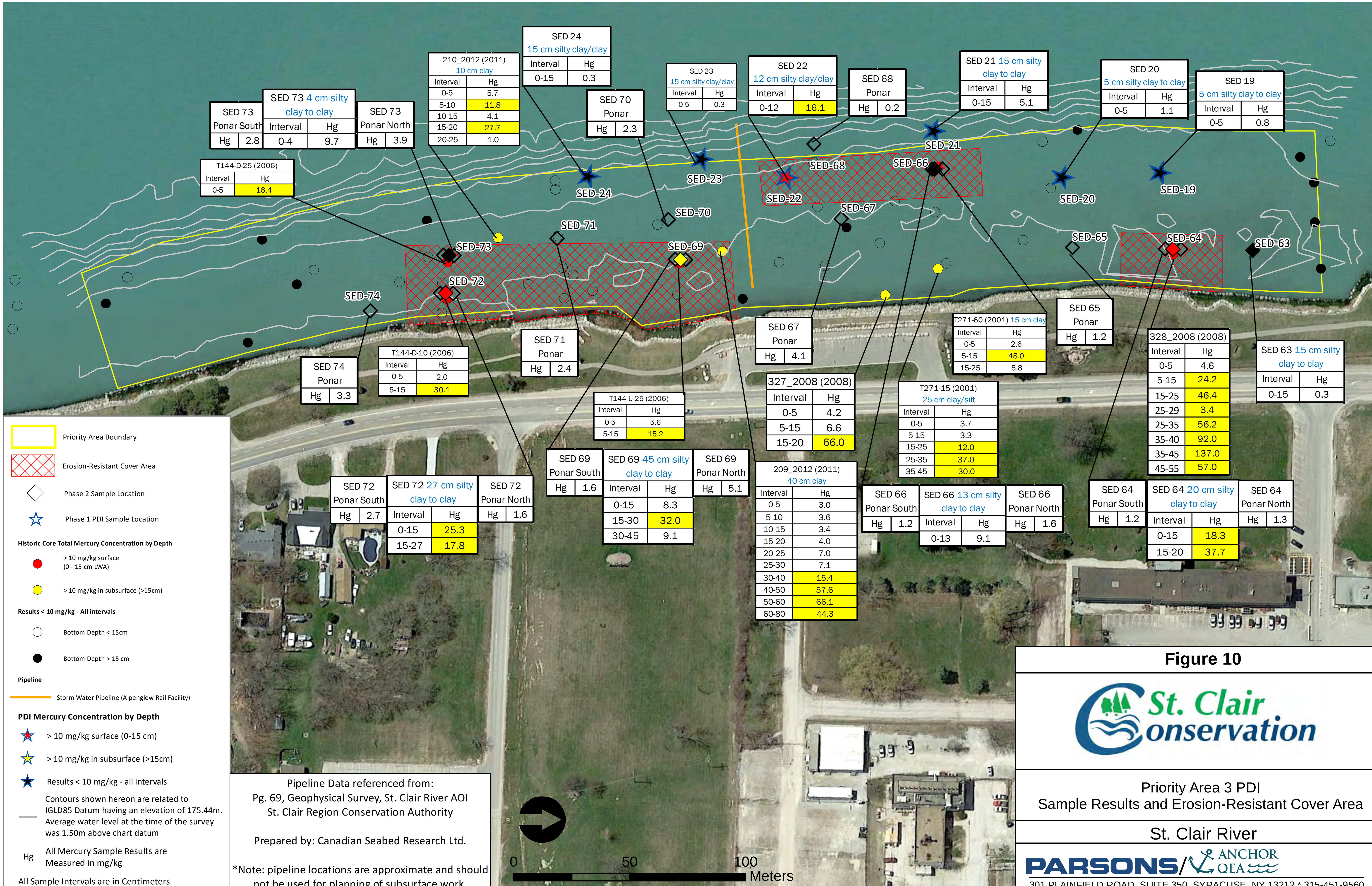
PARSONS / ANCHOR QEA

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plotted By: CS

Plot Date: 7/20/2021

Document Path: Q:\GIS\St Clair\MXDs\Priority Area 2 Phase 2 Cover Area.mxd



Plotted By: CS

Plot Date: 8/16/2019

Document Path: Q:\GIS\St Clair\MXDs\Priority Area 3 Phase 2 Cover Area.mxd

Note:
Elevations are based on Dry Dock Station, a U.S. National Oceanic and Atmospheric Administration monitoring station, located in Port Huron, MI, approximately 1km north of Priority Area 1.

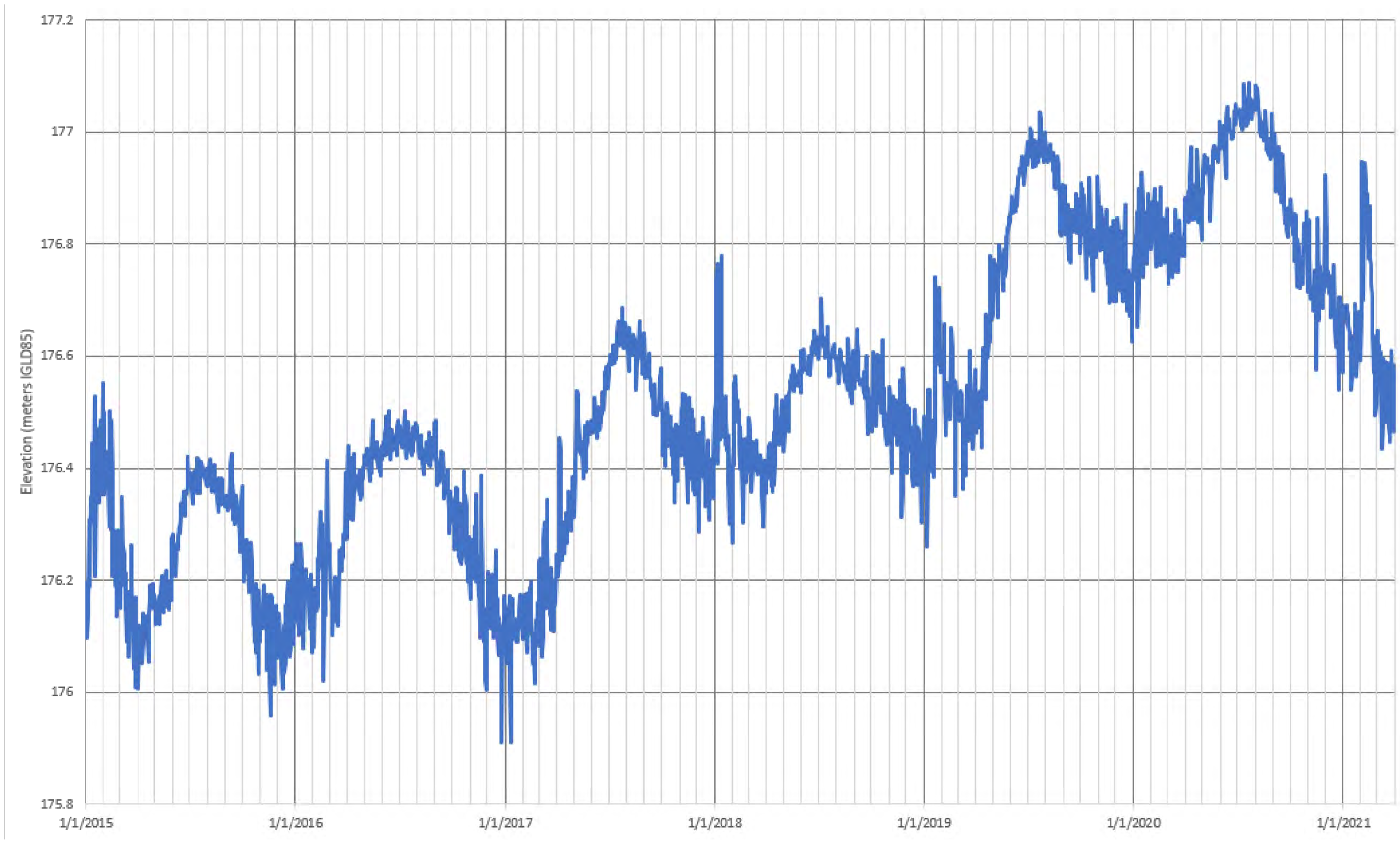


Figure 11

St. Clair Conservation

Historic Water Elevation from 2015 to 2021

St. Clair River

PARSONS

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212

Note:
Elevations are based on Dry Dock Station, a U.S. National Oceanic and Atmospheric Administration monitoring station, located in Port Huron, MI, approximately 1km north of Priority Area 1.

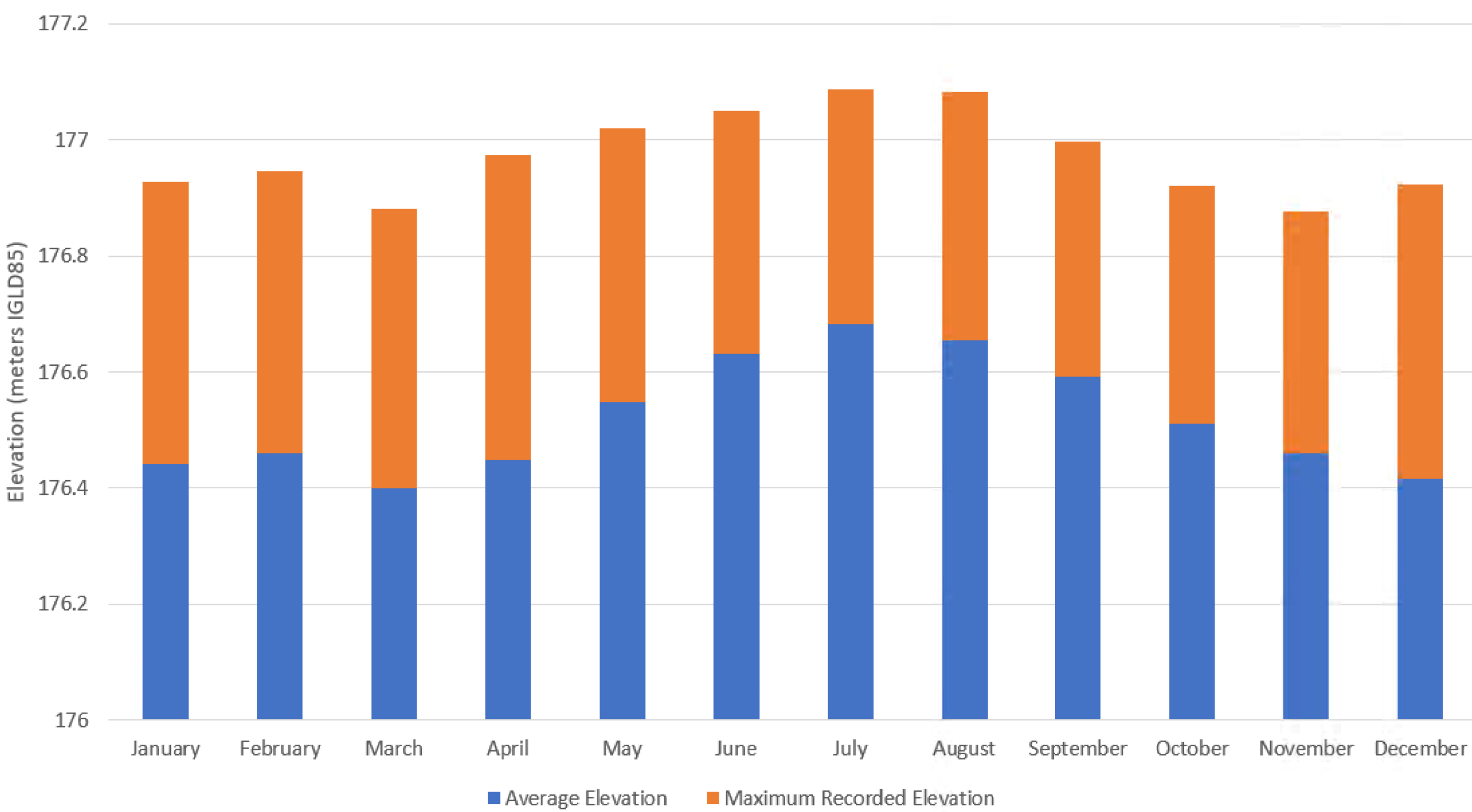


Figure 12

St. Clair Conservation

Average and Monthly Water Elevation from 2015 to 2021

St. Clair River

PARSONS

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212

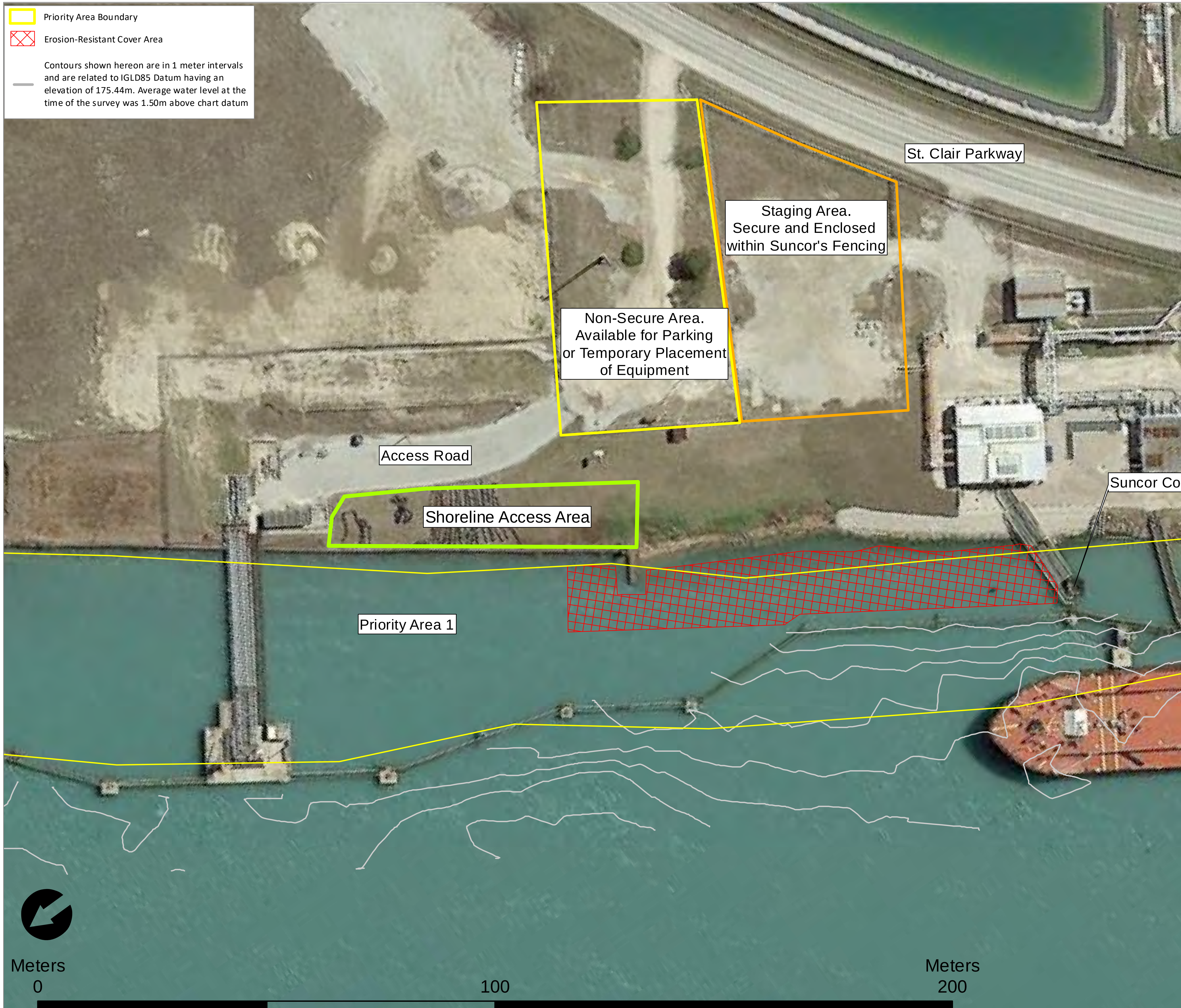


Figure 13

St. Clair Conservation

Priority Area 1
Staging and Support Area

St. Clair River

PARSONS/ANCHOR QEA

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, NY 13212 * 315-451-9560

Plotted By: CS

Plot Date: 10/28/2021

Document Path: Q:\GIS\St Clair\MXDs\Middle PA1 Staging Area.mxd

APPENDIX A PDI SUMMARY REPORT

APPENDIX B DRAWINGS

APPENDIX C SPECIFICATIONS

APPENDIX D WATER QUALITY AND SEDIMENT RESUSPENSION MONITORING PLAN

APPENDIX E CONSTRUCTION QUALITY ASSURANCE PLAN

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APPENDIX G MERCURY SURFACE-WEIGHTED AVERAGE CONCENTRATION CALCULATIONS

APPENDIX H PRELIMINARY TITLE DOCUMENTATION INFORMATION

APPENDIX I DFO LETTER OF ADVICE AND MECP SPECIES AT RISK BRANCH RECOMMENDATIONS