SECOND FIVE-YEAR REVIEW REPORT FOR
LAKE BOTTOM SUBSITE OF THE ONONDAGA LAKE SUPERFUND SITE
ONONDAGA COUNTY, NEW YORK

Prepared by

U.S. Environmental Protection Agency
Region 2
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LIST OF ABBREVIATIONS & ACRONYMS

AMP	Ambient Monitoring Program
ARAR	Applicable or Relevant and Appropriate Requirement
AWQS	Ambient Water Quality Standards
BERA	Baseline Ecological Risk Assessment
BAP	Biological Assessment Profile
BSQV	bioaccumulation-based sediment quality value
BTEX	Benzene, toluene, ethylbenzene, xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
COC	chemical of concern
CPOIs	chemical parameters of interest
CQA	construction quality assurance
CQAP	construction quality assurance plan
CQC	construction quality control
CY	cubic yard
DDT	Dichlorodiphenyltrichloroethane
DMU	Dredge Management Unit
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Difference
ft.	feet
FS	Feasibility study
FYR	Five-Year Review
GAC	granular activated carbon
$g/cm^2/yr$	grams per square centimeter per year
GWTP	Groundwater Treatment Plant
HHRA	Human Health Risk Assessment
ICs	Institutional Controls
ILWD	in-lake waste deposit
LMS	liquid management system
LOAELs	Lowest-Observed-Adverse-Effect Levels
MeHg	methylmercury
MERC	modified erosion-resistant cap
METRO	Metropolitan Syracuse Wastewater Treatment Plant
µg/L	micrograms per liter
$mg/m^2/day$	mg per square meter per day
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
mm	millimeter
MNR	monitored natural recovery
MPC	modified protective cap
NAPL	non-aqueous-phase liquid
NAVD88	North American Vertical Datum of 1988
ng/L	nanograms per liter

NOAA	National Oceanic and Atmospheric Administration
NOAELs	no-observed-adverse-effect levels
NPL	National Priorities List
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSOPRHP	New York State Office of Parks, Recreation and Historic Preservation
OLMMP	Onondaga Lake Monitoring and Maintenance Plan
O&M	Operation and Maintenance
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	Polychlorinated Biphenyl
PCDD/PCDF	polychlorinated dibenzo-p-dioxin/polychlorinated dibenzofuran
PDI	pre-design investigation
PEC	probable effect concentration
PECQ	probable effect concentration quotient
PRG	Preliminary Remediation Goal
RA	Remedial Area
RAO	Remedial Action Objective
RI	Remedial Investigation
RfD	reference dose
RG	Remedial Goal
ROD	Record of Decision
RPM	Remedial Project Manager
SCA	Sediment Consolidation Area
SEC	sediment effect concentration
SMS	Sediment Management System
SMU	Sediment Management Unit
SPA	Sediment Processing Area
SVOC	semivolatile organic compound
SWQS	surface water quality standard
TBC	To-be-considereds
TDS	total dissolved solids
TEQs	Toxic Equivalents
TLC	thin-layer cap
UCL	upper confidence limit
UFI	Upstate Freshwater Institute
USACE	United States Army Corps of Engineers
UU/UE	unlimited use and unrestricted exposure
VOC	volatile organic compound
WBB/HB	Wastebed B/Harbor Brook
WTP	Water Treatment Plant
ww	wet weight

I. INTRODUCTION

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports, such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) prepared this FYR review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

The Onondaga Lake Superfund site currently includes eleven subsites (subsites are defined as any site that is situated on Onondaga Lake's shores or tributaries that has contributed contamination to or threatens to contribute contamination to Onondaga Lake) as shown in Figure 1 (see Attachment 1 for figures). Each subsite consists of one or more operable units (OUs). This FYR report evaluates the Lake Bottom subsite (Subsite).[1] A status update of the other subsites is provided in Attachment 2.

This is the second FYR for the Subsite. The triggering action for this statutory review is the completion date of the previous FYR. The FYR has been prepared because hazardous substances, pollutants, or contaminants remain at the Subsite above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The FYR was led by Robert Nunes, the EPA Remedial Project Manager (RPM) for the Lake Bottom Subsite. Participants included Nicholas Mazziotta (EPA-Ecological Risk Assessor), Michael Sivak (EPA-Human Health Risk Assessor), Kathryn Flynn (EPA-Hydrogeologist), Larisa Romanowski (EPA-Community Involvement Coordinator [CIC]), Joel Singerman (EPA-Section Chief), Timothy Larson, Tracy Smith (NYSDEC-Project Managers), and Donald Hesler (NYSDEC-Section Chief). Honeywell, a potentially responsible party for the Subsite, was notified of the initiation of the FYR. The review began on November 1, 2019.

[1] Geddes Brook/Ninemile Creek subsite (OU 20) is considered by NYSDEC to be an OU of the Subsite. The first FYR for the Geddes Brook/Ninemile Creek subsite was completed in 2017.

Site Background

Site Setting

Onondaga Lake is a 4.6-square-mile, 3,000-acre lake, approximately 4.5 miles long and 1 mile wide, with an average water depth of 36 feet, with two (northern and southern) deep basins. The city of Syracuse is located at the southern end of Onondaga Lake, and numerous towns, villages, and major roadways surround the lake (see Figure 2). The lake has three main tributaries--Ninemile Creek to the west; Onondaga Creek to the south; and Ley Creek to the southeast. In addition, several small tributaries flow into the lake, including Bloody Brook, Sawmill Creek, Tributary 5A, the East Flume, and Harbor Brook. While Ninemile Creek and Onondaga Creek supply the vast majority of surface water to the lake, approximately 20 percent of the inflow comes from the Metropolitan Syracuse Wastewater Treatment Plant (METRO). The lake drains into the Seneca River through a single outlet located at the northern tip of the lake.

The area around Onondaga Lake is the most urban in central New York State. The region experienced significant growth in the twentieth century, and in 2000, Onondaga County was the tenth most populous county in the State. There are approximately 320 acres of state-regulated wetlands and numerous smaller wetlands directly connected to Onondaga Lake or within its floodplains.

History of Contamination

Onondaga Lake has been the recipient of industrial and municipal sewage discharges for more than 100 years. Honeywell International, Inc.'s (Honeywell's) predecessor companies (*e.g.,* Solvay Process Company, Allied Chemical Corp. and AlliedSignal, Inc.) have been major industrial waste contributors; however, other industries in the area have contributed contamination as well. Other contaminant sources to the lake include the METRO facility, industrial facilities and landfills along Ley Creek, the Crucible Materials Corporation (via Tributary 5A), and the former giant bulk petroleum-products storage and transfer facility located north of the Barge Canal known as "Oil City."

Honeywell's predecessor companies operated three manufacturing facilities in Solvay, New York from 1881 until 1986. The product lines were collectively known as the "Syracuse Works." The major products manufactured during this period included soda ash (sodium carbonate) and related products; benzene, toluene, xylenes, naphthalene at the Syracuse Works' Main Plant; chlorinated benzenes, chlor-alkali products, and hydrochloric acid at the Willis Avenue Plant, and chlor-alkali products and hydrogen peroxide at the Bridge Street Plant.[2] The manufacturing processes resulted in releases of primarily mercury, benzene, toluene, ethylbenzene, xylenes, chlorinated benzenes, polycyclic aromatic hydrocarbons (PAHs) (especially naphthalene), polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxin/polychlorinated dibenzofurans (PCDD/PCDFs), and calcite-related compounds.

[2] The Bridge Street Facility was sold to Linden Chemicals and Plastics (LCP) in 1979. LCP operated the facility until it closed in 1988.

Waste streams were discharged from the three facilities to at least four destinations--the Semet Residue Ponds (coke byproduct recovery only); Geddes Brook and Ninemile Creek (via the West Flume); the Solvay wastebeds, and directly to the lake (via the East Flume). The Solvay wastebeds are located in the towns of Camillus and Geddes, and in the city of Syracuse (see Figure 3). From approximately 1881 to 1986, the wastebeds were the primary means of disposal for the wastes produced by the Solvay operations. The wastebeds consist primarily of inorganic waste materials (Solvay waste) from the production of soda ash using the Solvay process. Initial Solvay waste disposal practices consisted of filling low-lying land adjacent to Onondaga Lake. Later, unlined wastebeds designed specifically for Solvay waste disposal were built using containment dikes constructed with native soils, Solvay waste, and cinders, or by using bulkheads made with timber along the lakeshore. The Solvay wastebeds and/or the East Flume also reportedly received chlorinated benzene still bottoms and portions of waste streams from the Willis Avenue and/or Bridge Street chlor-alkali plants.

The discharge of waste through the East Flume caused the formation of a large in-lake waste deposit (ILWD). The ILWD extends approximately 2,000 feet into the lake, approximately 4,000 feet along the lakeshore, and contains waste up to 45 feet thick. The majority of the ILWD is within the boundaries of Sediment Management Unit (SMU) 1 (see Figures 4 and 5), although some of the ILWD extends into the adjoining SMUs 2 and 7.[3] The ILWD contains waste from all of Honeywell's product lines. The discharges of waste to Geddes Brook and Ninemile Creek through the West Flume, as well as the overflow from Solvay Wastebeds 9 to 15, also caused the formation of deposits of Honeywell wastes and resulted in the development of the deposits in the Ninemile Creek delta in the lake in SMU 4. The seeps overflow from Solvay Wastebeds 1 to 8 contributed to the formation of Honeywell wastes in the lake itself.

Appendix A, attached, provides a list of the documents utilized to prepare this FYR.

Appendix B, attached, summarizes the site's physical characteristics, geology/hydrogeology and land use. For more details related to background, physical characteristics, geology/hydrogeology, land/resource use, and history related to the site, please refer to www.epa.gov/superfund/onondaga-lake.

[3] Onondaga Lake was divided into eight SMUs during the feasibility study (FS) based on water depth, sources of water entering the Lake, physical and ecological characteristics, and chemical risk drivers. During the remedial design, the littoral areas were redefined into Remediation Areas (RAs) A through F so as to more accurately reflect the current understanding of in-Lake conditions. The SMU boundaries and RAs, as well as the extent of the ILWD based on additional data collected during design, are shown on Figure 5.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Onondaga Lake Site (Lake Bottom Subsite)		
EPA ID: NYD986913580		
Region: 2	**State:** NY	**City/County:** Syracuse/Onondaga County
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: State ***[If "Other Federal Agency", enter Agency name]*:**		
Author name (Federal or State Project Manager): Robert Nunes		
Author affiliation: EPA		
Review period: 11/1/2019 – 9/25/2020		
Date of site inspection: N/A		
Type of review: Statutory		
Review number: 2		
Triggering action date: 9/25/2015		
Due date *(five years after triggering action date)*: 9/25/2020		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

The Subsite includes the contaminated surface water and sediments in the 4.5-square mile lake. Mercury contamination is found throughout the lake, with the most elevated concentrations detected in the Ninemile Creek delta and in the sediments/wastes present in the southwestern portion of the lake. Mercury contamination was widespread in the upper 6.5 feet of the sediments in the lake, and it is even deeper in sediment in the Ninemile Creek delta and the ILWD. Other contaminants present with lake sediments include benzene, toluene, ethylbenzene, xylenes (BTEX), chlorinated benzenes, PAHs, PCBs, and PCDD/PCDFs. Much of the contamination present in the southwestern portion of the lake is present in the ILWD, which comprises an area of approximately 100 acres. Elevated concentrations of some contaminants in certain locations of the ILWD extended to a depth of 25 feet or more in lake sediments. Elevated contaminant concentrations and visual evidence (*e.g.,* liquids, droplets, and sheens) indicated that chlorinated benzenes that were manufactured and released as a waste by Honeywell predecessor companies exist as nonaqueous-phase liquids (NAPLs) throughout the ILWD and in an area off the former Honeywell causeway. Based on data collected during the Subsite's remedial investigation (RI), it was determined that the NAPLs and highly contaminated waste materials in these areas of the lake were highly mobile, at least when disturbed, have high concentrations of toxic compounds, and presented a significant risk to human health and the environment should exposure occur; therefore, they were characterized as principal threat wastes.

Concentrations of total mercury in the lake water were highest in the nearshore areas around both Ninemile Creek and the ILWD. In the deep basins, water column total mercury concentrations increased significantly in the hypolimnion during summer stratification, with a high fraction of this hypolimnetic total mercury occurring in the dissolved phase. Concentrations of chlorobenzene and dichlorobenzenes in lake water were highest near the Honeywell source areas in the vicinity of the East Flume and Harbor Brook and exceeded surface water quality standards.

Mercury, PCBs, hexachlorobenzene, and PCDD/PCDFs have bioaccumulated in Onondaga Lake fish and mercury has been found at elevated levels in benthic macroinvertebrates. It is likely that these contaminants have bioaccumulated in other biota (*e.g.,* birds, mammals), as well. Fish tissue concentrations of mercury and PCBs in excess of diet-based toxicity reference values suggest injury to piscivorous birds and mammals that consume fish from the lake. Chemicals of concern (COCs) in sediment shown to exhibit acute toxicity on a lake-wide basis include mercury, ethylbenzene, xylenes, certain chlorinated benzenes, PAHs and PCBs. COCs in surface water include mercury, chlorobenzene, and dichlorobenzenes.

The baseline human health risk assessment (HHRA) showed that cancer risks and noncancer health hazards associated with ingestion of chemicals in sport fish *(e.g.,* Largemouth Bass [*Micropterus salmoides*]) from Onondaga Lake were above levels of concern. Fish ingestion is the primary pathway for exposure to COCs and for potential adverse health effects. The HHRA also evaluated risks associated with direct contact with contaminated sediments (inadvertently ingesting small amounts of sediment or having sediment contact the skin); this did not result in unacceptable risks.

Key results of the baseline ecological risk assessment (BERA) indicated that comparisons of measured tissue concentrations and modeled doses of chemicals to toxicity reference values showed exceedances of hazard quotients for site-related chemicals throughout the range of the point estimates of risk. Subsite-specific sediment toxicity data indicated that sediments are toxic to benthic macroinvertebrates on both an acute (short-term) and chronic (long-term) basis. Many of the contaminants in the lake were persistent and, therefore, the risks associated with these contaminants were unlikely to decrease significantly in the absence of remediation. On the basis of these comparisons, it was determined through the BERA that all ecological receptors of concern were at risk. Contaminants and stressors in the lake have either impacted or potentially impacted every trophic level examined in the BERA.

Response Actions

Site-specific sediment effect concentrations (SECs) and consensus-based probable effect concentrations (PECs) for COCs evaluated in the RI and the BERA were calculated using data from acute sediment toxicity testing using benthic macroinvertebrates. Benthic macroinvertebrates live in and around the sediments for most of their lives, and therefore experience the highest direct exposure to contamination in the lake. Because of the large number of COCs and the differences in sources, transport, and fate, a further refinement of the SEC/PEC approach was used to develop a single number, the mean PEC quotient (PECQ), which takes into account the presence and the concentrations of multiple chemicals in the sediments. The mean PECQ approach provides a consistent method of comparing the overall acute toxicity risk from the mixture of contaminants at various locations of the lake and to select a level of remediation that would address the risk of direct acute toxicity to the benthic macroinvertebrate community from the contamination in the lake sediments. The mean PECQ was used as a basis for delineating areas of the lake to be remediated. The areas of the lake in which COC concentrations in the littoral sediment exceed a mean PECQ of 1 generally coincide well with those areas where acute toxicity to benthic macroinvertebrates was observed in the sediment toxicity tests. Therefore, the mean PECQ of 1 was determined to be protective and was selected as a remediation goal to address direct acute toxicity to benthic invertebrates. Because mercury in the lake is a primary concern and elimination or reduction of mercury is part of all five Remedial Action Objectives (RAOs) discussed below, the mercury PEC of 2.2 milligrams per kilogram (mg/kg) was also selected as a remediation goal.

The selected remedy, which is presented in the Record of Decision (ROD) issued by NYSDEC and the EPA in July 2005, addressed surface sediments exceeding a mean PECQ of 1 or a mercury PEC of 2.2 mg/kg. The selected remedy would also attain a 0.8 mg/kg bioaccumulation-based sediment quality value (BSQV) for mercury on an area-wide basis for the lake and five subareas of the lake as determined during the remedial design. Another goal of the remedy was to achieve lake-wide fish tissue mercury concentrations ranging from 0.14 mg/kg for protection of ecological receptors to 0.3 mg/kg, which is based on the EPA's Methylmercury (MeHg) National Recommended Water Quality criterion for the protection of human health for the consumption of organisms. This range encompasses the goal for protection of human health based on the reasonable maximum exposure scenario of 0.2 mg/kg of mercury in fish tissue (fillets).

To accomplish the noted objectives, the major components of the selected remedy, as outlined in the ROD, include:

- Dredging up to an estimated 2,653,000 cubic yards (CY) of contaminated sediment from the littoral zone (the portion of the lake in which water depths range below 30 feet) in SMUs 1 through 7 to a depth that will prevent the loss of lake surface area, ensure cap effectiveness, remove NAPLs, reduce contaminant mass, allow for erosion protection, and reestablish the littoral zone habitat. Most of the dredging will be performed in the ILWD (which largely exists in SMU1) and in SMU 2.
- Dredging, as needed, in the ILWD to remove materials within hot spots and to ensure stability of the cap.
- Placement of an isolation cap over an estimated 425 acres within SMUs 1 through 7.

- Construction/operation of a hydraulic control system along the SMU 7 shoreline to maintain cap effectiveness. In addition, the remedy for SMUs 1 and 2 will rely upon the proper operation of the hydraulic control system, which is being designed to control the migration of contamination to the lake via groundwater from the adjacent upland areas.
- Placement of a thin-layer cap over an estimated 154 acres of the profundal zone (the portion of the lake in which water depths exceed 30 feet) within SMU 8.
- Treatment and/or off-site disposal of the most highly contaminated materials (*e.g.,* pure phase chemicals segregated during the dredging/handling process). The balance of the dredged sediment will be placed in a Sediment Consolidation Area (SCA), which will be constructed on one or more of Honeywell's Solvay wastebeds that historically received process wastes from Honeywell's former operations. The containment area will include, at a minimum, the installation of a liner, a cap, and a leachate collection and treatment system.
- Treatment of water generated by the dredging and sediment handling processes to meet NYSDEC discharge limits.
- Completion of a comprehensive lake-wide habitat restoration plan.
- Habitat reestablishment will be performed consistent with the lake-wide habitat restoration plan in areas of dredging/capping.
- Performance of an oxygenation pilot study to evaluate the effectiveness of oxygenation at reducing the formation of MeHg in the water column, fish tissue MeHg concentrations, and methane gas ebullition as well as to understand any other impacts. The pilot study would be followed by full-scale implementation (if supported by the pilot study) in SMU 8.
- Monitored natural recovery (MNR) in SMU 8.
- Implementation of institutional controls (ICs) including the notification of appropriate government agencies with authority for permitting potential future activities which could impact the implementation and effectiveness of the remedy.
- Implementation of a long-term operation, maintenance, and monitoring (O&M) program to monitor and maintain the effectiveness of the remedy (*e.g.,* cap repair).

The selected remedy also includes habitat enhancement, which is an improvement of habitat conditions in areas where CERCLA contaminants do not occur at levels that warrant active remediation, but where habitat impairment due to stressors has been identified as a concern. The ROD indicated that habitat enhancement would be performed along an estimated 1.5 miles of shoreline (SMU 3) and over approximately 23 acres (SMU 5) to stabilize calcite deposits and oncolites,[4] and promote submerged aquatic plant growth.

Remedial Action Objectives/Remediation Goals

The RAOs for Onondaga Lake were based on site-specific information, including the nature and extent of chemical parameters of interest (CPOIs),[5] the transport and fate of mercury and other

[4] Oncolites are a form of calcite in littoral sediments of Onondaga Lake and are closely associated with discharges of calcium-laden wastes to the Lake by Honeywell.
[5] The CPOIs are those elements or compounds that were identified as contaminants of potential concern, chemicals of concern, or stressors of concern for the Onondaga Lake RI/FS. The major classes of CPOIs include mercury and other metals, BTEX, chlorinated benzenes, PAHs, PCBs, PCDD/PCDFs, and calcite.

CPOIs, and the baseline human health and ecological risk assessments. The RAOs were developed during the RI as goals for controlling CPOIs within the lake and protecting human health and the environment. The RAOs for Onondaga Lake are:

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

In order to achieve the RAOs, Preliminary Remediation Goals (PRGs) were established for the three primary media that have been impacted by CPOIs: sediments, biological tissue, and surface water. The following three PRGs were developed, each addressing one of the affected media:

- PRG 1: Achieve applicable and appropriate SECs for CPOIs and the BSQV of 0.8 mg/kg for mercury, to the extent practicable, by reducing, containing, or controlling CPOIs in profundal and littoral sediments.
- PRG 2: Achieve CPOI concentrations in fish tissue that are protective of humans and wildlife that consume fish. This includes a mercury concentration of 0.2 mg/kg in fish tissue (fillets) for protection of human health based on the reasonable maximum exposure scenario assumptions from the Onondaga Lake Baseline Human Health Risk Assessment and the EPA's MeHg National Recommended Water Quality criterion for the protection of human health for the consumption of organisms of 0.3 mg/kg in fish tissue. This also includes a mercury concentration of 0.14 mg/kg in fish[6] (whole fish) for protection of ecological receptors (wildlife) based on the exposure assumptions from the Onondaga Lake Baseline Ecological Risk Assessment. These human health and ecological goals represent the range of fish tissue PRGs.
- PRG 3: Achieve surface water quality standards, to the extent practicable, associated with CPOIs.

In addition to the remediation goals for mercury in fish tissue cited above, ecological target tissue concentrations for mercury based on the no-observed-adverse-effect levels (NOAELs), as well as target tissue concentrations for bioaccumulative organic contaminants, corresponding to various risk levels (including both the 10^{-4} and 10^{-5} cancer risk levels for human health exposure and both the lowest-observed-adverse-effect levels (LOAELs) and NOAELs, were developed in the FS based on exposure parameters from the Onondaga Lake HHRA and BERA and were included in

[6] This ecological goal was based on the LOAEL for the river otter.

the ROD. These targets are not remediation goals, as presented in the ROD, but are points of reference for evaluations of reduction of risk for human and wildlife consumers of fish.

As indicated in the ROD, contaminants other than mercury, including PCBs, hexachlorobenzene, and PCDD/PCDFs, are not as widespread in sediments in the lake (as compared to mercury) and are found primarily in a few specific areas of the lake (*e.g.,* SMUs 1, 2, 6, and 7). These areas were remediated in accordance with the remedial design for lake dredging and capping.

As the areas of the lake with elevated concentrations of these bioaccumulative organic contaminants for which target tissue concentrations were developed are generally within the remedial areas based on exceedance of the cleanup criteria of the mean PECQ of 1 (which addresses multiple contaminants) plus the mercury PEC, the exposures to these compounds would be reduced to the same or greater extent as that of mercury. It was, therefore, expected that if the remediation goals for mercury in fish tissue are met in the future (*e.g.*, during the 10-year MNR period after completion of the dredging and capping, the future fish tissue concentrations for the contaminants listed in Table 7 of the ROD[7] would fall within the ranges shown in the table for each contaminant and receptor. If this assumption is proven not to be the case in the future, based on ongoing fish tissue monitoring, then an evaluation will take place to determine why this assumption may no longer be valid.

Target concentrations, PECs and/or remediation goals are further presented in Tables 1a, 1b, and 1c for fish, sediment, and surface water, respectively. (See Attachment 1 for tables.)

<u>Explanations of Significant Difference</u>

Three Explanations of Significant Difference (ESDs) have been issued since the issuance of the ROD to document modifications of the selected remedy.

Additional data were generated in 2005 and 2006 in SMU 2 as part of the pre-design investigation to more accurately define the extent of NAPLs in this area. These data showed that the site conditions and contaminant distribution were significantly different than were previously believed to be present in SMU 2 along the former causeway, and a small adjacent area in SMU 1. Based on the additional information, a revision to the portion of the remedy that pertains to the SMU 2 causeway area (and a small adjacent area in SMU 1) was evaluated. As a result of this evaluation, a modification to the remedy was made, including the placement of a portion of the lakeshore barrier wall in the southwest portion of the lake, backfilling behind the barrier wall with clean material, and collection of NAPLs present in the areas discussed above via wells with off-site treatment and/or disposal. The change was necessary to ensure the stability of the adjacent causeway and the adjacent area which includes a portion of I-690, and is supported by extensive sampling of the area which indicates that the areas containing NAPLs are significantly less extensive than estimated in the ROD (NYSDEC and EPA, 2006; Parsons, 2019a). This modification was documented in an ESD issued in December 2006 (the affected area is shown in Figure 6).

[7] The fish tissue concentration ranges in Table 7 of the ROD can be found in Table 1a except where modified as indicated in Note 6 in the table and discussed under V. Technical Assessment, Question B.

The second ESD, issued in August 2014, addressed two issues – a geotechnical concern in the eastern end of the lake and an alternative measure to address the release of methylmercury from sediment in the lake. This ESD allowed for the establishment of a buffer zone (approximately 10 acres) along the southeast shoreline where no dredging or capping would occur as the best means to prevent shoreline and rail line instability (See Figure 7). The ESD also identified nitrification of the hypolimnion by adding nitrate to the deep lake water instead of/in place of oxygenation. The change in approach was based on the success of a 3-year nitrate addition pilot study completed in 2013, which demonstrated that nitrate addition effectively inhibits the release of methylmercury from sediment in the deep water portions of the lake (NYSDEC and EPA, 2014; Parsons, 2019a).

A third ESD was issued in March 2018 to document the basis for the design and construction of modified protective caps (MPCs) in portions of RA-B, RA-C, and RA-D, as well as a modified erosion-resistant cap (MERC) in the vicinity of the METRO deep water outfall pipeline (see Figure 8). The MPCs were needed 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. These MPCs 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). The sediments in the MPC areas were 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 zone[8]).

A subset of the MPCs (approximately 2 percent of the entire capped area) included areas where underlying soft sediments limited the cap thicknesses such that it was not feasible to construct separate chemical isolation and habitat/erosion protection layers. These areas, which include areas of direct application of granular activated carbon (GAC) with limited sand placement, are referred to as mono-layer caps. In addition, following the collection of data subsequent to the cap disturbances, thin-layer caps and amended caps were required in approximately 7.4 acres in the profundal zone (SMU 8) adjacent to RA-C (where a thin-layer cap was not included in the Final Design) and 16.8 acres adjacent to RA-D. 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. The basis of the designs for the modified caps was to be protective consistent with the evaluation timeframe used in the Final Design and specified in the ROD. Given the relatively small size of these MPC 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

[8] 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 EPA, 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.

MERC areas to ensure cap effectiveness, it was concluded that the modifications would not affect remedial timeframes, degree of protectiveness of the overall remedy, remedial costs, or the extent of ICs needed. MPC design revisions were reviewed by NYSDEC and EPA and approved by NYSDEC prior to construction of the MPCs in 2015 and 2016 (NYSDEC and EPA, 2018; Parsons, 2018a; Parsons, 2019a). Post-construction physical and chemical monitoring is being conducted in all capped areas (starting in 2017), including the MERC and MPC areas addressed in the ESD, to ensure the effectiveness of the remedy in meeting the related goals specified in the 2005 ROD.

Status of Implementation

Dredging and Capping

Sediments were dredged hydraulically from designated areas within the lake and select adjoining wetland areas between July 2012 and November 2014. Approximately 2.15 million cubic yards (cy) of sediment were removed from the lake across 215 acres (Anchor QEA and Parsons, 2017) (dredging areas are denoted on Figure 9). Sediments were dredged hydraulically from designated areas within the lake and select adjoining wetland areas. Once a specific area of the lake was dredged, post-dredge surveys were conducted in accordance with a construction quality assurance plan (CQAP) to ensure that target elevations in the dredged area were achieved. Dredged material was transported via a series of booster pumps and a double-walled pipeline through non-residential areas to a lined sediment processing area (SPA) adjacent to the SCA. The SPA and SCA were located on a former Solvay wastebed, Wastebed 13. (See Figure 10.) At the SPA, the dredge slurry was passed through a screening process, which was designed to remove oversized material. Oversized material was trucked to a Debris Management Area maintained at the SCA (see Figure 11) where the material was contained and covered. After screening, the slurry was conveyed to thickeners to reduce the volume of water that would need to be removed from the solid material by geotextile tubes (geotubes). The thickened slurry then underwent polymer injection to precondition the slurry prior to being conveyed to and discharged into the geotubes for dewatering and long-term isolation of the dredged material. The geotubes were managed within the lined SCA which collected and managed the geotube filtrate (water discharged from the geotubes). As part of the SCA construction, two basins were constructed adjacent to the eastern and western extents of the Phase II area (see Figure 11). These basins were considered part of the sediment management system (SMS) for the SCA.

The geotube filtrate and water coming into contact with filling tubes or dredged sediment (referred to as "contact water") was collected and routed to the Water Treatment Plant (WTP) constructed adjacent to the SCA for treatment of metals, volatile organic compounds (VOCs), semi-volatile organic compounds, PCBs, and total suspended solids. The treated effluent was then conveyed to METRO where it underwent additional treatment for ammonia prior to discharge to the lake (EPA, 2015).[9] Mechanical dredging was used on a limited basis for a portion of the Wastebed B/Harbor Brook (WBB/HB) Outboard Area adjacent to RA-D (Anchor QEA and Parsons, 2017).

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[9] Operational modifications were made in 2014 that provided the option for wastewater generated by the dredging/sediment handling processes at the SCA and treated at the SCA water treatment facility to be discharged directly to the Lake in accordance with a supplemental treatment/Lake discharge operations

Capping operations commenced in August 2012 and were completed in December 2016. Cap material was placed on approximately 475 acres over six RAs of the lake, three adjacent lakeshore areas (*i.e.,* Wastebed B/Harbor Brook Outboard Area, Wastebeds 1-8 Connected Wetland, and the Ninemile Creek spits[10]), and portions of SMU 8. (See Figures 9 and 12.) The littoral areas which received cap material included all areas which were dredged. Cap materials were placed both hydraulically, using a custom hydraulic spreader barge, and mechanically, using a variety of mechanical placement methods. The placement method depended on the grain size of the cap material being placed, the water depth at the placement location, and the proximity to obstructions such as the barrier wall located along the southwest lakeshore. Approximately 3.1 million CY of cap material was placed, including 1.6 million CY hydraulically, and 1.5 million CY mechanically. The installed cap was designed for an effective life span of 1,000 years and was constructed of varying types of single-layer and multi-layer caps using sands, gravels, cobbles, topsoil and amendments. The amendments consisted of siderite (a naturally-occurring mineral consisting mostly of iron carbonate) to neutralize elevated pH and maintain conditions conducive to long-term biological decay of key contaminants within the cap, and GAC to improve sorption of contaminants within the cap and provide an added level of protectiveness. Amendments to the cap were used in RA-B, RA-C, RA-D, the Wastebed B/Harbor Brook Outboard Area, the Wastebeds 1-8 Connected Wetland, and in portions of RA-A (including the Ninemile Creek spits), RA-E, and SMU 8.

Both the dredging and the capping operations were subject to a robust construction quality control (CQC)/construction quality assurance (CQA) program designed to verify that the work was completed in accordance with the Final Design and subsequent NYSDEC-approved modifications. Dredging areas were divided into Dredge Management Units (DMUs) and completion was verified within each DMU using single-beam dual frequency bathymetric surveys. CQC bathymetric surveys were validated by performing duplicate CQA surveys across a minimum of 10% of each CQC survey area. The CQC/CQA program for the capping involved measurement of each individual cap layer in both single-layer and multi-layer caps. Layer thickness was verified using a variety of techniques, including core sampling, catch pans, and bathymetric surveys. Thermal processes were utilized to determine the presence of the necessary components for chemical isolation layers (siderite, GAC). Bathymetric survey data were collected across completed caps to verify that the installed cap was completed within the elevation tolerances specified by the design. Similar to the dredging program, CQA measurements were collected for a minimum of 10% of the CQC measurements. Additional details on capping and dredging operations are available in the September 2017 Capping and Dredging Construction Completion Report (Anchor QEA and Parsons, 2017).

Air Quality Monitoring

The Air Quality Monitoring Program consisted of real-time air monitoring and sampling for speciated VOCs. Real-time monitoring was performed at eight fixed locations around the SCA

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work plan and a State-approved wastewater discharge permit. The modifications provided operators with the capability to maximize operational up-time for dredging operations during wet weather conditions.

[10] The spits are depositional landforms caused by lake currents.

and two to three fixed locations around the lakeshore for dust, total VOCs, mercury, hydrogen sulfide, noise, and odors. Real-time monitoring commenced in July 2012 prior to dredging operations and continued to SCA closure in December 2016. Speciated VOC sampling was conducted at four of the fixed locations around the SCA for 25 project-specific VOCs. Speciated VOC monitoring for the 25 compounds was conducted between July 2012 and July 2017. Speciated monitoring for seven additional compounds was conducted between March 2014 and March 2015. Real-time monitoring and speciated VOC monitoring data were compared to short-term (1-hour) and long-term (12-month average) air quality criteria established by NYSDEC and EPA.

There were no instances where total VOCs exceeded the New York State Department of Health's (NYSDOH's) action levels. Background-corrected 12-month average VOC concentrations for all speciated compounds were below their respective work perimeter limits. Occasional localized criteria excursions for particulates were typically associated with truck traffic and were immediately addressed by additional dust suppression measures, such as increasing the use of water or reducing equipment speeds. Mercury, hydrogen sulfide, and odor annual averages were all at or below monitor detection limits at each monitoring location. There were no excursions of the mercury or hydrogen sulfide work perimeter limits and action levels. While low-level odors were detected at times at monitoring stations over the duration of the project, the average odor levels were below the detection limit of the field olfactometer. There was no work perimeter limit for odor (Parsons, 2019a).

Construction-Related Water Quality Monitoring

A water quality monitoring program was maintained throughout remedy construction. Only three action level turbidity exceedances were recorded while monitoring dredging and capping activities, and investigations of those events determined that none were the result of the remedial construction activities. All analytical results for discrete water column samples collected at compliance monitoring locations outside the dredging operations were below applicable New York State Aquatic (Acute) Class B/C Surface Water Quality Standards (Parsons, 2019a).

Sediment Consolidation Area Cover

A multilayer cover system was constructed between 2015 and 2017 at the SCA consistent with requirements established in the approved design (Parsons and Beech & Bonaparte, 2016). The final closure cross-section layers were constructed as follows (from top to bottom):

- 2-inch thick (average) layer of compost; initially seeded with temporary and later with a permanent seed mix;
- 6-inch thick vegetative soil layer consisting of a mixture of 60 percent on-site borrow soil, 30 percent of imported sand, and 10 percent on-site topsoil;
- 18-inch thick protective soil layer;
- Geocomposite drainage layer consisting of a 200-mil thick geonet heat bonded to a single-sided non-woven geotextile on top deck and 250-mil thick geonet heat bonded with geotextile on both sides (*i.e.,* double-sided) on sideslopes;

- 40-mil thick linear low-density polyethylene geomembrane cap, smooth on top deck and textured on sideslopes;
- Landfill gas vent layer consisting of a geonet composite strips, single-sided on top deck and double-sided on sideslopes;
- 8 ounces/square yard cushion geotextile; and
- Varying thickness of leveling layer material over sediment filled geotextile tubes.

Additional details on the construction and the imported backfill materials utilized at the SCA are provided in the SCA Closure Construction Quality Assurance Report (Geosyntec, 2018).

Habitat Restoration/Enhancement

The restoration of habitat is an integral component of the overall remedy for Onondaga Lake and was one of the important elements in the design for the dredging and capping activities specified for the lake. A goal of habitat restoration in these areas is to achieve ecological systems that function naturally, are self-sustaining, and are integrated with the surrounding habitats. One of the factors that was addressed during the design was the type and thickness of the habitat restoration layer that would be placed above the isolation layer in a given area based on specific habitat needs in that area. Another factor that was considered was the types of structure and aquatic plants that might be placed in various areas of the lake. Accordingly, the ROD called for the development of a comprehensive lake-wide habitat restoration plan and required that habitat re-establishment be performed in all areas of dredging and capping consistent with the plan. The ROD specified that the littoral zone in the vicinity of the dredging/capping should be restored to reestablish appropriate habitat and function following removal of contaminated sediments. Specific goals associated with this objective as set forth in the ROD can be found in the Onondaga Lake Capping, Dredging, Habitat and Profundal Zone Final Design Habitat Addendum (Parsons and Anchor QEA, 2018a).

Habitat re-establishment was performed in RA-A through RA-E within Onondaga Lake (see Figure 13). Habitat quality and diversity was achieved by planting and seeding more than 40 acres of naturalized shoreline and wetlands, which are primarily located in the Ninemile Creek spits, the adjacent in-lake area in RA-A, and in the WBB/HB Outboard Area. More than 450,000 plants representing over 125 native species were installed in accordance with design specifications detailed in the Habitat Design Addendum (Parsons, 2018b).

In addition to plantings and seeding, habitat enhancement was achieved by the placement of habitat "structures" throughout all of the RAs. Structures can be tree stumps, clusters of rock piles, submerged macrophytes, logs, or woody debris on the lake bottom or shoreline. Structural complexity is an important component to fisheries population dynamics and predator-prey relationships. Adding structures improves the quality of habitat for key species and increases angling opportunities by attracting sport fish to accessible locations near shore. The habitat restoration for the lake was designed to achieve these objectives through installation of more than 1,000 habitat structures, including rock piles, individual boulders and boulder clusters, basking logs, downed trees, porcupine cribs (constructed wooden structures specifically designed to provide habitat for fish) (Parsons, 2018b). Habitat structure was also incorporated on the sediment cap adjacent to the Semet/Willis Sheetpile Wall. The habitat structures placed in this area include reef balls, which are custom designed and constructed structures. The access holes and hollow interior spaces of the reef balls provide ideal habitat and shelter for a variety of species and provide additional diversity with the other habitat structures placed throughout the lake (Parsons, 2019a).

Wetland optimization design revisions were incorporated into the WBB/HB Outboard Area wetlands to increase habitat diversity and wetland resilience to wind/wave action, and provide for cap surface elevations that would facilitate wetland vegetation establishment. These revisions did not impact the original cap design or protectiveness of the cap. These revisions provided for an increase in the cap thickness in some areas, and additional protection against erosion by placing protective berms around portions of the wetland (see Figure 14) to aid in their establishment (Anchor QEA and Parsons, 2017).

As noted above, the selected remedy included habitat enhancement, which is improvement of habitat conditions in areas where CERCLA contaminants do not occur at levels that warrant active remediation, but where habitat impairment due to stressors has been identified as a concern. The ROD indicated that habitat enhancement would be performed along an estimated 1.5 miles of shoreline (SMU 3) and over approximately 23 acres (SMU 5) to stabilize calcite deposits and oncolites, and promote submerged aquatic plant growth. The intent of the habitat enhancement along the SMU 3 shoreline was to reduce near-shore turbidity associated with wind/wave events and to reduce shoreline erosion.

Implementation of habitat enhancement of the SMU 3 shoreline, which was integrated with the Wastebeds 1-8 interim remedial measure (IRM), included the placement of six inches, on average, of coarse gravel from elevation 360 feet North American Vertical Datum of 1988 (NAVD88) to 10 feet inland from elevation 362.5 feet NAVD88 to stabilize the substrate. From elevation 362.5 feet to 366.5 feet above mean sea level, the shoreline was stabilized with graded gravel material up to 18 inches. Shoreline stabilization was expanded to include much of the SMU 4 shoreline adjacent to Wastebeds 1-8. Shoreline stabilization along the SMUs 3 and 4 shorelines adjacent to Wastebeds 1-8 was implemented between January to April 2014 and September to November 2014. Morooka trucks were used to transport gravel to excavators that subsequently placed the gravel. Because portions of the shoreline stabilization area extended into the lake, the gravel was used to construct a temporary land bridge to access these portions of the placement area. The gravel from the land bridge was then side-cast into the placement area to complete the shoreline stabilization placement (Anchor QEA and Parsons, 2017).

As noted in the first FYR report for the Subsite, in a 2008 survey, significantly more acreage in SMU 5 was found to be naturally colonized by aquatic plants than would have resulted from implementation of habitat enhancement of the 23 acres in this part of the lake. Therefore, the goals outlined in the ROD for habitat enhancement in this area were already met without implementing active measures.

<u>Nitrate Addition</u>

As during previous years, nitrate addition was performed between 2015 and 2018 in accordance with the approved O&M Plan (Parsons and UFI, 2014). During this period, liquid calcium nitrate solution was diluted with upper lake waters and added directly to the lower waters in the profundal zone at three locations in the lake. One application location was in the northern basin of Onondaga

Lake, and the other two were in the southern basin of the lake (see Figure 15).[11] Equipment and procedures used to apply nitrate during this period were essentially the same as were used during the prior years.

Adjacent Hydraulic Control Systems

Consistent with remedial actions and IRMs associated with adjacent contaminated subsites, shoreline subsurface barrier walls and/or groundwater collection systems have been installed directly adjacent to several capped areas within the lake and adjacent wetlands. Hydraulic containment by these systems limits groundwater upwelling in adjacent lake and wetland areas, and is, therefore, an important factor in ensuring that the caps achieve their established performance criteria. Groundwater flows through three zones in the aquifer—shallow; intermediate; and deep. A clay layer acts as a confining layer between the intermediate and deep zones. Thus, the only potential source of groundwater upwelling through the cap is from the deep zone through the underlying clay layer. This was the design basis used to generate the groundwater upwelling rates for cap modeling for the final design.

The hydraulic containment systems include:

- Shoreline barrier walls and groundwater collection systems that have been implemented as part of the remedial action for OU1 of the Semet Residue Ponds subsite, and the Willis/Semet and Wastebed B/Harbor Brook IRMs
- Shoreline groundwater collection system that has been implemented as part of the Wastebeds 1-8 IRM

Infiltration of impacted groundwater to Onondaga Lake along the southwestern shoreline is being controlled as part of the Willis/Semet and WBB/HB IRMs through hydraulic containment systems that include an epoxy-coated steel sheet pile barrier wall, which extends a minimum of three feet into the clay layer present at depths ranging from 35 to 70 feet below grade, and shallow and intermediate groundwater collection systems. The Wastebeds 1-8 IRM includes Eastern and RA-A shoreline groundwater collection systems to control shallow and intermediate groundwater discharges to Onondaga Lake. Collected groundwater from the hydraulic control systems is conveyed to the nearby Willis Avenue Groundwater Treatment Plant (GWTP) where it is treated for metals and organics prior to conveyance to METRO, where further treatment for ammonia is conducted prior to discharge to Onondaga Lake.

Monitored Natural Recovery

The selected remedy includes MNR to address mercury contamination in the profundal zone and hypolimnion of the lake. Natural recovery is ongoing in SMU 8 (see Figure 5 for the location of SMU 8) through the burial of the contaminated sediments as new sediment enters the lake as inflows from tributaries and direct runoff to the lake. As the remediation of other subsites impacted by mercury are completed, mercury concentrations in sediment entering the lake are expected to further decline.

[11] Figure 15 shows the three 2018 liquid nitrate application locations. The application locations used in 2018 were the same locations where liquid nitrate was applied from 2011 through 2017.

Sediment remediation goals in the profundal zone include achieving the mercury PEC of 2.2 mg/kg or lower on a point basis and the mercury BSQV of 0.8 mg/kg or lower on an area-wide basis within 10 years following the remediation of upland sources, littoral sediments, and initial thin-layer capping in the profundal zone. The remediation of upland sources, littoral sediments, and initial thin-layer capping in the profundal zone was completed in 2016. The mercury BSQV is being applied over five subareas of the lake bottom that together cover the entire surface area of the lake. The five lake subareas from north to south are designated as: North Basin, Ninemile Creek Outlet, Saddle, South Basin, and South Corner (see Figure 16).

CSX Shoreline Area of Remediation Area E

A dredging and capping offset was developed in RA-E in the vicinity of the active rail lines along the southeastern shoreline based on rail line stability considerations. This offset ranges from approximately 130 to 200 feet (ft.) from the shoreline and impacts an area of approximately 10.1 acres.

Institutional Controls

Institutional Controls (ICs) are included as part of the ROD remedy for the Subsite to protect the integrity of the cap and ensure long-term protectiveness of human health and the environment. Specifically, ICs are being implemented to prevent unacceptable exposure to residual contamination within the lake, prevent recreational boaters from accidently contacting any navigational hazards created by capping and restoration components of the remedy, and preventing damage to the cap from activities such as navigational dredging. The controls are being achieved through the NYSDEC and United States Army Corps of Engineers (USACE) permitting process to restrict actions that may disrupt the cap or SMU 8 sediment, the placement and maintenance of navigational buoys in the lake by the New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP), the provision of updated (post-capping) bathymetric survey results to the National Oceanic and Atmospheric Administration (NOAA) to facilitate updating of the Navigational Chart for Onondaga Lake, and the establishment of environmental easements. Consistent with the Onondaga Lake Subsite Site Management Plan, the Onondaga Lake Monitoring and Maintenance Plan, and the ROD, ICs being implemented in support of the remedy also include NYSDOH's Fish Consumption Advisory for Onondaga Lake. (See Appendix B for a description of the advisory.) A summary of the ICs enacted and being applied is provided in the table below.

Table I: Summary of Planned and/or Implemented Institutional Controls

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Document s	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Soils, sediments	Yes	Yes	Capped Areas; CSX Dredging/ Capping Offset Area; SCA	Prevent future exposure to remaining contamination by controlling disturbances of the subsurface contamination; limit the use and development of the site.	Environmental Easement, December 31, 2020 (planned)
					Placement and maintenance of navigational buoys by NYSOPRHP (Ongoing)
					NOAA navigational chart for Onondaga Lake (Chart # 14786 for the Small-Craft Book Chart for the New York State Barge Canal System (November 2018)
					NYSDEC and USACOE Permitting Process (Ongoing)
Fish	Yes	Yes	Onondaga Lake	Provides recommended limits for consumption of fish caught from Onondaga Lake and its tributaries.	NYSDOH Finger Lakes Region Fish Advisories (Ongoing)

Systems Operations/Operation & Maintenance

Adjacent Hydraulic Control Systems

Operational and monitoring data from the hydraulic containment systems discussed in the "Status of Implementation" section, above, are used to determine if groundwater from the shallow and intermediate zones is being successfully captured.

The Willis/Semet and WBB/HB IRM hydraulic containment systems are, generally, meeting the design goals (*i.e.,* groundwater levels are below lake level, indicating that hydraulic capture and an inward hydraulic gradient are achieved). On several occasions, groundwater levels have been above lake levels; however, these conditions occurred over relatively short periods of time during scheduled maintenance, extreme weather conditions, and elevated lake levels and are not indicative of overall system performance (Parsons and O'Brien & Gere, 2018; Parsons and O'Brien & Gere, 2019; Parsons, 2020c).

For the Wastebeds 1-8 IRM Eastern Shoreline Groundwater/Seep and Northern (RA-A) Shoreline Groundwater Collection Systems, data through the end of March 2016 indicated general achievement of hydraulic control for these systems, with periodic exceptions during scheduled maintenance, extreme weather conditions, and elevated lake levels (Parsons and O'Brien & Gere, 2016). As a result, NYSDEC approved capping of lake areas adjacent to these systems. Since then, numerous system upgrades and optimization activities have been implemented that have resulted in improved system performance. The upgrades included the installation of a dedicated collection pipe adjacent to the existing Northern Shoreline groundwater collection trench to connect the passive recovery wells and convey the intermediate groundwater from those wells to the Northern Shoreline pump station, installation of a vacuum extraction system along a portion of the Northern Shoreline Groundwater Collection System, and placement of acid delivery systems at both the Northern and Eastern Shoreline pump stations to reduce scaling and downtime for maintenance. Other modifications have also been implemented to improve system performance and conveyance capacities. These included the construction of physical barriers of steel sheet piling with hydrophilic sealed joints along areas at both the Northern and Eastern Shoreline systems to limit collection of lake water, the establishment of an alternate pH adjustment and discharge option for groundwater being collected under the Wastebeds 1-8 IRM in lieu of treatment at the Willis Avenue GWTP, and upgrading of the forcemain from the Wastebeds 1-8 Eastern Shoreline pump station to the GWTP.

The Eastern and RA-A systems are undergoing initial performance verification with oversight by and ongoing coordination with NYSDEC. Demonstration of consistent performance has been challenging along a portion of the system that is directly adjacent to the capped area in RA-A. Additional cap monitoring was conducted in this area in 2019 and will be conducted in 2022 to verify that the cap adjacent to this portion of the hydraulic containment system is functioning as designed. Monitoring of upwelling velocities in this area is also being conducted as part of the monitoring program for the lake remedy (Parsons, 2020c; Parsons, 2019b).

Habitat Restoration Monitoring

As noted above, planting and seeding was conducted in the Ninemile Creek spits and the adjacent in-lake area in RA-A, and in the WBB/HB Outboard Area to enhance habitat quality and diversity. The mouth of Ninemile Creek was planted in 2016 following the completion of construction activities, and 2018 represented the second year of the five-year monitoring program in that area. The WBB/HB Outboard Area was planted in 2017 following the completion of construction, and 2018 was the first year of the five-year monitoring program for that area. Consistent with the Onondaga Lake Monitoring and Maintenance Plan (OLMMP), quantitative vegetative monitoring was conducted at 59 and 64 50-square-foot plot locations in both areas, respectively. Vegetation cover types and wetland acreages were estimated from these data and included extensive areas of emergent wetland and aquatic bed. The overall cover of vegetation at the mouth of Ninemile Creek was 85% in 2018, which exceeded the interim goal of 75% for the second year of the five-year monitoring program (see Figure 17). The average vegetation coverage in the WBB/HB Outboard Area was 78% in 2018, which, in the first year of the five-year monitoring program, exceeded the interim goal of 75% for the second year of the program (see Figure 18).[12] Invasive species coverage in both areas was less than 1% in 2018. In both areas, the interim goal is 0% invasive species. The intent of the interim goal is to manage all invasive species to achieve the goal of 5% or less after five years.

The restored planted wetland vegetation and upland areas are being monitored annually for a minimum of five years to evaluate the success of the restoration, and verify that success criteria goals are met. The monitoring program includes both quantitative and qualitative evaluations, which document parameters such as vegetative aerial percent cover, relative percent cover of each species, aerial percent cover of invasive species, cover type, counts of woody species, and wetland acreages (Parsons, 2018b).

Total wetland acreages temporarily lost during remediation of the lake that required restoration to meet mitigation success criteria were 1.9 acres for the Ninemile Creek Spits and 7.5 acres for the WBB/HB Outboard Areas. Qualitative estimates of wetland acreage for the Ninemile Creek spits and the WBB/HB Outboard Area were made in 2018 based on observed vegetation cover types. In addition to these areas, adjacent wetland areas were either temporarily or permanently lost during remediation activities conducted at other Onondaga Lake site subsites, as well as permanent loss of an open water area along the former SMU 2 shoreline, as documented in the 2006 ESD for the Subsite discussed above. Consistent with the OLMMP, mitigation wetland acreage will be assessed holistically across respective parts of the Onondaga Lake site that comprise the mitigation areas to determine if the required mitigation has been attained. In year three of the five-year monitoring program (2019 for the Nimemile Creek spits, 2020 for the Wastebed B/Harbor Brook Area), a formal wetland survey was/will be performed by a certified wetland delineator based on vegetation and hydrology. A wetland delineation conducted in accordance with federal and state delineation methods will be completed in year five (2021 for the Nimemile Creek spits and 2022 for the Wastebed B/Harbor Brook Area) to quantify wetland mitigation acreage (Parsons, 2018a).

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[12] The interim goal for the first year of planting is increased percent cover of wetland plants from the initial plantings.

At the mouth of Ninemile Creek and WBB/HB Outboard Area, 134 and 159 plant species were observed, respectively, during surveys conducted in 2018. Additionally, the conditions of large trees were surveyed in the WBB/HB Outboard Area in 2018. Out of 103 large trees planted, 101 survived and were generally in good condition. The two trees that did not survive were replaced in fall 2018 and spring 2019 (Parsons, 2020c).

Qualitative and quantitative surveying of aquatic macrophytes was conducted in 2017 and 2018 to document the natural recolonization by aquatic plants in remediation areas and the coverage in non-remediated areas (reference areas). Species observed included Sago pondweed (*Stuckenia pectinata*), watermilfoil, (*Myriophyllum* spp.), coontail (*Ceratophyllum demersum),* curly pondweed (*Potamageton crispus*), common waterweed (*Elodea canadensis*), water stargrass (*Heteranthera dubia*) and stonewort (*Nitellopsis* sp.). Although the size, distribution, and density of beds were variable, most of the lake, including remediation areas, was characterized by moderate (26-75%) to dense (76-100%) macrophyte coverage. There are no specific success criteria for aquatic vegetation that naturally recolonizes shallow remediated non-planted areas. In both the qualitative and quantitative surveys, remediated areas contained slightly sparser growth compared to other areas of the lake. The sparser growth in remediation areas is likely attributable to the short period of time that plants have had to colonize these areas and the generally coarser substrate now present. Overall, more of the quantitative sampling locations surveyed in 2018 contained vegetation relative to surveyed sampling locations in 2017, particularly in remediation areas (see Figure 19).

While there are no goals for the fish community, monitoring was conducted in 2017 to document how fish are using the newly-restored habitats in the lake. Forty-one and 42 fish species were documented in Onondaga Lake in 2017 and 2018, respectively, which is comparable to the lake-wide average richness of 40 species observed during the baseline sampling period (2008 through 2011) and the 38 species observed during the construction period (2012 through 2016). The species richness in both remediated areas (39 in 2017, 36 in 2018) and unremediated areas (34 in 2017, 38 in 2018) were comparable to average richness within these areas during the baseline and construction periods. Richness within remediated areas was higher than what was observed in sampling during the construction sampling period. Year-to-year fluctuations in the relative abundance of fish are expected due to natural variability in such factors as year-class strength and catchability. However, the lake continues to contain a predominantly warm water fish community with abundance proportions similar to that of the baseline sampling period prior to dredging and construction. Some notable species of this community and their relative abundance in 2018 are Largemouth Bass (14.26 percent), Gizzard Shad (*Dorosoma cepedianum*) (27.04 percent), Banded Killifish (*Fundulus diaphanous*) (36.56 percent), and Bluegill (*Lepomis macrochirus*) (7.87 percent) (Parsons, 2020c).

In accordance with the OLMMP, monitoring for evidence of spawning/reproduction of Northern Pike (*Esox lucius*) and other wetland species was conducted in the WBB/HB Outboard wetlands in 2018 from April 3 to May 8 during the Northern Pike spawning season and from July 16 to August 9 when the young-of-the-year would likely be present. No adult or juvenile Northern Pike were observed during the monitoring period. However, 15 species were observed during the April through May monitoring event, including Banded Killifish, Bluegill, and Brown Bullhead [*Ameiurus nebulosus*], indicating that the newly established habitat is being used by fish. Eleven species were observed during the July through August monitoring event, including young of the year Largemouth Bass and Brown Bullhead. Potentially spawning Longnose Gar (*Lepisosteus osseus*) were also observed. Since 2018 was the first year of monitoring following the completion of construction and associated plantings and because Northern Pike are uncommon in Onondaga Lake, it was not unexpected that adult or juvenile Northern Pike were not observed. Wetland spawning species may increasingly find and use these areas as vegetation expands (Parsons, 2020c).

Although there are no specific success criteria for wildlife usage in remediated areas, monitoring was conducted in 2017 and 2018 to document functional wildlife use of the sites. Recorded observations indicate that the restored areas are attracting diverse wildlife including large numbers of migrating waterfowl during spring and fall. Overall, approximately 90 species were observed across all remediation areas in 2018. As expected, most were found within the restored wetlands. This included 60 species of birds, nine fish species, 12 macroinvertebrates, six mammals, and three amphibians. Common wildlife species included Great Blue Heron (*Ardea herodias*), Spotted Sandpiper (*Actitis macularius*), and Killdeer (*Charadrius vociferus*). Other notable species include northern leopard frog (*Lithobates pipiens*), American toad (*Bufo americanus*), green frog (*Lithobates clamitans*), Pied-billed Grebe (*Podilymbus podiceps*), and Bald Eagle (Parsons, 2020c).

Benthic community data (benthic macroinvertebrates) were collected in 2018 from representative areas within remediation areas, the CSX shoreline area, and reference (unremediated) areas of the lake as per the OLMMP to assess recolonization of new cap substrate. Samples were collected using petite ponars in areas of soft substrate and sediments in both remediated and unremediated areas, while multiplates were used in remediated areas of coarse substrate such as gravel. Following NYSDEC Standard Operating Procedures (SOP) for Biological Monitoring of Surface Waters in New York (NYSDEC, 2018), individual metrics calculated from the data as described in the SOP were converted to Biological Assessment Profile (BAP) scores. Average BAP scores from ponars ranged from 1.3 to 3.4 in the remediated areas and from 1.4 to 3.6 in the unremediated areas of the lake.[13] Remediated and unremediated areas of the lake from ponars had identical overall average BAP scores of 2.6, indicating that the remediated areas are developing a macroinvertebrate community consistent with other comparable locations in Onondaga Lake. Multiplates had an average score of 2.3, which is similar to the ponar sample results. While the average BAP score in both remediated and unremediated areas were generally lower in 2018 than in baseline sampling, the substrate, lake bathymetry, sampling locations, and methods are different than these historical locations, which make direct point-to-point comparisons impractical. As it is believed that recolonization of capped areas is still ongoing, a second post-remediation benthic macroinvertebrate sampling event is expected to be conducted in 2021.

To evaluate the effectiveness of the habitat enhancement conducted along the SMU 3 shoreline, high frequency turbidity measurements obtained from three data sondes affixed to stakes driven into the lake bottom or suspended from a buoy during the September to November interval in 2017 were compared with turbidity data obtained from data sondes deployed in 2012. The 2017 data indicated reductions in wind-driven resuspension of nearshore sediments occurred following

[13] The BAP scale ranges from zero to ten, with zero indicating the lack of a benthic community and ten being comparable to a reference/pristine benthic invertebrate community.

stabilization of the Wastebeds 1-8 shoreline. The results indicate that shoreline stabilization measures implemented along the Wastebeds 1-8 shoreline were successful in stabilizing calcite deposits and in reducing sediment resuspension and turbidity along this shoreline (Parsons, 2019a).

Cap Monitoring

Physical monitoring of the capped areas is conducted in RAs A through F, adjacent wetland areas, and thin layer and amended areas of SMU 8 to verify that the habitat/erosion protection layer and underlying chemical isolation layer for multi-layer caps and mono-layer caps are stable. Comprehensive physical monitoring of the cap and the Wastebeds 1-8 shoreline stabilization area was conducted in 2017 and 2018, consistent with the scope and schedule detailed in the OLMMP.

Cap probing was conducted in 2017 and 2018 in coarse gravel- and gravelly-cobble areas of the cap to verify the presence of these materials. Probing was conducted by manually tapping the cap along OLMMP-specified transects shown in Figures 20.1 through 20.6 at 25-foot intervals with a steel plate attached to rods. In probing areas where the water depth, water clarity, and/or vegetation cover did not interfere, the presence of the coarse substrate was also verified to the extent possible based on visual observations from the water surface. Probing and visual inspections were also conducted directly adjacent to shoreline tributaries and outfalls to verify the cap remains physically stable at these locations. Probing did not identify any anomalies, such as the apparent absence of coarse substrate or significant accumulation of sediment on top of the cap.

Comprehensive bathymetric surveys were conducted for the capped areas in 2017 and 2018 consistent with methods and coverage areas specified in the OLMMP. Minor exceptions were associated with shallow areas where vegetation prevented access in 2017. Bathymetry in these areas was measured as part of the 2018 comprehensive bathymetry measurements. The surveys were conducted on transect lines running perpendicular to the slope and spaced 30 feet apart (Figures 20.1 through 20.6) repeating every other survey line that was established during the collection of as-built data during construction. In areas that were too shallow for boat-based surveying (*e.g.,* where the cap meets the shore), elevations were manually surveyed by wading and using conventional survey techniques.

Within topsoil areas in RA-A, the Ninemile Creek spits, Outboard Area wetlands (including lower Harbor Brook), and the Wastebeds 1-8 connected wetland, the survey lines were modified, as necessary, to collect as much data as possible in and around wetland vegetation. However, portions of these areas are too shallow and/or vegetated for a boat-based survey, and a comprehensive survey using manual methods could damage the wetland vegetation. Vegetation in these areas was inspected on a regular basis in 2017 and 2018 as part of the habitat restoration monitoring. This, in combination with cores collected in these areas and observations from the aerial drone photography, provided verification that there has not been significant erosion of material in these areas.

Comparisons of 2018 to 2017, 2018 to as-built, and 2017 to as-built bathymetries for all RAs are shown in Figures 20.7 through 20.24. Based on the 2017 bathymetry results and in consultation with NYSDEC, several of the 2017 planned chemical coring locations were relocated to locations of relatively greater bathymetric change (i.e., decrease in cap elevation compared to as-built survey). Several additional coring locations for physical cap thickness measurements were also added in 2017, as shown in Figures 20.7 through 20.24. The 2017 multi- and mono-layer cap thickness measurements based on the cap coring are provided in Tables 3.1a and 3.1b, respectively. The 2018 cap thickness measurements based on cap coring are provided in Table 3.2. Based on a comprehensive review of the bathymetry survey results, probing results, and originally-planned and additional coring results, there has been no significant loss of cap material in any capped area and the cap remains physically stable. Bathymetry changes greater than 0.5 ft. shown on Figures 20.7 through 20.24 are generally attributable to settlement of the underlying sediment as a result of the weight of the cap and/or a result of loss of finer-grained habitat material overlying the coarser erosion protection layer. Such changes were anticipated in the final design (Parsons, 2020b; Parsons, 2020c).

One hundred seventy-seven cores were collected in multi-layer cap areas in 2017. With one exception, all individual layer and cap thicknesses measured in multi-layer capped areas in 2017 met or exceeded the target thickness goals specified in the OLMMP. The exception was a result of two duplicate cores where the measured erosion protection layer thickness was one inch less than the target thickness specified in the OLMMP. These cores are in MPC area RA-C-2A (4 to 10 ft.). One hundred twenty-eight cores were collected in mono-layer cap areas in 2017. Of these cores, 93 percent of the measured thicknesses exceeded the specified average design thickness. Measured thicknesses in the remaining cores were consistent with expectations considering construction variability and the average thickness-based goal.

Additional coring was completed at 13 initial multi-layer cap locations in 2018, coinciding with the peeper (*in-situ* diffusion porewater sampler) chemical sampling locations in RAs B, C, D and E. All individual layer and cap thicknesses measured in multi-layer capped areas in 2018 in RAs D and E met or exceeded the target thickness goals specified in the OLMMP. Erosion protection layer thickness measurements from initial cores in Zone 2 of RA-B and in Model Area RA-C-2A (4 to 10 ft.) were less than target thickness goals. Additional monitoring of Zone 2 RA-B conducted in 2018 and 2019 indicated that the measured core thickness may have been biased low and that thickness of the fine gravel layer or total thickness based on videoprobe measurements were not less than the target thicknesses. Based on these findings, no further action with respect to Zone 2 of RA-B was determined to be needed at that time.

Based on the physical monitoring results in Model Area RA-C-2A (4 to 10 ft.), total cap thicknesses meet the target thickness in most areas within MPC RA-C-2A. The thickness of the chemical isolation layer in this area was greater than the target thickness. However, the monitoring results indicate that there were very small areas where fine gravel (for the erosion protection/habitat layer) was not observed or where the total cap thickness was less than the target thickness. These areas are part of an area where stability of the underlying sediment is very sensitive to the thickness of the cap material placed. Based on comprehensive follow-up investigations it was determined that cap materials were not placed here as intended during construction, most likely as a result of caution related to overplacement of materials that could have adversely impacted the underlying sediment stability (Parsons, 2019c). In order to meet the design criteria, placement of additional cap material in a portion of this area (approximately 0.12 acres) took place in November 2019. (See Figure 21.)

The combined 2017 and 2018 chemical monitoring programs included over 8,200 chemical analyses from 165 sampling locations, including multi-layer and monolayer isolation caps in the littoral zone and thin layer capping and direct application areas in SMU 8. The monitoring of the cap includes both bathymetric surveys (including conventional survey methods in shallow areas) as well as coring and/or probing throughout the entire cap area, including thin-layer and amended cap areas in SMU 8. In areas where the cap consists entirely of sand-sized materials or a combination of sand and fine gravel, physical monitoring includes verification, via coring, that the thickness of both the habitat/erosion protection layer and chemical isolation layer is maintained. In areas where the sediment cap habitat/erosion protection layer consists of coarse gravel- and cobble-sized material that prevent coring, the monitoring program consists of verifying the presence of the overlaying habitat/erosion protection layer from the results of probing and bathymetric surveying (Parsons, 2018a).

Chemical monitoring is being conducted to verify that the chemical isolation in multi-layer caps and mono-layer caps is occurring consistent with design criteria. Chemical monitoring, which includes sampling within each of 17 primary cap modeling areas developed during the remedial design and within each MPC area, entails collection of porewater and/or cap material samples from the chemical isolation and habitat layers of the cap. All chemical monitoring includes "focused" constituents, referred to as "indicator chemicals," which were constituents determined during the design phase to represent the most significant potential for migration through the cap and which therefore dictated cap design, including GAC application rates. Indicator chemical groups are shown on Table 2. Chemicals in addition to the indicator chemicals are included in the sampling program during "comprehensive" chemical monitoring events. The additional chemicals include all constituents that have chemical isolation performance criteria that are not already identified as indicator chemicals.

Comprehensive chemical monitoring was conducted in 2017 in accordance with the approved cap monitoring work plan. This included collection and analysis of 421 porewater and solid-phase samples at 157 sampling locations. The methods for sample collection are dependent upon various factors, such as the grain size of the material being sampled, presence or absence of GAC in the material, and detection limits/sample volumes of certain constituents in porewater. Cap porewater concentrations for constituents included in the mean PECQ calculation are compared to the solid-phase performance criteria (see Table 1b for solid-phase criteria) by converting the porewater concentration to a solid phase concentration based on partitioning calculations using the equilibrium partitioning coefficients. Similarly, cap solid-phase sample results for benzene, toluene, and phenol are compared to porewater screening criteria by converting the solid-phase concentration to porewater concentrations based on partitioning calculations using the equilibrium partitioning coefficients.

In 2018, 13 peeper locations were sampled that had not been completed in 2017 (Parsons and Anchor QEA, 2017; Parsons, 2020c).

A schedule of the physical and chemical monitoring activities through 2026 is available in the OLMMP. Additional work plans documenting the cap monitoring schedule after 2026 will be developed subject to NYSDEC review and approval. The post-remediation results for chemical monitoring of the cap are discussed in the "Data Review" section, below.

Nitrate Addition Program

Based on the success of the three-year pilot test, nitrate addition is continuing as part of the long-term remedy consistent with the 2014 ESD. Nitrate is applied after thermal stratification is established in summer and it has been applied at the same three locations in the lake, as necessary, since 2011 to maintain a concentration of 1.0 milligrams per liter (mg/L) in the hypolimnion. Water quality measurements are used to determine the density of nitrate solution, and there is frequent sampling of nitrate concentrations at depth and a submersible ultraviolet nitrate analyzer deployed to analyze nitrate conditions. The extent of nitrate needed in Onondaga Lake during summer months prior to fall turnover is anticipated to decline gradually over the coming years as mercury-contaminated sediment in SMU 8 is further isolated via MNR. Therefore, nitrate addition will be evaluated annually based on the prior year's results, the lake's fluctuating seasonal hydrologic and nitrate inputs, and other factors. Observed reductions of methylmercury in surface water and in zooplankton are discussed in the "Data Review" section, below.

Sediment Consolidation Area

Monitoring and maintenance activities at the SCA from closure through 2018 were performed consistent with the SCA Post-Closure Care Plan (Parsons and Beech & Bonaparte, 2017), with the objective of maintaining and verifying the integrity and effectiveness of the cover system, surface water management system, liquid management system (LMS), and the SCA perimeter berm. Monitoring activities include quarterly visual inspections of the SCA final cover system and of the surface water management systems, monthly inspections of the LMS system, odor monitoring, and additional inspections after major storm events and prior to mowing events. Maintenance activities (*i.e.,* mowing, seeding, and invasive species control) were conducted, as needed, based on inspection findings. Conditions and operation of the SCA during the 2017 and 2018 monitoring period were satisfactory. Inspections of the LMS inspections conducted during 2017 and 2018 found equipment to be in working order. Odor monitoring consisted of odor observations by a qualified individual who has experience with site-related odors at eight air monitoring stations along the SCA work zone perimeter road. No site-related odors were detected during inspections conducted during the 2017 or 2018 monitoring periods (Parsons, 2020a).

Monitored Natural Recovery

The primary mechanism by which profundal zone surface sediment mercury concentrations are declining is burial by incoming clean sediments that are continually being deposited from overlying water. Collection and total mercury analysis of shallow sediment cores (0-4 cm and 4-10 cm) in SMU 8 is the primary method of determining attainment of MNR performance criteria. In 2017, shallow cores were collected at 20 profundal zone locations sampled in 2014 and two new locations to verify compliance with the mercury BSQV of 0.8 mg/kg in each of the five designated BSQV areas (Figure 16), and throughout the profundal zone for compliance with the mercury PEC of 2.2 mg/kg.

The MNR monitoring scope includes several components that can aid in the assessment of the extent and rate of natural recovery in SMU 8:

- sampling and total mercury analysis of surface sediment samples and comparing these data with predicted concentrations obtained via site-specific natural recovery modeling;
- use of sediment traps deployed at a location in the South basin (South Deep) from May through October each year to monitor sediment deposition rates of solids and total mercury in settling sediment;
- measurement over time of the depth of sediment above fluorescent sand-sized microbeads, which were placed in nine 1,400-square-foot plots in the deep-water zone of in SMU 8 during 2009 to provide a vertical marker of the SMU 8 sediment, and which provide a quantitative demonstration of the extent of ongoing sediment burial;
- visual observations of varves/layers collected from profundal zone sediments in 2014, 2015 and 2017 and frozen cores to assess vertical mixing of sediment; and
- assessment of abundance and composition of benthic macroinvertebrates (*e.g.,* worms), which if present in significant numbers, can affect ongoing natural recovery by increasing the extent to which sediment is vertically mixed.

<u>CSX Shoreline Area of Remediation Area E</u>

As specified in the Design Addendum for this area (Parsons and Anchor QEA, 2014), the offset area includes baseline surface sediment sampling at approximately the same density as sampled during the PDI for the full list of mean PECQ parameters, plus benzene, toluene, and phenol; total organic carbon; grain size; and post-remedy surface sediment sampling at/near baseline locations to confirm natural recovery.

Baseline surface sediment sampling in the offset area was completed in fall 2016. Sampling details and results are provided in the Summary Report Onondaga Lake 2016 Cap Monitoring (Parsons and Anchor QEA, 2018c). As specified in the OLMMP, post-remedy sampling events and bathymetric surveys were and will be completed in this area in 2019 and 2024, respectively. The need for scope and timing for subsequent monitoring in this area will be determined based on the results of the 2024 sampling event (Parsons, 2020c).

In addition to the surface sediment sampling, baseline habitat sampling was conducted in June and July 2016 to characterize current habitat present along the shoreline of the offset area. The baseline habitat survey found that conditions immediately above and below the water line are harsh and support only a few plant species with the invasive species common reed (*Phragmites australis*) being most common. However, there is substantial canopy cover at the upper end of the zone, which provides perches for birds such as Bald Eagle (*Haliaeetus leucocephalus*), which are routinely observed in the area during the winter months. The offshore aquatic vegetation community was found to provide much better habitat value and is composed of a diversity of mostly native species which are expanding naturally (Parsons, 2019d).

<u>Fish Tissue</u>

Contaminant data from fish tissue in Onondaga Lake are being used to assess the progress of the remediation in several contexts. These include the exposure of the public from consuming fish, and exposure experienced by two types of wildlife (those consuming smaller prey fish, and those consuming larger fish). In addition, the trends in the data are being considered to assess improvements (*i.e.,* declines) in the contaminant concentrations due to the remediation. Although fish have been collected on an annual basis during the post-ROD baseline monitoring period (2008 to 2011) prior to commencement of remedial actions in the lake and during the remedial action period (2012 to 2016), only two years of data (2017 and 2018) have been collected and are available since remediation activities were completed in 2016. To statistically assess the direction and rate of change in fish concentrations post-remedy (*i.e.,* after 2016), additional data collection is needed and will be undertaken in future years as defined in the OLMMP. Therefore, the discussion in the "Data Review" section, below, focuses on a qualitative comparison of pre-remedy and post-remedy concentrations and comparisons to the fish tissue goals for mercury and the fish tissue target concentrations for the organics.

Both Honeywell and NYSDEC have collected fish over the time frames prior to, during and subsequent to implementation of remedial activities, although they typically sample different species, with NYSDEC concentrating on Largemouth Bass, with other species being less consistently collected.

Potential Effects from Climate Change

Potential site impacts from climate change have been assessed, and the performance of the remedy may be impacted by the climate change effects in the region and near the site. Potential effects from climate change include erosion of the lake and wetland sediment caps and SCA cover due to severe storms/weather events and associated flooding. The sediment cap has been designed to provide long-term physical isolation and stability, as well as chemical isolation with no anticipated cap maintenance or enhancement. The erosion protection layer of the cap was designed to be physically stable under conditions predicted to occur based on consideration of a 100-year return-interval wind-generated wave event and a 100-year tributary flood flow event. The cap includes over 40 different design profiles across the capping area, each of which was developed based on goals and input parameters specific to a given area, including sediment contaminant concentrations, water depth, wave erosive forces, and habitat substrate goals. EPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (2005) recommends that the physical cap integrity be monitored both routinely and after events with certain recurrence intervals. Therefore, in addition to routine monitoring of the cap, physical monitoring will be performed after extreme events to verify the integrity of the cap. The extreme event conditions that will be used to trigger a monitoring event include a 50-year or greater wind-generated wave event or a 50-year or greater tributary flow event (Parsons, 2019e).[14] Stormwater calculations performed for the SCA as part of the Final Design Report showed the stormwater management system is capable of handling a 100-year, 24-hour storm. Vulnerability assessments will be conducted for the SCA when deemed necessary and will address the vulnerability of the SCA and/or engineering controls to severe storms/weather events and associated flooding (Parsons, 2019f).

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the last FYR, as well

[14] Consistent with the OLMMP, cap monitoring would also occur following a seismic event measuring 5.5 or larger within 30 miles of Onondaga Lake as measured by the US Geological Survey.

as the recommendations from the last FYR and the current status of those recommendations.

Table II: Protectiveness Determinations/Statements from the 2015 FYR

OU #	Protectiveness Determination	Protectiveness Statement
02	Will be Protective	The OU2 remedy, which includes dredging, capping, habitat restoration, nitrate addition and monitored natural recovery, is expected to be protective of human health and the environment upon completion. In the interim, remedial activities conducted to date are operating as intended to protect human health and the environment.

There were no issues and recommendations in the last FYR.

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

On October 1, 2019, EPA Region 2 posted a notice on its website indicating that it would be reviewing site cleanups and remedies at 42 Superfund sites in New York, New Jersey, and Puerto Rico, including the Subsite. The announcement can be found at the following web address: https://www.epa.gov/aboutepa/fiscal-year-2020-five-year-reviews. In addition to this notification, a notice of the commencement of the FYR was sent to local public officials. The notice was provided to Villages of Liverpool and Solvay, Towns of Camillus, Geddes and Salina, and City of Syracuse by email on June 24, 2020 with a request that the notice be posted in town hall and on their webpages. In addition, on June 25, 2020, the notice was distributed via the NYSDEC's Onondaga Lake News email listserv, which includes approximately 11,000 subscribers. The purpose of the public notice was to inform the community that the EPA would be conducting a FYR to ensure that the remedy implemented at the site remains protective of public health and the environment and is functioning as designed. In addition, the notice included contact information, including addresses and telephone numbers, for questions related to the FYR process for the site. No interviews were conducted for this FYR.

The results of the review and the report will be made available at the Onondaga Lake site information repositories and the site website: https://www.epa.gov/superfund/onondaga-lake. The information repositories are maintained at the NYSDEC Region 7 Office, 615 Erie Boulevard West, Syracuse, New York; NYSDEC Central Office, 625 Broadway, Albany, New York; Onondaga County Public Library, Syracuse Branch at the Galleries, 447 South Salina Street, Syracuse, New York; Solvay Public Library, 615 Woods Road, Solvay, NY 13209; and Atlantic States Legal Foundation, 658 West Onondaga Street, Syracuse, New York. In addition, efforts will be made to reach out to local public officials to inform them of the results.

Data Review

A discussion of the performance of the remedy based on data for all relevant media (*e.g.,* capped areas, surface water, SMU 8 sediment, fish tissue) is presented in this section. Figures and tables referenced in this section associated with cap monitoring, surface water/mercury methylation in the hypolimnion and natural recovery can be found in Attachment 1. The tables and figures associated with monitoring of fish tissue and a general description of the fish tissue monitoring program since 2008 is presented in Attachment 3.

Cap Chemical Monitoring

The combined 2017 and 2018 chemical monitoring programs included over 8,200 chemical analyses from 165 sampling locations. Over 90 percent of the analytical results were "nondetects" or very low concentrations (less than five percent of the performance criteria). Detected concentrations were primarily attributable to background influences as well as potentially anomalous data or isolated occurrences (Parsons, 2020c). The monitoring results are summarized below.

Table III: Cap Chemical Combined 2017-2018 Monitoring Summary

Cap Type	Number of Sample Locations	Number of Samples	Number of Analyses	Number of Exceedances
Multi-Layer	120	441	6961	10
Mono-Layer	20	46	345	0
SMU 8 TLC	25	38	950	0

There were exceedances of the cap performance criteria in multi-layer caps at ten locations. Five of the sample locations with exceedances, all for toluene, were subsequently resampled. None of the results from the resampling exceeded the cap criteria. Of the five remaining sample locations with exceedances, one was for toluene, two were for phenol, one was for benzo(a)pyrene, and one was for mercury. In the case of the remaining toluene and phenol exceedances, it could not be concluded whether the exceedances were attributable to chemical migration from the underlying chemical isolation layer or to other factors. As documented in the ROD, neither toluene nor phenol was shown to exhibit acute toxicity on a lake-wide basis. Therefore, these chemicals were not included among the chemicals used to develop the mean PECQ, which was the primary basis for identifying areas of the lake that pose potential unacceptable risks to benthic organisms based on toxicity considerations. There were no exceedances of the mean PECQ among all of the samples collected. Unlike toluene and phenol, benzo(a)pyrene is included in the calculation of the mean PECQ. The level of benzo(a)pyrene detected in the sample (200 micrograms per kilogram [µg/kg]) exceeded the criterion (146 µg/kg), but, as there was a lower level (76 µg/kg) of benzo(a)pyrene deeper within the habitat layer at the same sample location and both samples have similar total organic carbon levels, this exceedance does not appear to be attributable to chemical migration from the underlying chemical isolation layer and is likely a result of background influences. Because this elevated result was identified in one isolated sample and because the mean PECQ was not exceeded at this location, it is not considered to be indicative of an unacceptable risk to benthic organisms.

The one exceedance for mercury was in the lower habitat interval in one of the two topsoil locations sampled in the Ninemile Creek spits. The sample had a mercury concentration of 0.353 mg/kg, which although less than the mercury PEC of 2.2 mg/kg, is greater than the mercury criterion of 0.15 mg/kg, which is the applicable criterion that applies to the Ninemile Creek spits.

All samples collected from the monolayer, SMU 8 thin-layer cap (TLC) and direct GAC application areas were below the performance criteria. Summary information on the exceedance locations, depths and concentrations is available in Tables 4.1 and 4.2 for 2017 and 2018, respectively.

The results from the 2017 and 2018 chemical monitoring programs do not indicate any significant chemical migration through any of the capped areas. All 2017 and 2018 sample locations were resampled in 2019; the results are pending.

Surface Water Compliance Monitoring

Surface water sampling was conducted in 2017 and 2018 for filtered (dissolved) and unfiltered (total) mercury, methylmercury, PCBs, and select VOCs/semivolatile organic compounds (SVOCs) (benzene, toluene, ethylbenzene, xylenes, chlorobenzenes, acenapthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, fluorene, naphthalene, phenanthrene, phenol, pyrene). Consistent with the OLMMP, surface water samples were collected at ten littoral zone locations and two mid-lake locations (Figures 22.1 and 22.2) at sample depths ranging from 0.33 to 6.6 feet prior to and after fall turnover each year.

The results for dissolved mercury, total mercury, and methylmercury in surface water are summarized on Tables 5.1 and 5.2 for 2017 and 2018, respectively. The results for dissolved mercury are also shown on Figure 23. Detected levels of dissolved mercury at littoral and mid-lake locations were estimated from 0.08 to 0.37 nanograms per liter (ng/L) in 2017 and from 0.12 to 0.40 ng/L in 2018. The levels are below dissolved mercury goals of 2.6 ng/L for the protection of wildlife and 0.7 ng/L for human health via fish consumption for both pre- and post- turnover events in 2017 and 2018. Total mercury concentrations in surface water ranged from 0.43 ng/L to 2.29 ng/L in 2017 and from 0.43 ng/L to 2.88 ng/L in 2018. Methylmercury concentrations ranged from "nondetect" to 0.21 ng/L in 2017 and from "nondetect" to 0.15 ng/L in 2018. There are no surface water criteria for total mercury or methylmercury.

Benzene and chlorobenzene were detected at estimated concentrations of 0.2 micrograms per liter (µg/L) and 0.3 µg/L, respectively, at one location in RA A in 2018. The surface water quality standard (SWQS) for benzene and chlorobenzene are 10 µg/L and 5 µg/L, respectively. Toluene was detected at one location in RA E in 2018 at an estimated concentration of 0.3 µg/L (SWQS of 100 µg/L). All of the other pre-turnover VOC/SVOC samples in 2017 and 2018 were nondetect. (See Tables 6.1 and 6.2.) VOC and SVOC samples were not collected after fall turnover because all the pre-turnover results were below standards.

Total PCBs were evaluated during pre- and post-turnover events in both 2017 and 2018 at all specified littoral and mid-lake locations using a congener-based approach to achieve low detection limits. Total PCBs averaged 1.15 and 1.45 ng/L during pre- and post-turnover events in 2017.

Similarly, total PCBs averaged 0.69 and 1.20 ng/L, respectively, during pre- and post-turnover events in 2018 (Table 7). Concentrations were generally lower in 2018 than those observed in 2017. The detected concentrations are above both the criteria for the protection of wildlife (0.12 ng/L) and the protection of human health via fish consumption (0.001 ng/L) (Figure 24). The highest total PCB concentrations observed in the lake during the 2017 pre-turnover period and both the 2018 pre- and post-turnover periods occurred at the monitoring location that is closest to the Ley Creek outlet to the lake (SW-03). Four subsites located along Ley Creek (two of the subsites include portions of the Creek itself) are current or former PCB sources. While some IRM and remedial actions addressing PCB sources located adjacent to Ley Creek have been conducted at two of the subsites and a portion of another subsite, remediation of the Creek itself has not yet been implemented.

The Onondaga Lake ROD lists calcite and ionic waste constituents as CPOIs. Stressors of concern include calcium, chloride, salinity, ammonia, nitrite, phosphorus, sulfide, dissolved oxygen and transparency. These stressors have been routinely monitored by Onondaga County in both the tributaries and deep portions of the lake as part of the Ambient Monitoring Program (AMP). As noted in the AMP reports from 2012 through 2017, the high concentrations of total dissolved solids (TDS) in Onondaga Lake, which include concentrations of cations and anions (calcium, chloride, sodium, sulfate and others) are primarily associated with the natural hydrogeology of the lake and not with anthropogenic effects. The most recently approved Onondaga County AMP report (Onondaga County, 2019) was reviewed and is summarized below (Parsons, 2020c).

TDS measurements at South Deep exceeded the Ambient Water Quality Standards (AWQS) guidance value of 500 mg/L in 2017. TDS reflects the concentration of major cations such as calcium, sodium, magnesium, potassium, and anions such as bicarbonate, chloride, and sulfate. Exceedance of the guidance value is associated with the natural hydrogeology of the lake and not with anthropogenic effects. The bedrock of Onondaga County is high in concentrations of calcium and sulfate, which contribute to the high levels of TDS in the lake and its tributaries. For the 2007-2017 period, trends in lake concentrations show a statistically significant decrease of 1.3% in TDS at the lake outlet (3.7 m depth), but no significant trends in elsewhere. Calcium, chloride, and salinity are all monitored separately from TDS; calcium and salinity showed no statistically significant trends over the period reviewed in the report (2007-2017). However, a statistically significant decrease in chloride of 2.1% at the south basin (low waters) and 1.7% at the lake outlet (3.7-meter depth) were observed over the 2007-2017 period. No statistically significant trends were observed elsewhere (Parsons, 2020c).

Monitored Natural Recovery

Mercury concentrations measured in 2014 and 2017 in surface (0 to 4 centimeters [cm]) and subsurface (4 to 10 cm) sediments throughout the profundal zone are provided in Table 8. The appropriate compliance depth for the mean PECQ of 1, the mercury PEC and the mercury BSQV in SMU 8 has been conservatively defined as the top 4 cm of sediment. The sediment from 4 cm to 10 cm is also being evaluated in order to provide further data in the event of mixing deeper than the 4 cm compliance depth. Mercury concentrations measured in 2017 are generally less than those measured in 2014, indicating ongoing natural recovery of sediments in SMU 8. Mercury concentrations were below the mercury PEC of 2.2 mg/kg in all 22 of the surface samples and in

20 of the 22 subsurface samples. Two samples in the 4 to 10 cm interval were marginally above 2.2 mg/kg (2.55 mg/kg and 2.26 mg/kg) in the South Corner and Saddle areas (Parsons, 2018a and Parsons, 2020c). At all locations, 2017 concentrations are higher in the 4 to 10 cm interval than in the 0 to 4 cm interval.

In addition to the 2014 and 2017 SMU 8 measured surface sediment mercury concentrations, Table 8 includes the model-predicted surface sediment mercury concentrations from the final design. Of the 22 sediment locations sampled in 2017, 14 were modeled as part of the final design analysis. Measured mercury concentrations in 2017 ranged from 0.4 to 1.4 mg/kg in the top four cm. These levels are lower than the model levels predicted to occur in 2017 at all 14 locations, indicating that recovery of profundal zone sediments is occurring more rapidly than predicted.

Area-weighted average mercury concentrations were calculated for the five sub-basins of Onondaga Lake, which include the profundal zone (SMU 8) and littoral zone, for comparison to the BSQV. Two methods were used to calculate the area-weighted average concentrations in each sub-basin. The first method (Method 1) relied on the 2017 SMU 8 surface sediment samples only from the 22 locations to calculate area-weighted average concentrations in the SMU 8 portion of each sub-basin (Figure 25.1). Because the number of 2017 data points was less than the data density used to calculate the area-weighted average concentration during the final design, a second method (Method 2) was employed, which supplements the 2017 data from the 22 locations along with the SMU 8 data from the final design and assigned a mercury concentration to each location not sampled in 2017 based on a percent reduction that has occurred since that time (Figure 25.2). Average percent reductions for each of the five BSQV sub-areas were calculated by comparing the surface sediment mercury concentrations measured during the 2017 sampling to the surface sediment mercury concentrations from co-located sample locations measured as part of the PDI.

The following datasets were used to develop the area-weighted average surface sediment mercury concentrations inclusive of SMU 8 and littoral zone capped and uncapped areas:

- 2017 SMU 8 surface sediment samples (0 to 4 cm)
- PDI SMU 8 surface sediment samples (Method 2 only)
- 2017 and 2018 cap monitoring samples (including both solid phase and porewater converted to solid phase using equilibrium partitioning) collected within the 0- to 15-cm depth interval within the littoral zone (0- to 6-inch samples and 3- to 6-inch samples included) and 0- to 4- cm depth interval for locations within the profundal zone
- Remedial investigation samples collected within the 0- to 15-cm depth interval from locations within the littoral zone outside the cap areas

For Method 2, percent reductions applied to the PDI sampling locations were calculated for each sub-area as presented in Table 9. Where 2017 samples exist, those were used in place of the PDI sample concentration with reduction. Areas of influence (based on Thiessen polygons) for each sample location are presented in Figures 25.1 (Method 1) and 25.2 (Method 2). Areas of influence were defined for the profundal zone, non-capped areas, and each cap type separately. For example, the area of influence for a sample collected in SMU 8 does not extend beyond the boundary of non-capped areas in SMU 8.

Regardless of the method used, the analysis indicates that the area-weighted average surface sediment mercury concentrations have declined to values less than or equal to the mercury BSQV of 0.8 mg/kg in all five sub-basins of Onondaga Lake. Surface sediment area-weighted average concentrations across Onondaga Lake in each of the five lake zones are presented in Table 10 for Methods 1 and 2. The area-weighted mercury concentrations are less than predicted to occur by 2017 during the final design, indicating that recovery is occurring more rapidly than predicted.

It should be noted that the 2017 sampling results noted above and presented in Table 9 are from a "routine" sampling event as described in the OLMMP. Routine results alone are not being used to verify compliance, but are being used to determine when compliance verification sampling would be conducted. In accordance with the OLMMP, once routine monitoring results indicate that the mercury PEC and BSQV are being met (which have been achieved based on the 2017 SMU 8 surface sediment samples from 0 to 4 cm), compliance verification sampling events would be conducted using a more robust number of sampling locations in SMU 8 and include additional sampling of the littoral zone including in un-remediated areas. Compliance with the mercury PEC would be based on meeting that criterion at every location. Compliance with the mercury BSQV would be based on the calculated surface-weighted average concentrations (SWACs) meeting the BSQV in each of the five sub-areas. To demonstrate attainment of the performance criteria, compliance verification results would need to meet the criteria over two consecutive verification sampling events completed within one to three years of each other. Since all recent mercury concentrations in SMU 8 surface (0 to 4 cm) sediment were below the mercury PEC (Table 9) and the mercury SWACs calculated under both Methods 1 and 2 were below the BSQV for each of the five sub-areas (Table 10), the next sampling event, which is scheduled to be conducted in 2021, will be the first compliance verification sampling event. If the mercury performance criteria are attained in 2021, a subsequent compliance verification sampling event would be conducted in accordance with the OLMMP to further evaluate compliance.

In addition to the collection of shallow cores and their analysis for mercury, monitoring to assess monitored natural recovery also includes evaluations of the depth of mixing of surface sediments, sedimentation rates, and the concentrations on the settling particles.

To assess mixing depths in SMU 8, cores were collected from profundal zone sediments in 2014, 2015 and 2017. The presence of layers or laminations in the SMU 8 sediment is primary evidence that SMU 8 sediment is relatively undisturbed and not affected by bioturbation or resuspension of lakebed sediment. Based on observations of laminations from the cores collected from SMU 8 in 2014, 2015 and 2017, mixing depths range from 0.1 to 7 cm, with an average of 1.5 cm (see Table 11). The average depth of 1.5 cm is within the SMU 8 compliance depth of 4 cm for the mercury PEC and mercury BSQV, but there are some locations in the north and south basins where mixing appears to be deeper. Additional monitoring is planned for 2021.

Based upon the fluorescent microbeads that were placed on top of sediments to visually demarcate the sediment surface, allowing for the quantification of the depth of settling sediments since the time of placement. Sedimentation rates were estimated from cores collected in the microbead plots by measuring the thickness of sediment that accumulated on top of the microbead marker. Sediment cores have been collected periodically (2011, 2014, 2015 and 2017). The cores were visually inspected for the green microbead marker. Results from the 2014, 2015 and 2017 events are summarized in Table 11. The results indicate that sedimentation rates range from 0.04 to 0.32 grams per square centimeter per year ($g/cm^2/yr$), with an average of 0.16 $g/cm^2/yr$. The sedimentation rate of 0.25 $g/cm^2/yr$ (1.0 cm year) used in the final design natural recovery modeling is within the range measured in 2015 and 2017.

Based upon the results from sediment traps deployed at a location in the South Deep, it was determined that the average deposition of suspended solids during the 2014 through 2018 period ranged from 11,151 to 17,800 mg per square meter per day ($mg/m^2/day$), all of which are higher than the solids deposition rate of 6,850 $mg/m^2/day$ (or 0.25 $g/cm^2/yr$) used in the MNR modeling conducted as part of the final design. The results are tabulated in Table 12 and shown in Figure 26. The average mercury concentrations in settling suspended solids in SMU 8 declined from 0.91 mg/kg in 2014 to 0.18 mg/kg in 2018, with an average of 0.43 mg/kg (see Table 12). In 2017 and 2018, mercury concentrations in settling suspended solids (approximately 0.2 mg/kg) were lower than the mercury concentration of 0.4 mg/kg used to represent the post-remediation period in the natural recovery modeling conducted during the final design. These lower mercury concentrations result in lower concentrations at the surface sediments and therefore result in faster recovery of SMU 8 sediments (Parsons and Anchor QEA, 2012; Parsons, 2020c).

As Onondaga Lake recovers, there is potential for increased density in benthic organisms, which could in turn lead to increased mixing in SMU 8 sediments. Therefore, the benthic macroinvertebrate community was monitored and compared to previous years to understand the potential for increased mixing depth. In 2015, the benthic macroinvertebrate community was documented in SMU 8 at three different water depths along three transects, as well as two deeper locations. Most (greater than 95 percent) organisms collected during the June and August 2015 sampling events were chironomids and oligochaetes. Considerable variability was observed among grab samples at most locations. Macroinvertebrate densities were generally lower at profundal zone locations in the deepest water compared to the most-shallow water depths along the transects. Profundal zone macroinvertebrate densities observed in 2015 (mean of approximately 1,300 organisms/square meter) were higher than those reported in 1992 and 2000 for water depths greater than 7.5 meter (mean of 36 organisms/square meter) suggesting an improvement in the profundal macroinvertebrate community. The observed densities do not appear to be contributing to significant bioturbation, as evident from the mixing depth estimated from the frozen cores. Differences in sampling months, locations, and water depths preclude more detailed comparisons among years.

<u>Mercury Methylation in the Hypolimnion</u>

Nitrate addition has achieved the goal concentration of 1 mg/L nitrate in the hypolimnion since 2011 (see Figure 27). The time series of methylmercury concentrations for the 18-m water depth at the South Deep location for the period between 2007 and 2018 is shown on Figure 28. The annual maximum mass of methylmercury in the hypolimnion for the period between 1992 and 2018 is shown on Figure 29. As illustrated in the figures, methylmercury concentrations and total methylmercury mass declined considerably in the lake's hypolimnion since 2011. Low methylmercury concentrations in Onondaga Lake since 2011 are consistent with the higher nitrate concentrations.

Zooplankton samples have been collected from a single deep water station and analyzed for total mercury and methylmercury. Zooplankton total mercury concentrations have primarily decreased since nitrate addition began in 2011 (Figure 30). Methylmercury, a more bioaccumulative and toxic form of mercury, has consistently comprised a very low percentage of the total mercury present. Peak methylmercury concentrations in zooplankton spiked when nitrate was depleted from the hypolimnion in 2009 and have remained relatively low since nitrate addition began (see Figure 31). Proceeding with mercury and methylmercury monitoring in zooplankton and Daphnia, which are large zooplankton that are important fish prey, will continue to facilitate interpretation of the long-term results of the fish tissue monitoring program (Parsons, 2018a; Parsons, 2020c).

To date, significant adverse effects on water quality or growth of algae in the lake have not been observed as a result of the application of nitrate to Onondaga Lake. Total dissolved gas (TDG) measurements have been monitored as part of the nitrate addition monitoring program to provide information on the fate of added nitrate and the potential occurrence of oversaturated dissolved gas levels that could be harmful to fish. Levels of TDG between 2007 and 2017, which include the baseline period and the period in which the nitrate addition has been implemented, have been consistent. Despite natural oversaturation of nitrogen gas, TDG levels in the hypolimnion have consistently remained at or slightly below 100 percent saturation over this period (Figure 32). EPA has published TDG water quality guidelines which recommend a maximum TDG pressure of 110 percent of local atmospheric pressure (EPA, 1986). Fish can usually tolerate supersaturated water of less than 110 percent of saturation near the surface of the water. At a water depth of 3.3 feet (1 meter), most fish can tolerate a total gas pressure of 120 percent of saturation with tolerance increasing about 10 percent for each additional meter of water depth. Because of the consistent results at levels below EPA guidelines for protection of fish, the requirement to measure TDG was removed from the monitoring program following monitoring conducted in 2017.

Nitrite-nitrogen concentrations were measured in Onondaga Lake from 2006 through 2018 and were compared to the New York State SWQS established for nitrite (100 µg/L as nitrogen) to protect warm water fish from effects of nitrite (see Figure 33). For the 2006-2017 period, weekly average concentrations were below the SWQS for nitrite except in late June and early July at the 16- and 18-m depths. In 2018, the SWQS for nitrite was exceeded at the 12-m depth during July and again during early October. Elevated nitrite concentrations during 2018 were caused by incomplete nitrification of ammonia. Nitrification treatment at Metro was suspended temporarily for project-related construction from October 16, 2017 through March 3, 2018 and again from October 16, 2018 through February 28, 2019. The shutdown during the winter of 2017-2018 resulted in higher loading of nitrite and ammonia to the lake in 2018 and lower loading of nitrate. In 2018, nitrite concentrations did not exceed the standard at the water depth most affected by application of nitrate (18 m). Nitrate added to the hypolimnion is denitrified to dinitrogen gas (N2) (Parsons, 2020c). During the 2006-2018 period, concentrations of nitrite remained below the New York State surface water quality standard in the upper waters (2 m) where fish reside.

<u>Fish Tissue</u>

Both Honeywell and NYSDEC have collected fish over the time frames prior to, during and subsequent to implementation of remedial activities, although they typically sample different species, with NYSDEC concentrating on Largemouth Bass, with other species being less consistently collected. For the fish tissue data reporting, both the Honeywell data sets from 2008 to 2018 (fillets of Smallmouth Bass (*Micropterus dolomieu*), Walleye (*Sander vitreus*), Common Carp (*Cyprinus carpio*) and Pumpkinseed (*Lepomis gibbosus*) and whole-body small and large prey fish) and NYSDEC data sets from 2008 to 2018 (Largemouth Bass, Carp, Yellow Perch [*Perca flavescens*], White Perch [*Morone americana*], and Channel Catfish [*Ictalurus punctatus*]) are used.

The discussion of fish tissue monitoring results below generally focuses on the 2015-2018 monitoring period for both the Honeywell and NYSDEC data sets, as this period follows that which was covered in the first FYR report (data through 2014). Fish tissue sampling and analysis conducted by Honeywell in 2015 and 2016 were implemented consistent with NYSDEC approved submittals, including the 2015 and 2016 work scopes for tissue monitoring submitted as work plan addenda to the Onondaga Lake Tissue Monitoring Work Plan for 2012 (Parsons and Anchor QEA, 2015; Parsons and Anchor QEA, 2016). Fish tissue monitoring conducted by Honeywell in 2017 and 2018 was implemented consistent with draft and final versions of the Onondaga Lake Monitoring and Maintenance Plan (Parsons and Anchor QEA, 2018b). Data for the period prior to 2015, including the baseline monitoring period, are also discussed to some extent, particularly when considering potential trends in contaminant concentrations. The figures referenced in the discussion below can be found in Attachment 3 along with a general description of the fish tissue monitoring program since 2008 and a summary of the data sets used in this assessment.

Potential human health exposures associated with fish consumption are evaluated based on adult sport fish species selected to cover a range of trophic levels including top level piscivores (Smallmouth Bass, Walleye), invertivores (Pumpkinseed), and benthic herbivores (Common Carp)[15]. A total of 25 individual fish for each of up to four adult sport fish species were targeted for collection each year during the 2015-2018 period for a total of up to 100 adult sport fish samples. The actual number of species collected by Honeywell between 2008 and 2018 is presented in Table 1 of Attachment 3. Approximate fish tissue sampling locations are provided on Figure 34.

For ecological exposure, the fish were grouped into two size classes: small (3 to 18 cm) and large (18 to 60 cm) consistent with the Onondaga Lake BERA (TAMS, 2002). Small prey fish composite samples collected by Honeywell, each consisting of a single species, were comprised of approximately 10-15 small prey fish per sample, depending on individual weights, consistent with prior sampling. The target species of small prey fish for composites were Banded Killifish, consistent with baseline monitoring, but may vary based on availability at the time of collection. For the small prey fish, three composite samples were targeted for collection at each of eight locations (see Figure 32) for a total of 24 samples per year during the 2015-2018 period. To represent the large prey fish, 24 White Sucker, were targeted for collection by Honeywell within eight locations (see Figure 32) during the 2015-2018 period. The large prey fish were analyzed as individuals on a whole-body basis.

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[15] From 2008-2014, Brown Bullhead was one the four sport fish species included in the Honeywell monitoring program. In 2014, Common Carp, was also collected at the request of NYSDEC. In 2015, Brown Bullhead was dropped from the program and replaced by Common Carp.

Sport and prey fish were collected using the same methods that were successfully used from 2008 through 2014, including nighttime electrofishing, gill netting, trap netting, and seining (Parsons, 2018a). All of the total sample collection targets were met during the 2015-2018 period with the exception of Pumpkinseed in 2017 and in 2018, where there was insufficient sample mass remaining to complete the analysis of hexachlorobenzene in 5 of the 25 samples in 2017 and 2 of the 25 samples in 2018).

Analyses were conducted for mercury, PCBs, lipids, and percent moisture for all Honeywell samples (both sport and prey fish) collected for the 2015-2018 period. In 2015, 2017, and 2018, all Honeywell sport and prey fish collected fish were analyzed for hexachlorobenzene unless sufficient mass was not available as noted above. In 2015, 2017, and 2018, Honeywell collected prey fish were analyzed for dichlorodiphenyltrichloroethane (DDT) + metabolites, and a subset of the Honeywell collected sport fish (11-14 samples per species) were analyzed for dioxins/furans. Sport fish samples were analyzed as NYSDEC standard fillets, consistent with NYSDEC's fish preparation procedures for contaminant analysis (NYSDEC, 2014). The large and small prey fish were analyzed as whole body and whole body composites, respectively.

To supplement the small and large prey fish data, whole-body concentrations were estimated based on the fillet samples from that size class and the fillet to whole-body conversion factors (0.7 for mercury, 2.5 for PCBs, and 2.3 for DDTs and hexachlorobenzene) from the Onondaga Lake BERA (Section 8.2.6.4). These conversion factors may be reassessed with new data in the future, if appropriate.

During the 2015-2018 period, NYSDEC collected Largemouth Bass in Onondaga Lake in 2015 (53 samples), 2016 (55 samples), and 2017-2018 (50 samples each year), as well as Yellow Perch in 2016 and 2018 (20 samples each year). Analyses were conducted for mercury, PCBs, DDT, hexachlorobenzene, and lipids on all samples with the exception of mercury in one of the 20 Yellow Perch in 2016. The number of samples and species collected by NYSDEC between 2008 and 2018 is presented in Table 2 of Attachment 3.

The data in Sets 1, 2, and 3 represent results for sport fish, small prey fish, and large prey fish, respectively. These data are presented in the figures as box-and-whisker plots, similar to the figures presented in the First FYR Report, but which now also include the 95% upper confidence limit (UCL) values, and are compared with human health (fillet data in Set 1 figures) or ecological-based remedial goals or targets (whole-body concentrations for small prey fish in the Set 2 figures and for large prey fish in the Set 3 figures) for fish tissue as presented in Table 13, where applicable.

The discussion of the fish data presented below focuses on mean and 95% UCL values and the figures included in Attachment 3 present the full range of concentrations. For annual data sets for a contaminant where the 95% UCL value in a species is less than the goal (for mercury) or target concentration (for organics) but the maximum value (as presented in the box-and-whisker plots) is greater than the goal or target, the text below includes a discussion of the number (and percentage) of samples that exceed the goal or target.

Annual fish tissue mean and 95% UCL contaminant concentrations for each species for the 2015-2018 period for the Honeywell data for sport fish fillet data, prey fish whole-body data, and calculated whole-body concentrations based on the fillet data are presented in Attachment 3 Tables 3a, 3b, and 3c, respectively. Annual fish tissue mean and 95% UCL contaminant concentrations for the NYSDEC sport fish fillet data for Largemouth Bass and Yellow Perch, and calculated whole-body concentrations based on the NYSDEC fillet data are presented in Attachment 3 Tables 4a and 4b, respectively.

For information on the potential impact of remediation on contaminant concentrations in fish tissue (as opposed to the risk to consumers of fish), the changes in concentration over time are reported. In these figures (Set 4), the data are presented in a way that controls factors which may influence the wet-weight concentrations, but are independent of any exposure to the site-related contamination. This reduces the variability (*e.g.,* noise) in the data. For mercury, the variability due to fish age is corrected by using length as a surrogate for age. The wet-weight mercury concentration of each individual fish is adjusted by dividing the concentration (in mg/kg) by its length (in millimeters [mm]), providing a concentration as mg/kg per mm. For the organic contaminants, the amount of lipid in the fish has a major influence on the wet-weight concentrations (Sloan et al., 2002). For PCBs, dioxin/furans, DDTs, and hexachlorobenzene, the wet-weight concentrations for each individual fish are adjusted by dividing the concentration by its lipid content, providing a lipid-normalized concentration (*e.g.,* mg PCBs/kg lipid). The data in Set 4 are presented as means plus and minus two standard errors, which provide an estimate of 95 percent UCL and lower confidence limit.

The data for Sets 1, 2, 3 and 4 are discussed, below.

SPORT FISH (SET 1)

Honeywell Data

<u>Mercury</u>

Mercury concentrations in all sport fish species have generally declined since completion of dredging and capping in 2016. Smallmouth Bass, Walleye, Common Carp and Pumpkinseed concentrations for mercury on a wet-weight basis are depicted on Set 1, Figures 1 and 2. Smallmouth Bass (mean of 0.79 mg/kg wet weight [ww] in 2018 and 95% upper confidence limit (UCL)[16] of 0.91 mg/kg ww in 2018) and Walleye (mean of 0.71 mg/kg ww in 2018 and 95% UCL of 0.81 mg/kg ww in 2018) mercury concentrations remain well above the human-health-based Remedial Goals (RGs) of 0.2 and 0.3 mg/kg ww. These results are not unexpected as Smallmouth Bass and Walleye are longer-lived, higher trophic level species that take longer to respond to the effects of the remedy.

Mercury concentrations in Common Carp show a decline since initial sampling in 2014, with the 2018 mean (0.10 mg/kg ww) and 95% UCL (0.14 mg/kg ww) having the lowest mean and 95% UCL reported values to date. Mean concentrations in Common Carp have been below the human-health-based RG of 0.3 mg/kg ww since 2014, and below the human-health-based RG of 0.2 mg/kg

[16] The 95% UCL is an estimate of the upper bound for the true population mean.

ww in 2017 and 2018. In 2016 and 2017, the 95% UCL values were below the human-health-based RG of 0.3 mg/kg ww but above the human-health-based RG of 0.2 mg/kg ww. Maximum concentrations of 0.4 and 0.7 mg/kg ww in 2016 and 2017, respectively, were above both goals. In 2016 and 2017, mercury concentrations in Common Carp were above the RG of 0.3 mg/kg ww in six of 25 (24%) and three of 25 (12%) samples, and above the RG of 0.2 mg/kg ww in ten of 25 (40%) and nine of 25 (36%) samples, respectively. In 2018, the 95% UCL was below both RGs with the maximum concentration of 0.34 mg/kg ww from the one sample of 25 (4%) that exceeded the higher RG of 0.3 mg/kg ww. The lower human-health-based RG of 0.2 mg/kg ww was exceeded in five of 25 (20%) samples in 2018.

Mean and 95% UCL concentrations in Pumpkinseed on a wet-weight basis were elevated in 2015 relative to 2014, but have generally decreased from 2015 to 2018. The 2018 mean (0.09 mg/kg ww) and 95% UCL (0.11 mg/kg ww) in Pumpkinseed are the lowest mean and 95% UCL reported values to date. Mean mercury concentrations in Pumpkinseed have been below the 0.3 mg/kg ww RG since 2010 and were below the 0.2 mg/kg ww RG in 2013, 2014, and from 2016 to 2018. In 2016, the mercury 95% UCL was below the 0.3 mg/kg ww RG but above the 0.2 mg/kg ww RG and there were four of 25 (16%) and nine of 25 (36%) Pumpkinseed samples that were above the 0.3 mg/kg ww RG and the 0.2 mg/kg ww RG, respectively. In 2017, the mercury 95% UCL was below the 0.3 mg/kg ww RG and at the 0.2 mg/kg ww RG and there were four of 25 (16%) and eight of 25 (32%) Pumpkinseed samples that were above the 0.3 mg/kg ww RG and the 0.2 mg/kg ww RG, respectively. In 2018, the mercury 95% UCL was below both RGs and there were no exceedances of the 0.3 mg/kg ww RG and only one of 25 (4%) samples exceeded the 0.2 mg/kg ww RG.

PCBs

Sport fish PCB concentrations on a wet-weight basis are depicted on Set 1, Figures 3 and 4. PCB 2017 and 2018 mean concentrations in Smallmouth Bass (0.50 mg/kg ww in 2017 and 0.47 mg/kg ww in 2018) are lower compared to mean PCB concentrations in 2014 (1.38 mg/kg ww), 2015 (1.91 mg/kg ww), and 2016 (1.20 mg/kg ww). Similarly, PCB 2017 and 2018 mean concentrations in Walleye (0.74 mg/kw ww in 2017 and 0.96 mg/kg ww in 2018) are lower compared to mean PCB concentrations in 2014 (2.21 mg/kg ww), 2015 (3.82 mg/kg ww), and 2016 (2.51 mg/kg ww). The mean and 95% UCL PCB levels for the Smallmouth Bass and Walleye remain well above human-health-based targets (0.3 mg/kg ww cancer-based target and 0.04 mg/kg ww noncancer-based target) throughout the 2014-2018 period.

PCB concentrations in Pumpkinseed show no discernable trend on a wet-weight basis, while concentrations in Common Carp were higher in 2015 and 2016 relative to 2014, but were considerably lower in 2017 and 2018 relative to 2014. In 2017 and 2018, the mean (0.10 mg/kg ww in 2017, 0.09 mg/kg ww in 2018) and 95% UCL (0.13 mg/kg ww in 2017, 0.12 mg/kg ww in 2018) PCB levels for Pumpkinseed and the 2018 mean for Common Carp (0.27 mg/kg ww in 2018) were below the 0.3 mg/kg ww cancer-based target, but above the 0.04 mg/kg ww noncancer-based target. The 95% UCL in Common Carp in 2018 (0.44 mg/kg ww) remained above the 0.3 mg/kg ww cancer-based target. PCB concentrations exceeded the 0.3 mg/kg ww cancer-based target in two of 25 (8%) Pumpkinseed samples in 2015 and in one of 25 (4%) samples in both 2016 and 2017. Although all Pumpkinseed samples were below the 0.3 mg/kg ww cancer-based target in 2018, the 95% UCL values continue to remain above the 0.04 mg/kg ww noncancer-based target through 2018 (0.12 mg/kg ww).

Dioxins/Furans

Wet-weight concentrations of dioxins and furans (evaluated as Toxic Equivalents [TEQs]) in sport fish are depicted on Set 1, Figures 5 and 6. Dioxins and furans (evaluated as TEQs) in Smallmouth Bass and Walleye have, in general, declined in concentration since baseline. In 2018, the mean and 95% UCL for Smallmouth Bass were 1.04 ng/kg ww and 1.33 ng/kg ww, respectively. In 2018, the mean and 95% UCL for Walleye were 1.81 ng/kg ww and 2.52 ng/kg ww, respectively. These levels for Smallmouth Bass and Walleye are below the 4 ng/kg ww cancer-based target, but only the 2018 mean for Smallmouth Bass is below the 1.3 ng/kg ww noncancer-based target. For Smallmouth Bass and Walleye, the 95% UCL values were below the 4 ng/kg ww cancer-based target but above the 1.3 ng/kg ww noncancer-based target from 2014 through 2018. In 2015, there was one of 12 (8.3%) Smallmouth Bass samples above the 4 ng/kg ww cancer-based target. Walleye exceeded the 4 ng/kg ww cancer-based target in two of 13 (15.4%) samples in 2014, one of 11 (9%) samples in 2017, and two of 13 (15.4%) samples in 2018.

Dioxin and furan TEQ concentrations in Common Carp have declined since 2014 (when this species was first sampled since the RI), while concentrations in Pumpkinseed have remained relatively unchanged, although significantly lower than other species. In 2015 and 2017, the mean and 95% UCL in Common Carp were above the 4 ng/kg ww cancer-based target. In 2018, the mean and 95% UCL in Common Carp were 1.08 ng/kg ww and 3.24 ng/kg ww, respectively. These levels are below the 4 ng/kg ww cancer-based target, but the 95% UCL is above the 1.3 ng/kg ww noncancer-based target. There were two of 14 (14.3%) Common Carp samples in 2018 that exceeded the 4 ng/kg ww cancer-based target. The 2017 mean (0.27 ng/kg ww), 2017 95% UCL (0.33 ng/kg ww), 2018 mean (0.54 ng/kg ww), and 2018 95% UCL (0.73 ng/kg ww) for Pumpkinseed are below both human-health-based targets.

Hexachlorobenzene

Sport fish hexachlorobenzene concentrations on a wet-weight basis are depicted on Set 1, Figures 7 and 8. Detected mean and 95% UCL concentrations in all sport fish were lower in 2017 and 2018 relative to prior years. Hexachlorobenzene concentrations have a low frequency of detection in most samples analyzed in the last two years (see Attachment 3, Table 3a). No human health-based goals or targets for hexachlorobenzene were identified in the ROD.

NYSDEC Data

The discussion below focuses on the two species sampled by NYSDEC in Onondaga Lake since 2015 (Largemouth Bass and Yellow Perch). The figures referenced below are included in Attachment 3.

Mercury

Mercury concentrations in Largemouth Bass and Yellow Perch fillet samples since 2015 are generally lower than pre-remediation (baseline) concentrations prior to 2012. (See Set 1, DEC Figure 1.) Although mean and 95% UCL values in Largemouth Bass have remained relatively constant since 2015, mercury concentrations in Yellow Perch, which was only sampled in two years since 2015, declined in 2018 (95% UCL of 0.45 mg/kg ww) compared to 2016 (95% UCL of 0.61 mg/kg ww). Mean and 95% UCL concentrations remain well above the human-health-based RGs of 0.2 and 0.3 mg/kg ww for both species since 2008.

PCBs

PCB concentrations in Largemouth Bass and Yellow Perch fillets are depicted in Set 1, DEC Figure 2. Although mean and 95% UCL PCB concentrations in Largemouth Bass in 2017 and 2018 are lower than in most years prior to commencement of remediation (with the exception of 2009 and 2010), there is no discernable trend since 2015. All PCB mean and 95% UCL concentrations in Largemouth Bass continue to exceed both the 0.3 mg/kg ww cancer-based target and the 0.04 mg/kg ww noncancer-based target. Mean and 95% UCL PCB concentrations in Yellow Perch in 2016 and 2018 are below the 0.3 mg/kg ww cancer-based target but above the 0.04 mg/kg ww noncancer-based target. There were one of 20 (5%) and six of 20 (30%) exceedances of the 0.3 mg/kg ww cancer-based target in 2016 and 2018, respectively.

DDT

DDT concentrations in Largemouth Bass and Yellow Perch fillets are depicted in Set 1, DEC Figure 3. Similar to PCBs, although mean and 95% UCL DDT concentrations in Largemouth Bass in recent years are lower than in most years prior to commencement of remediation (with the exception of 2009 and 2010), there is no discernable trend since 2015. Although mean and 95% UCL concentrations in Yellow Perch were higher in 2018 than in 2016, mean and 95% UCL concentrations in Yellow Perch remain low (below 0.01 mg/kg ww). No human-health-based targets for DDTs were identified in the ROD.

Hexachlorobenzene

Hexachlorobenzene concentrations in Largemouth Bass and Yellow Perch fillets are depicted in Set 1, DEC Figure 4. Mean and 95% UCL hexachlorobenzene concentrations in Largemouth Bass in recent years are lower than in the years prior to commencement of remediation, with only a limited number of detections in 2016 (8 of 55 samples) and no detections in 2017 and 2018 (50 samples each year). Hexachlorobenzene was not detected in Yellow Perch in both 2016 and 2018 (20 samples each year). No human health-based goals or targets for hexachlorobenzene were identified in the ROD.

SMALL PREY FISH (SET 2)

Honeywell Data

Contaminant concentrations in small prey fish (*e.g.,* Banded Killifish) collected under the Honeywell monitoring program. In addition to the collected small prey fish, this category of samples also includes Small Pumpkinseed (30-180 mm) from the Honeywell mercury, PCB, and hexachlorobenzene fillet data corrected to provide an estimate of the whole-body concentrations (based on the fillet to whole-body factors used in the BERA). These data were evaluated via comparison to ecological remedial goals and targets, which are presented in the Set 2 figures.

Mercury

On a lake-wide basis, mercury wet-weight concentrations in small prey fish are generally lower for the 2015-2018 period relative to prior years. The 2016 mean (0.09 mg/kg ww) and 95% UCL (0.10 mg/kg ww), the 2017 mean (0.06 mg/kg ww) and 95% UCL (0.07 mg/kg ww), and the 2018 mean (0.07 mg/kg ww) and 95% UCL (0.09 mg/kg ww) were below the ecological-based RG of 0.14 mg/kg ww. (See Set 2, Figure 1.) Mercury concentrations exceeded the ecological-based RG in two (8.3%), one (4.2%), and one (4.2%) of 24 annual small prey fish samples in 2016, 2017, and 2018, respectively. Calculated Small Pumpkinseed whole-body mercury wet-weight concentrations are depicted in Set 2, Figure 2. Calculated mean and 95% UCL whole-body mercury concentrations in Small Pumpkinseed were above the ecological-based RG in 2015. Between 2016 and 2018, both the mean and 95% UCL were below the RG. Calculated whole-body mercury concentrations in Small Pumpkinseed were above the ecological-based RG in three of 17 (17.6%) and five of 20 (25%) samples in 2016 and 2017, respectively, and calculated concentrations in all samples were below the RG in 2018.

PCBs

PCB wet-weight concentrations in small prey fish have generally declined since 2015. (See Set 2, Figure 3.) On a lake-wide basis in 2018, the small prey fish mean PCB level (0.05 mg/kg ww) and the 95% UCL PCB level (0.13 mg/kg ww) were below the 0.19 mg/kg ww ecological target, which is based on protection of the river otter receptor at the LOAEL level. In 2018, the PCB concentrations exceeded the 0.19 mg/kg ww ecological target in three of 24 (12.5%) small prey fish samples. Calculated Small Pumpkinseed whole-body mean and 95% UCL total PCB wet-weight concentrations (Set 2, Figure 4) were above the ecological-based target for PCBs between 2015 and 2018, although the levels were lower in 2017 and 2018 relative to 2015 and 2016.

DDT and Metabolites

Concentrations of the sum of DDT and metabolites in small prey fish are generally low with respect to the ecological target and are relatively unchanged throughout the collection period. (See Set 2, Figure 5.) On a lake-wide basis, the mean and 95% UCL in 2015, 2017 and 2018 (samples were not collected in 2016) for the sum of DDT and metabolites in small prey fish were less than or equal to 0.01 mg/kg ww, which is below the ecological target of 0.049 mg/kg ww for the sum of DDT and metabolites. Maximum concentrations in each of these years were also less than the small prey fish target. The ecological target for small prey fish is based on protection of the belted kingfisher receptor at the LOAEL level.

<u>Hexachlorobenzene</u>

Mean and 95% UCL hexachlorobenzene concentrations in small prey fish (Set 2, Figure 6) and calculated Small Pumpkinseed whole-body hexachlorobenzene wet-weight concentrations (Set 2, Figure 7) show no discernable trends over the collection period. Hexachlorobenzene was not detected in 11 of 24, 21 of 24, and 24 of 24 small prey fish samples collected in 2015, 2017, and 2018, respectively. Hexachlorobenzene was not detected in the Small Pumpkinseed samples collected in 2017 and 2018. There are no ecological goals or targets for hexachlorobenzene in fish tissue.

LARGE PREY FISH (SET 3)

Larger prey fish (*e.g.,* White Sucker and sport fish) were collected to assess exposure to larger wildlife which consume fish (*e.g.,* otter, great blue heron, osprey). Estimated or measured concentrations of whole fish in this size class (180 to 600 mm) are presented because they would also consume the entire fish. This category of samples includes seven species to provide an assessment of this exposure, including whole-body samples of White Sucker analyzed by Honeywell beginning in 2014 along with the four large sport fish (Smallmouth Bass, Walleye, Common Carp and Pumpkinseed) from the Honeywell data set and two species from the NYSDEC data set (Largemouth Bass and Yellow Perch) corrected to provide an estimate of the whole-body concentrations (based on the fillet to whole-body conversion factors used in the BERA). These data for White Sucker and calculated concentrations for the sport fish species are presented in the Set 3 figures.

Honeywell Data

<u>Mercury</u>

For the White Sucker, the mercury mean concentration in 2016 (0.13 mg/kg ww) and mean 2017 (0.09 mg/kg ww) were lower than the ecological-based RG of 0.14 mg/kg ww (Set 3, Figure 1), but the 2018 mean (0.17 mg/kg ww) was above this RG. In 2014 through 2016 and in 2018, the 95% UCL values were above the ecological-based RG of 0.14 mg/kg ww. In 2017, the 95% UCL was equal to the 0.14 mg/kg ww RG with seven of 24 (29.2%) samples exceeding the RG.

There are clear differences in the calculated whole-body mercury concentrations among species. The larger, higher trophic level, longer-lived fish (*e.g.,* Smallmouth Bass and Walleye) have higher concentrations than other species such as Pumpkinseed (Set 3, Figures 2 and 3). Smallmouth Bass and Walleye calculated whole-body mercury concentrations (about 0.1 to 2 mg/kg) during the 2015-2018 period are generally above the ecological goal of 0.14 mg/kg ww. Over this period, Walleye whole-body mercury concentrations are generally lower relative to the 2010-2014 period, but Smallmouth Bass whole-body mercury concentrations are mostly similar to mercury whole-body levels for this species over the 2010-2014 period. For the 2014-2018 period, mean mercury calculated whole-body concentrations for Common Carp are below the ecological RG. The 95%

UCLs are slightly above the RG in 2014 but are at or below the RG in 2015 through 2018. In 2015, 2016, and 2017, there were 13 of 25 (52%), ten of 25 (40%), and nine of 25 (36%) Common Carp samples above the ecological RG of 0.14 mg/kg ww, respectively. The maximum was below the RG in 2018. The mean of the calculated whole-body mercury concentrations in Pumpkinseed declined over the 2015-2018 period, with the 2018 mean level dropping below the RG and the 2018 95% UCL just above the RG.

PCBs

Mean PCB wet-weight concentrations for the White Sucker were considerably higher in 2015 compared to 2014, but have declined since 2015 (Set 3, Figure 4). In 2018, the mean (0.10 mg/kg ww) and 95% UCL (0.13 mg/kg) PCB levels for the White Sucker were below corresponding levels in 2014 and the 0.19 mg/kg ww ecological target for prey fish based on protection of the river otter receptor at the LOAEL level. The 95% UCL values exceeded the target through 2017 and declined to below the 0.19 mg/kg ww ecological target in 2018. In 2018, three of 24 (12.5%) White Sucker samples exceeded the target.

Whole-body PCB concentrations calculated from collected sport fish fillet data are depicted on Set 3, Figures 5 and 6. As is the case for mercury, the larger, higher trophic level, longer-lived fish (*e.g.,* Smallmouth Bass and Walleye) have higher PCB concentrations than lower trophic level species. Concentrations in Smallmouth Bass and Walleye were higher in 2015 than 2014, but are generally declining since 2015. The calculated concentrations for both Smallmouth Bass and Walleye, however, remain elevated relative to the ecological target of 0.19 mg/kg for PCBs. The calculated whole-body mean and 95% UCL PCB concentrations in Common Carp in 2017 and 2018 are lower than in prior years but remain above the target of 0.19 mg/kg ww. The calculated whole-body mean PCB concentration in Pumpkinseed was below the ecological target in 2016, but the means in 2015, 2017 and 2018 and the 95% UCLs between 2015 and 2018 were above the target.

Hexachlorobenzene

Hexachlorobenzene concentrations in White Sucker samples collected are depicted in Set 3, Figure 7. There is no discernable pattern in hexachlorobenzene levels since monitoring for the White Sucker commenced in 2014. Hexachlorobenzene was not detected in 14 of 24 and 23 of 24 White Sucker samples in 2017 and 2018, respectively.

Whole-body hexachlorobenzene concentrations calculated from collected sport fish fillet data are depicted on Set 3, Figures 8 and 9. The 2017 and 2018 levels are generally lower than levels in 2014 and 2015 for Smallmouth Bass and Walleye. There is no discernable pattern in hexachlorobenzene levels in Common Carp and Pumpkinseed during the 2015-2018 monitoring period with the majority of the 2017 and 2018 samples of Common Carp and all Pumpkinseed samples reported as non-detect.

There are no ecological goals or targets for hexachlorobenzene in fish tissue.

DDT and Metabolites

Concentrations of the sum of DDT and metabolites in large prey fish (White Sucker) for the 2015-2018 period are relatively unchanged throughout the collection period and generally below the ecological target of 0.14 mg/kg ww for the sum of DDT and metabolites based on protection of the osprey receptor at the LOAEL level. (See Set 3, Figure 10.) In 2015, the mean and the maximum concentration of DDT and metabolites for the White Sucker on a lake-wide basis were 0.02 mg/kg ww and 0.09 mg/kg ww, respectively. In 2017, the mean and 95% UCL lake-wide concentrations for the White Sucker were both at 0.02 mg/kg ww. In 2018, the mean and 95% UCL concentrations for the White Sucker were 0.03 mg/kg ww and 0.10 mg/kg ww, respectively. The White Sucker mean and 95% UCL concentrations in 2014, 2015, 2017 and 2018 were below the ecological target of 0.14 mg/kg ww. In 2018, there was one of 24 (4.2%) White Sucker samples that considerably exceeded the ecological target of 0.14 mg/kg ww.

NYSDEC Data

Mercury

Calculated whole-body mercury concentrations in Largemouth Bass and Yellow Perch (Set 3, DEC Figures 1a and 3a) since 2015 are generally lower than pre-remediation (baseline) concentrations prior to 2012. Although mean and 95% UCL values in Largemouth Bass have remained relatively constant since 2015, calculated whole-body mercury concentrations in Yellow Perch, which was only sampled in two years since 2015, declined in 2018 (95% UCL of 0.32 mg/kg ww) compared to 2016 (95% UCL of 0.44 mg/kg). Calculated whole-body mean and 95% UCL concentrations remain well above the ecological RG of 0.14 mg/kg ww for both species since 2008.

PCBs

Although calculated whole-body mean and 95% UCL PCB concentrations in Largemouth Bass in 2017 and 2018 are lower than in most years prior to commencement of remediation (with the exception of 2009 and 2010), there is no discernable trend since 2015 (Set 3, DEC Figure 1b). Calculated whole-body mean and 95% UCL PCB concentrations in Largemouth Bass continue to exceed the 0.19 mg/kg ww ecological target. Calculated whole-body mean and 95% UCL PCB concentrations in Yellow Perch in 2016 and 2018 exceed the 0.19 mg/kg ww ecological target (Set 3, DEC Figure 3b).

Hexachlorobenzene

Calculated whole-body mean and 95% UCL hexachlorobenzene concentrations in Largemouth Bass in recent years are generally lower than in the years prior to commencement of remediation, with only a limited number of detections in 2016 (8 of 55 samples) and no detections in 2017 and 2018 (50 samples each year) (Set 3, DEC Figure 2b). Hexachlorobenzene was not detected in Yellow Perch in both 2016 and 2018 (20 samples each year) (Set 3, DEC Figure 4b). No ecological-based targets for hexachlorobenzene were identified in the ROD.

DDT and Metabolites

Similar to PCBs, although calculated whole-body mean and 95% UCL DDT concentrations in Largemouth Bass in recent years are lower than in most years prior to commencement of remediation (with the exception of 2009 and 2010), there is no discernable trend since 2015 (Set 3, DEC Figure 2a). The calculated whole-body mean and 95% UCL concentrations of DDTs in Largemouth Bass have been below the ecological target of 0.14 mg/kg ww for all years since 2009. Since 2015, only a limited number of samples (less than 10% each year) exceeded the ecological target of 0.14 mg/kg ww, including two of 53 samples (3.8%) in 2015, one of 55 samples (1.8%) in 2016, five of 50 samples (10%) in 2017, and two of 50 samples (4%) in 2018.

Calculated whole-body mean and 95% UCL DDT concentrations in Yellow Perch have been below the ecological target of 0.14 mg/kg ww in all sampled years (Set 3, DEC Figure 4a).

ADDITIONAL REPORTING TO ASSESS POTENTIAL TRENDS AND LOCATION IMPACTS (SET 4)

The previous sections reported the concentrations in fish tissue as they would appear to the consumers of those fish--as fillet or whole-body samples on a wet-weight basis. As discussed above and in Attachment 3, there are factors that will affect the concentrations of contaminants, causing increased variability that will make it more difficult to discern trends and understand the mechanisms influencing the results in the context of remedial success. These factors include the trophic level and age of fish for mercury, lipid content for organic contaminants, and location for species with limited home ranges. These factors are addressed in the data presented in the Set 4 figures in Attachment 3.

The first subset of figures presents mercury data normalized to fish length and organic contaminants normalized to lipids for both sport fish and prey fish. As the normalized data are not compared to the goals and targets (which are on a wet-weight basis), the data are presented as mean plus and minus two standard errors rather than box-and-whisker plots to provide a simpler image.

The second subset of figures presents the normalized data by sample location for localized small and large prey fish species collected by Honeywell (note, whole-body prey fish were not collected by NYSDEC). These figures show normalized concentrations for the SMUs from which the prey fish samples were collected. Note, Honeywell's fish sampling program did not include stations in SMU 1 prior to 2017. As small prey fish, large prey fish, and Pumpkinseed tend to be more localized and feed more heavily in the littoral zone than the other fish collected, figures for these species are also included in this subset.

Honeywell Data

Mercury

Mercury concentrations in sport fish species have generally declined since completion of dredging and capping. The general trend is apparent in the length-normalized plots (Set 4, Subset 1, Figure

1). Mean length-normalized concentrations in Common Carp and Pumpkinseed were elevated in 2015 relative to 2014, but have generally decreased from 2015 to 2018. Mean length-normalized concentrations in Smallmouth Bass were also elevated in 2015 relative to 2014, and decreased from 2015 to 2017. The 2018 mean for Smallmouth Bass is higher than the 2017 mean but lower than the 2016 mean. Mean length-normalized concentrations in Walleye have been declining since 2014.

Length-normalized mercury concentrations in small and large prey fish for all SMUs are depicted in Set 4, Subset 1, Figure 2. In small prey, fish length-normalized mercury concentrations appear to generally be declining between 2014 and 2017/2018 on a lake-wide basis. Length-normalized mercury concentrations in small prey fish, Small Pumpkinseed (30-180 mm), and large prey fish for individual SMUs are depicted in Set 4, Subset 2, Figures 1, 2, and 3, respectively. Length-normalized mercury concentrations were generally higher in small prey fish in 2017 relative to 2016 in SMU 4 and higher in 2018 relative to 2017 in SMUs 5 and 7. Otherwise, length-normalized mercury concentrations generally declined in small prey fish between 2015 and 2018 and concentrations in 2018 in samples from SMUs 1, 2, 4, 6, and 7, where nearly all of the active remediation (dredging and capping) took place from 2012 to 2016, are similar to concentrations in SMU 5. For the Small Pumpkinseed, length-normalized mercury concentrations generally declined between 2015 and 2018, except for increases between 2016 and 2017 in SMUs 3, 5 and 7. The length-normalized Small Pumpkinseed mean mercury level in SMU 7 in 2018 was lower than in 2017 and similar to that for 2016.

For the large prey fish (White Sucker), length-normalized mercury levels declined between 2014 and 2017. (See Set 4, Subset 1, Figure 2.) The 2018 length-normalized mercury levels for the White Sucker are higher than those for 2017 and are near the 2015 and 2016 levels. The higher levels in 2018 for the White Sucker also appear to be most evident in SMUs 1 and 4, as well as SMU 5. (See Set 4, Subset 2, Figure 3.) Similar to small prey fish, length-normalized mercury concentrations in 2018 in large prey fish samples from SMUs 1, 2, 4, 6, and 7, where nearly all of the active remediation (dredging and capping) took place from 2012 to 2016, are similar to concentrations in SMU 5.

PCBs

Lipid-normalized concentrations for total PCBs in sport fish are depicted on Set 4, Subset 1, Figures 3 and 4. Mean lipid-normalized PCB concentrations in Smallmouth Bass and Walleye show no discernable trends but concentrations in these species are lower in 2017 and 2018 compared to prior years. Mean lipid-normalized PCB concentrations in Common Carp and Pumpkinseed also show no apparent trends, but the lowest mean concentrations in both species were observed in 2018.

Lipid-normalized concentrations for total PCBs in small and large prey fish are depicted on Set 4, Subset 1, Figures 5 and 6, respectively. Mean lipid-normalized concentrations for total PCBs in small prey fish were higher in 2015 relative to 2014, but declined in 2016 and 2017. The mean lipid-normalized concentrations for total PCBs in small prey fish in 2018 was about the same as in 2017, although the variability around the mean was greater in 2018. Lipid-normalized mean PCB concentrations for the large prey fish (White Sucker) were elevated in 2015 and 2016 compared to 2014, but have declined since 2016 on a lipid-normalized basis; mean lipid-normalized PCB concentrations in 2017 and 2018 for the White Sucker were lower than the 2014 levels.

In small prey fish, the lipid-normalized PCB concentrations in SMUs 1 through 5 and SMU 7 between 2015 and 2018 were lower than in 2014 and generally declined during this period on a lipid-normalized basis (see Set 4, Subset 2, Figure 4). Mean PCB concentrations in small prey fish remain elevated in SMU 6 compared to other SMUs, as they have for most years. This condition may continue until remedial activities addressing PCBs in and adjacent to Ley Creek have been fully implemented since Ley Creek enters Onondaga Lake at the northern end of SMU 6. In Pumpkinseed, lipid-normalized PCB concentrations generally decreased in SMUs 1, 3, 5 and 7 between 2015 and 2018. (See Set 4, Subset 2, Figure 5.) In SMU 2, the mean lipid-normalized Pumpkinseed concentration in 2017 was similar to that in 2015, but the mean was at its lowest level in 2018. In SMU 6, mean lipid-normalized concentrations in Pumpkinseed were similar in 2017 and 2018 relative to 2015. In 2018, the relatively high variability in lipid-normalized PCB concentrations in small prey fish from SMU 6 is attributable to one unusually low lipid result (0.53 percent) (Parsons, 2019b). On a wet-weight basis, average concentrations in small prey fish in SMU 6, as well as in SMUs 2 and 7 near former Honeywell source areas, have continued to decline from 2015 (during capping) through 2018. In large prey fish (see Set 4, Subset 2, Figure 6), lipid-normalized PCB concentrations have generally declined between 2015 and 2018. Since 2016, the observed lipid-normalized PCB concentrations in SMU 6 in large prey fish are similar to or higher than those in other SMUs.

<u>Dioxins/Furans</u>

Lipid-normalized dioxins and furans (evaluated as TEQs) in sport fish on a lake-wide basis are depicted in Set 4, Subset 1, Figures 7 and 8. Lipid-normalized dioxins and furans (evaluated as TEQs) in Smallmouth Bass, Walleye, and Pumpkinseed have, in general, remained relatively unchanged during the 2014-2018 period. Lipid-normalized dioxins and furans (evaluated as TEQs) in Common Carp were higher in 2017 relative to 2014 and 2015. The lipid-normalized concentrations in 2018 returned to levels similar to the levels observed in 2014 and 2015. Lipid-normalized concentrations in Pumpkinseed on an individual SMU basis showed no particular pattern over time (Set 4, Subset 2, Figure 7).

<u>DDT and Metabolites</u>

Lipid-normalized concentrations for DDT and metabolites in small prey fish lake-wide and on an individual SMU basis are depicted in Set 4, Subset 1, Figure 9 and Set 4, Subset 2, Figure 8, respectively. Mean lipid-normalized DDT concentrations in small prey fish are variable over the 2014-2018 period on both a lake-wide and individual SMU basis. Mean concentrations in small prey fish are somewhat higher in 2017 and 2018 relative to the means observed in 2014 and 2015, although all lake-wide mean levels over this period are significantly less than the 2013 lake-wide mean. Mean lipid-normalized DDT concentrations in large prey fish are also variable with the highest lake-wide mean reported in 2018 due to an unusually high DDT concentration in one sample collected from SMU 4. (See Set 4, Subset 1, Figure 10 and Set 4, Subset 2, Figure 9.)

Hexachlorobenzene

Lipid-normalized hexachlorobenzene concentrations in Smallmouth Bass, Walleye, Common Carp and Pumpkinseed on a lake-wide basis are depicted in Set 4, Subset 1, Figures 11 and 12. Lipid-normalized hexachlorobenzene concentrations in Pumpkinseed on an individual SMU basis are depicted in Set 4, Subset 2, Figure 10. Levels for Smallmouth Bass, Walleye and Common Carp declined between 2014 and 2017. Lipid-normalized hexachlorobenzene concentrations for Walleye and Common Carp in 2018 were higher relative to 2017. Hexachlorobenzene was not detected in Smallmouth Bass in 2018 and was not detected in Pumpkinseed in 2017 and 2018.

Mean lipid-normalized hexachlorobenzene concentrations in small and large prey fish on a lake-wide and individual SMU basis are depicted in Set 4 Subset 1, Figures 13 and 14 and Set 4, Subset 2, Figures 8 and 9, respectively. Lipid-normalized hexachlorobenzene levels in small prey fish on a lake-wide basis were lower in 2015 and 2017 relative to 2014, and were non-detect in 2018. Mean lipid-normalized concentrations in small prey fish were similar among SMUs, and concentrations since 2014 were low or non-detect except for SMU 7 in 2014. In large prey fish, lipid-normalized concentrations on a lake-wide basis declined between 2014 and 2017, but increased in 2018 as a result of one relatively elevated detection in SMU 7. Lipid-normalized hexachlorobenzene concentrations in large prey fish declined in most SMUs between 2014 and 2017. With the exception of SMU 7, large prey fish hexachlorobenzene concentrations in 2018 were reported as non-detect in all other SMUs.

NYSDEC Data

Mercury

Mean length-normalized mercury concentrations in Largemouth Bass since 2015 are generally lower than pre-remediation (baseline) concentrations prior to 2012, although there has been no discernable trend since 2015 (Set 4, Subset 1, DEC Figure 1). Mean length-normalized concentrations in Yellow Perch were lower in 2018 than in 2016.

PCBs

Although mean and 95% UCL lipid-normalized PCB concentrations in Largemouth Bass in 2016, 2017 and 2018 are lower than in most years prior to commencement of remediation (with the exception of 2009 and 2010), there is no discernable trend since 2015 (Set 4, Subset 1, DEC Figure 2a). Mean lipid-normalized concentrations in Yellow Perch were higher in 2018 than in 2016, and these mean concentrations in 2016 and 2018 were slightly lower than pre-remediation mean concentrations in 2011 and 2012.

DDT and Metabolites

Similar to PCBs, there is no discernable trend in lipid-normalized DDT concentrations in Largemouth Bass since 2015 (Set 4, Subset 1, DEC Figure 2b). Mean lipid-normalized DDT concentrations in Yellow Perch were higher in 2018 than in 2016, and similar to pre-remediation mean concentrations in 2010 to 2012.

Hexachlorobenzene

Although lipid-normalized hexachlorobenzene concentrations in Largemouth Bass increased from 2014 to 2015, concentrations decreased significantly in 2016 and hexachlorobenzene was not detected in 2017 and 2018 (Set 4, Subset 1, DEC Figure 3). Hexachlorobenzene was also not detected in Yellow Perch in 2016 and 2018.

Site Inspection

Due to health and safety considerations from the COVID-19 pandemic, a site inspection was not conducted by the review team during the review period. In lieu of a site inspection, photographs of the site depicting the SCA and shoreline areas along the lake were received from Honeywell and are provided in Attachment 4. No issues impacting protectiveness were observed. A formal site inspection by the review team will be scheduled when it is determined to be safe to do so.

V. TECHNICAL ASSESSMENT

QUESTION A: *Is the remedy functioning as intended by the decision documents?*

Based on a comprehensive review of the bathymetry survey results, probing results, and originally-planned and additional coring results, there has been no significant loss of cap material in any capped area and the cap remains physically stable. The monitoring results did indicate that there were very small areas in Model Area RA-C-2A where fine gravel was not observed or where the total cap thickness was less than the target thickness. Based on comprehensive follow-up investigations, it was determined that cap materials for the erosion protection/habitat layer were not fully placed here as intended during construction (most likely as a result of caution related to overplacement of materials that could have adversely impacted the underlying sediment stability in an area identified as being very sensitive to the thickness of cap material). Accordingly, additional cap material in a portion of this area (approximately 0.12 acres) was placed here in November 2019.

The combined 2017 and 2018 chemical monitoring programs of capped areas of the lake included over 8,200 chemical analyses from 165 sampling locations, including multi-layer and monolayer isolation caps in the littoral zone and thin layer capping and direct application areas in SMU 8. Over 90 percent of the analytical results were non-detects or very low concentrations (less than five percent of the performance criteria). Detected concentrations were primarily attributable to background influences. Although there were exceedances of cap criteria in the habitat layer at ten locations in 2017/2018 (as summarized in Tables 4.1 and 4.2), it does not appear that any of these exceedances were attributable to chemical migration from the underlying chemical isolation layer, and that the exceedances were due to other factors such as background impacts, potentially anomalous data, or isolated occurrences as detailed above. The chemical monitoring results indicate that the cap appears to be functioning consistent with the design.

In 2017 and 2018, surface water sampling results for dissolved mercury indicated that the levels are below goals for the protection of human health via fish consumption and for protection of wildlife. Benzene, chlorobenzene and toluene were detected at concentrations below criteria or not detected. All other VOC/SVOC samples were nondetect. Total PCBs were detected in surface water at concentrations above criteria for the protection of wildlife and of human health via fish consumption in 2017 and 2018. The highest total PCB concentrations observed in the lake during three of the four sampling events conducted during the 2017-2018 period occurred at the monitoring location that is closest to the Ley Creek outlet to the lake. Four subsites located on Ley Creek (two of the subsites include portions of the Creek itself) are current or former PCB sources. While some IRM and remedial actions addressing PCB sources located adjacent to Ley Creek have been conducted at two of the subsites and a portion of another subsite, remediation of the Creek itself has not yet been implemented.

In SMU 8, mercury surface sediment concentrations in 2017 are generally lower than mercury concentrations in 2014 and lower than they were projected to be as part of the Final Design analysis. Also, the sedimentation rate assumed in the Final Design analysis for predicting natural recovery rates is within the range of sedimentation rates as measured from the 2014, 2015 and 2017 collected cores with the microbead markers, and the solids deposition rate assumed in the Final Design is less than annual average deposition rate of suspended solids as measured from sediment traps deployed between 2014 and 2018. Recent mercury concentrations on settling sediments are lower than they were assumed to be for purposes of natural recovery modeling completed during the Final Design. Based on the above, natural recovery appears to be progressing at a rate consistent with or more rapidly than predicted.

Declining methylmercury concentrations in Onondaga Lake since 2011 are consistent with the higher nitrate concentrations (as a result of nitrate additions). Methylmercury concentrations in zooplankton have also remained consistently low since nitrate addition began. As zooplankton are critical for the base of the food chain for upper level sport fish (*e.g.,* walleye, bass), the lower methylmercury concentrations in zooplankton are expected to result in lower exposure of fish to methylmercury. Similarly, reductions in methylmercury exposures from the water column and through the food chain are anticipated over time to result in lower concentrations of methylmercury in fish in Onondaga Lake which in turn will reduce potential risks to humans and wildlife that consume fish.

Mercury concentrations in fish collected in Onondaga Lake were evaluated to assess the progress of the remediation towards meeting human health and ecological based RGs established in ROD. There are no RGs in the ROD for organic compounds in fish tissue, however, detected concentrations of organic compounds in fish tissue were compared to points of reference (*i.e.,* targets) for evaluations of risk reduction for human and wildlife consumers of fish. These compounds include PCBs in sport fish and prey fish, dioxins/furans in sport fish, and DDT and metabolites in prey fish. Contaminant concentrations for these compounds as well as for hexachlorobenzene were also evaluated. A summary of the principal findings of fish tissue contaminant concentrations with a focus on available data obtained since 2014 is provided below:

- Mercury concentrations in all monitored sport fish species have generally declined since 2014. The mean and 95% UCL mercury levels in Common Carp and Pumpkinseed in 2018 were below RGs for human consumption of fish (0.2 and 0.3 mg/kg ww) established in the ROD. While concentrations of mercury in Smallmouth Bass and Walleye have also declined, mercury levels in these species remain well above RGs during the 2015-2018 monitoring period. Mercury concentrations in Largemouth Bass and Yellow Perch fillet samples since 2015 are generally lower than pre-remediation (baseline) concentrations prior to 2012; however, mean and 95% UCL concentrations remain well above the human-health-based RGs for both species. On both a lake-wide wet weight and length-normalized individual SMU basis, mean mercury concentrations in small prey fish have declined since 2014. Lake-wide mean and 95% UCL mercury concentrations in small prey fish in 2017 and 2018 were below the ecological-based RG (0.14 mg/kg ww), with only one of 24 samples still exceeding the goal in each year. Mean small prey fish mercury concentrations have been at or below this RG in all SMUs since 2016. Large prey fish (White Sucker) mercury levels lake-wide declined from 2014 to 2017, although levels were somewhat higher in 2018 relative to 2017. Calculated whole-body mercury concentrations in Smallmouth Bass and Walleye remain above the ecological RG over the 2015-2018 period. Except for the 2018 calculated whole-body mean concentration which is below the RG, calculated whole-body mean and 95% UCL mercury concentrations in Pumpkinseed remain above the ecological RG over the 2015-2018 period. Calculated whole-body mean and 95% UCL mercury concentrations in Common Carp are at or below the ecological RG over the 2015-2018 period. Calculated whole-body mercury concentrations in Largemouth Bass and Yellow Perch remain above the ecological RG over the 2015-2018 period.

- PCBs in Smallmouth Bass and Walleye generally decreased in recent years, but mean PCB levels for these species remain above human-health-based targets throughout the 2014-2018 period. In 2017 and 2018, the mean and 95% UCL PCB levels for Pumpkinseed and the 2018 mean for Common Carp were below the 0.3 mg/kg ww cancer-based target, but above the 0.04 mg/kg ww noncancer-based target. Although mean and 95% UCL PCB concentrations in Largemouth Bass in 2017 and 2018 are lower than in most years prior to commencement of remediation, there is no discernable trend since 2015. Mean PCB concentrations for the large prey fish (White Sucker) were elevated in 2015 compared to 2014, but have declined since 2015; concentrations in 2018 were comparable to or lower than the 2014 levels. In 2018, the mean and 95% UCL PCB levels for both large prey fish (White Sucker) and small prey fish were below the ecological target of 0.19 mg/kg ww with three of the 24 (12.5%) samples exceeding the target. The 95% UCL calculated whole-body total PCBs in sport fish and Small Pumpkinseed remain elevated with respect to the ecological target. Calculated whole-body mean and 95% UCL PCB concentrations in Largemouth Bass and Yellow Perch continue to exceed the ecological target.
- Dioxins and furans (evaluated as TEQs) in Smallmouth Bass and Walleye have, in general, declined in concentration since baseline. The 2018 mean and 95% UCL for these species are below the 4 ng/kg ww cancer-based target, but only the 2018 mean for the Smallmouth Bass is below the 1.3 ng/kg ww noncancer-based target. Dioxin and furan TEQ concentrations in Common Carp have declined since 2014 (when this species was first sampled), while concentrations in Pumpkinseed have remained relatively unchanged. In 2018, the mean and 95% UCL for the Common Carp were below the 4 ng/kg ww cancer-based target, but the 95% UCL is above the noncancer-based target. The 2017-2018 mean and 95% UCL for Pumpkinseed remained below both human-health-based targets.
- Concentrations for the sum of DDT and metabolites in large and small prey fish are generally low with respect to the ecological targets, and are relatively unchanged throughout the 2015-2018 period. The calculated whole-body mean and 95% UCL

concentrations of DDTs have been below the ecological target of 0.14 mg/kg in Largemouth Bass for all years since 2009 and in Yellow Perch in all years when samples were collected. Hexachlorobenzene concentrations in sport and prey fish show no discernable trends over the 2015-2018 period and have a low frequency of detection in most samples analyzed in the last two years. There are no human health or ecological targets for hexachlorobenzene.

The fish tissue results generally indicate lower contaminant concentrations in the 2015-2018 period relative to prior years. While contaminant concentrations are below or near RGs or targets for some fish species, for other species, particularly longer-lived, higher trophic level species (*e.g.,* Smallmouth Bass, Walleye), contaminant concentrations remain at levels that are considerably above RGs or targets. This condition is not unexpected, however, as it is anticipated that longer-lived, higher trophic level species will take longer to respond to reduced contaminant concentrations in other media as a result of remedy implementation.

The discussion of the fish tissue data presented above and in the Data Review section primarily focuses on mean and 95% UCL values and the Sets 1, 2 and 3 figures included in Attachment 3 present the full range of concentrations. It should be noted that the mean and 95% UCL are not indicative of the distribution of individual sample results within a data set and do not indicate the percentage of sample results which may exceed a fish tissue RG or target concentration. To date, metrics which would be used to statistically evaluate contaminant concentrations for each target fish species relative to the fish tissue RGs and targets, have not yet been formalized.

It is noted in the OLMMP that "*to account for natural variability, performance criteria [for fish tissue] will be considered to have been met after multiple years of data indicate attainment. Performance criteria should be met at least three years in a row or four years out of five to verify achievement of goals. Fish monitoring will continue until NYSDEC/EPA determine that the relevant RAOs and PRGs in the ROD have been achieved. The data will be provided to NYSDOH for consideration in setting fish consumption advisories, as changes to the advisories can denote trends toward meeting the PRG and RAO*." Although there are some fish tissue data sets where the 95% UCL was below goals or targets for at least three years in a row based on data from 2015-2018 (*i.e.,* dioxins/furan TEQs in Pumpkinseed, mercury in small prey fish on a lake-wide basis and DDT and metabolites in small and large prey fish), modifications to the Honeywell fish tissue monitoring program will be evaluated by EPA and NYSDEC, if appropriate, following a review of the 2017 and 2018 organics and lipids data quality (as discussed in Attachment 3), as well as the results from the 2019 and 2020 fish tissue monitoring which is incorporating refinements in the laboratory procedures and improvements in the QA/QC procedures as documented in the revised QAPP (Parsons/UFI/Eurofins Lancaster Labs, 2020, in progress).

Qualitative and quantitative surveys of aquatic macrophytes conducted in 2017 and 2018 to document the natural recolonization by aquatic plants in remediation areas and the coverage in non-remediated areas (reference areas) indicate that significant natural recolonization of capped areas has occurred since cap placement such that remediated and non-remediated areas were characterized as having moderate to dense macrophyte coverage. The continued colonization and growth of submerged aquatic macrophytes in remediated areas is expected to continue.

The results of monitoring and maintenance activities at the SCA, from closure through 2019, of the cover system, surface water management system, liquid management system, and the SCA perimeter berm indicate that these systems and features are functioning as intended. Odor monitoring inspections conducted at eight air monitoring stations along the SCA work zone perimeter road indicated that no site-related odors were detected during the 2017 or 2018 monitoring periods.

ICs are being implemented to prevent unacceptable exposure to residual contamination within the lake, prevent recreational boaters from accidently contacting any navigational hazards created by capping and restoration components of the remedy, and prevent damage to the cap from activities, such as navigational dredging. The controls achieved to date include use of the NYSDEC and USACE permitting process to restrict actions that may disrupt the cap or SMU 8 sediment, the placement and maintenance of navigational buoys in the lake by the NYSOPRHP, and the provision of updated (post-capping) bathymetric survey results to NOAA to facilitate updating of the Navigational Chart for Onondaga Lake. These ICs are functioning as intended. The establishment of additional ICs (*i.e.,* environmental easements) is currently underway.

QUESTION B: *Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*

The exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the selection of the remedy are still valid. The risk assessment methodology used to complete the 2002 BERA was consistent with both EPA and NYSDEC guidance. Assessment and measurement endpoints encompassed the sustainability (survival, growth, and reproduction) of organisms at the base of the food web (aquatic macrophytes, phytoplankton, zooplankton, benthic invertebrates, and terrestrial plants) and up the food chain (fish, amphibians and reptiles, insectivorous birds, benthivorous waterfowl, piscivorous birds, carnivorous birds, insectivorous mammals, and piscivorous mammals). Measurement endpoints included measured or modeled concentrations of chemicals and stressors in water, sediment, fish, birds, and mammals, laboratory toxicity studies, and field observations. Toxicity Reference Values were selected based on LOAELs and/or NOAELs from laboratory and/or field-based studies reported in the scientific literature. Reproductive effects (*e.g.,* egg maturation, egg hatchability, and survival of juveniles) were generally the most sensitive exposure endpoints and were selected when available and appropriate. Site-specific SECs using toxicity and chemistry data were derived to allow assessment of whether the sediment chemical concentrations found at various stations in the lake would result in adverse biological effects. These SECs were then used to derive consensus-based PECs for use in determining areas of the lake bottom that potentially pose a risk to the benthic community.

The exposure assumptions and toxicity values that were used in the HHRA to estimate the potential risk and hazards to human health from exposure to the contaminants followed the general practice at the time that the risk assessment was performed. Although specific parameters and toxicity values may have changed, the risk assessment process that was used is still consistent with current practices, and the conclusions remain valid. Toxicity values for PCDD/PCDFs and for benzo(a)pyrene have been updated since the time of the ROD. The conclusions of the HHRA remain valid; a discussion of the revised toxicity values is presented below.

At the time of the ROD, the human health target fish tissue concentrations for PCDD/PCDFs were based on RME carcinogenic risks at risk targets ranging from $1x10^{-5}$ (0.4 ng/kg) to $1x10^{-4}$ (4.0 ng/kg). Noncarcinogenic targets were not developed for PCDD/PCDFs prior to the issuance of the ROD since a noncarcinogenic reference dose (RfD) was not available. Subsequent to the issuance of the ROD, an RME noncancer endpoint target of 1.3 ng/kg was developed using the parameters presented in Appendix G of the FS report for a target concentration for the noncancer endpoint and the EPA 2012 reference dose of $7x10^{-10}$ mg/kg-day. The RME target based on noncancer effects of PCDD/PCDFs fall within the range based on carcinogenic risks. Therefore, the PCDD/PCDF targets for comparison with the PCDD/PCDF fish tissue data considered in this FYR included the noncancer endpoint, 1.3 ng/kg (noncancer), in addition to 4.0 ng/kg ($1x10^{-4}$ cancer).

The HHRA concluded that benzo(a)pyrene was not associated with unacceptable risk. As part of this FYR, the updated toxicity values for benzo(a)pyrene have been reviewed to assess if the conclusions of the HHRA would be different when including the updated information; the review concluded the conclusions are the same, and that benzo(a)pyrene is not associated with unacceptable risk.

The RAOs identified in the ROD include reducing or eliminating potential risks to humans and ecological receptors. Currently, there are advisories in place that recommend that consumption of fish is limited to certain types and specific meal frequencies. The actions taken through the implementation of the remedy to date include reducing methylation rates of mercury, completion of dredging, capping and habitat enhancement/reestablishment. The State's fish consumption advisories currently in place help to reduce exposure through ingestion. Fish tissue monitoring will continue, and it is expected that concentrations will continue to decrease.

Sediment-based cleanup levels identified at the time of the remedy incorporated site-specific criteria established during the RI/FS and were developed consistent with published scientific literature. Fish-based remediation goals include fish tissue mercury concentrations ranging from 0.14 mg/kg, which is for protection of ecological receptors, to 0.3 mg/kg, which is based on the EPA's MeHg National Recommended Water Quality criterion for the protection of human health for the consumption of organisms. This range encompasses the goal for protection of human health based on the reasonable maximum exposure scenario of 0.2 mg/kg of mercury in fish tissue (fillets).

QUESTION C: *Has any* ***other*** *information come to light that could call into question the protectiveness of the remedy?*

Based on media reports and other information, some individuals, including members of refugee communities, may not currently be aware of the NYSDOH fish consumption advisory for Onondaga Lake and may be consuming fish caught from the lake and/or its tributaries at rates above recommended guidelines provided in the advisory. Further efforts to conduct outreach on, and enhance the effectiveness of the fish consumption advisory, may be warranted.

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VI. ISSUES/RECOMMENDATIONS

Table IV, below, presents the recommendations and follow-up actions for this FYR.

Table IV: Issues and Recommendations

Issues/Recommendations				
OU(s) without Issues/Recommendations Identified in the Five-Year Review:				
None				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): 02	**Issue Category:** Remedy Performance			
	Issue: Post-construction fish tissue data to be collected through 2022 should be statistically evaluated with prior post-construction data to ascertain when the RGs identified in the ROD will be achieved.			
	Recommendation: In four years, evaluate whether rates of decline in fish tissue contaminant levels can be estimated with statistical significance.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	State	9/30/2024
OU(s): 02	**Issue Category:** Remedy Performance			
	Issue: Statistical metrics that would be utilized to evaluate attainment of fish tissue RGs and targets have, to date, not been formalized.			
	Recommendation: Statistical metrics that would be utilized to evaluate attainment of fish tissue RGs and targets should be developed. The metrics should characterize the population of the sample set, including an assessment of the significance of samples that exceed the RGs and targets.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA/State	State	9/30/2021
OU(s): 02	**Issue Category:** Institutional Controls			
	Issue: All institutional controls are not in place.			
	Recommendation: Institutional controls should be put into place.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	State	3/31/2021

OTHER FINDINGS

A site inspection could not be performed during the review period due to the ongoing COVID-19 pandemic. A site inspection will be scheduled when it is determined that it is safe to conduct the inspection.

Available information indicates that some individuals, including members of refugee communities, may not currently be aware of the NYSDOH fish consumption advisory for Onondaga Lake and may be consuming fish caught from the lake and/or its tributaries at rates above recommended guidelines provided in the advisory. It is recommended that NYS consider implementing additional outreach activities or techniques to increase awareness of the fish consumption advisory, particularly with respect to refugee communities located in the vicinity of Onondaga Lake.

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)		
Operable Unit: 02	*Protectiveness Determination:* Protectiveness Deferred	*Planned Addendum Completion Date:* 9/30/2024
Protectiveness Statement: A protectiveness determination of the remedy for the Lake Bottom Subsite cannot be made until additional post-construction fish tissue data are available to ascertain when the remedial goals identified in the ROD will be achieved. It is anticipated that at least four additional years of fish data will be needed to determine when the rates of decline can be estimated with statistical significance. Following the evaluation of the additional data, a protectiveness determination will be made. In the interim, remedial operation, maintenance and monitoring activities will continue to be implemented in accordance with existing plans and requirements. The construction components of the remedy, which includes in-lake dredging, capping, habitat restoration, capping/closure of the Sediment Consolidation Area located on Wastebed 13, which contains sediment and debris removed from the lake have been completed. Other components of the remedy, including nitrate addition in the hypolimnion and MNR are ongoing. The establishment of ICs is anticipated to be completed in 2021.		

VIII. NEXT REVIEW

The next FYR report for the Lake Bottom Subsite of the Onondaga Lake Superfund site is required five years from the completion date of this review.

APPENDIX A – REFERENCE LIST

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APPENDIX B – PHYSICAL CHARACTERISTICS, GEOLOGY/HYDROGEOLOGY, AND LAND USE

APPENDIX B: PHYSICAL CHARACTERISTICS, GEOLOGY/HYDROGEOLOGY AND LAND USE

Physical Characteristics

Onondaga Lake is a 4.6-square-mile, 3,000-acre lake, approximately 4.5 miles long and 1 mile wide, with an average water depth of 36 feet, with two (northern and southern) deep basins. The city of Syracuse is located at the southern end of Onondaga Lake, and numerous towns, villages, and major roadways surround the lake (see Figure 2). The lake has three main tributaries--Ninemile Creek to the west; Onondaga Creek to the south; and Ley Creek to the southeast. In addition, several small tributaries flow into the lake, including Bloody Brook, Sawmill Creek, Tributary 5A, the East Flume, and Harbor Brook. While Ninemile Creek and Onondaga Creek supply the vast majority of surface water to the lake, approximately 20 percent of the inflow comes from the Metropolitan Syracuse Wastewater Treatment Plant (METRO). The lake drains into the Seneca River through a single outlet located at the northern tip of the lake.

The area around Onondaga Lake is the most urban in central New York State. The region experienced significant growth in the twentieth century, and in 2000, Onondaga County was the tenth most populous county in the State. There are approximately 320 acres of state-regulated wetlands and numerous smaller wetlands directly connected to Onondaga Lake or within its floodplains.

Site Geology/Hydrogeology

Onondaga Lake is underlain by a thick layer of soft, unconsolidated sediments ranging from approximately 80 feet to over 300 feet thick beneath the mouth of Onondaga Creek at the south end of the lake. These unconsolidated deposits consist (from top to bottom) of layers of fill, marl, silt and clay, silt and fine sand, sand and gravel, and till. The bedrock geology beneath the lake consists of 500 to 600 feet of sedimentary rocks of the Vernon Shale Formation, which are comprised of soft and erodible mudstones with some localized, discontinuous gypsum seams.

Two primary hydrogeologic units exist at the lake--unconsolidated deposits and underlying bedrock shale. Groundwater in the unconsolidated deposits, which overlies the silt and clay layer, comprises an unconfined groundwater zone that provides most of the discharge of groundwater to the lake. There is limited groundwater discharge from the deeper bedrock to the lake Total quantities of groundwater discharged to the lake are small compared to discharges of surface water to the lake.

Land and Resource Use

From 1970 to 1985, fishing on the lake was banned due to contamination. From 1986 to 1999, the fish consumption advisory for Onondaga Lake was "Don't eat any fish" from the lake. In 1999, the advisory was updated to "Don't eat any Walleye [*Sander vitreus*] and eat up to one meal a month of all other species." In 2007, the advisory was updated to "Don't eat Largemouth Bass [*Micropterus salmoides*] and Smallmouth Bass [*Micropterus dolomieu*] over 15 inches, and Walleye. Eat up to one meal a month of Smallmouth Bass and Largemouth Bass less than 15 inches, Carp [*Cyprinus carpio*], Channel Catfish [*Ictalurus punctatus*],White Perch [*Morone americana*] and all other species." In 2010, the advisory was updated to "For men over 15 and women over 50: Don't eat Largemouth Bass and Smallmouth Bass greater than 15 inches, Walleye, Carp, Channel Catfish and White Perch. Eat up to four meals a month of Brown Bullhead [*Ameiurus nebulosus*] and Pumpkinseed [*Lepomis gibbosus*]. Eat up to one meal a month of all other fish. (including Largemouth Bass and Smallmouth Bass less than 15 inches). For women under 50 and children under 15: Don't eat any fish." This advisory, which is established by the New York State Department of Health, is currently in effect. The fish consumption advisory is based on the presence of mercury, dioxin, and polychlorinated biphenyls (PCBs) in fish tissues.

In general, the eastern shore of Onondaga Lake is mainly urban and residential, and the northern shore is dominated by parkland, wooded areas, and wetlands. The northwest upland is primarily residential, with interspersed urban structures and several undeveloped areas. The southern and western shorelines are dominated by industrial wastebeds, consisting mainly of ionic wastes, many of which have been revegetated. Urban centers and industrial zones dominate the landscape surrounding the south end of Onondaga Lake from approximately the New York State Fairgrounds to Ley Creek. Land around the southwest corner and southern portion of the lake is generally industrial and has been significantly modified as part of long-term development of the Syracuse area. Land around much of the lake is recreational, providing hiking and biking trails, picnicking, sports, and other recreational activities.

Anticipated recreational uses of Onondaga Lake include fishing without lake specific consumption advisories and swimming. In early 2014, Onondaga County announced plans to construct an amphitheater complex near Lakeview Point, located on the Wastebeds 1-8 Subsite, as part of a community revitalization effort that is supported by New York State. The construction of the amphitheater commenced in January 2015 and was substantially completed in the late summer 2015 (EPA, 2015). Onondaga County is currently performing a feasibility study and design for a beach on Onondaga Lake's northeastern shoreline. Onondaga County has proposed to complete a recreational trail, the Loop the Lake Trail, around Onondaga Lake. Sections of this trail currently cross the Wastebeds 1-8 Subsite and are anticipated to be extended over the Semet Residue Ponds, Willis Avenue, and Wastebed B/Harbor Brook Subsites in 2020.

The Onondaga Nation has a unique cultural, spiritual, and historic relationship with and an obligation to act as an environmental steward of Onondaga Lake. The Nation's Vision for Onondaga Lake is a safe, clean, and healthy ecosystem that supports a thriving and varied community of fish in its waters, benthic organisms in its sediments, and wildlife along its shores. The Nation also envisions waters clean enough for drinking, swimming, and other human contact and shorelines safe enough for traditional and ceremonial uses by Nation citizens (Heath, 2020).

References

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Onondaga Lake Second Five Year Review

Attachment 1

Tables and Figures

Attachment 1 – List of Tables

Table 1a: Target Tissue Concentrations for Fish (all concentrations in mg/kg wet weight)		
Contaminants of Concern	**Target Tissue Concentrations**	
Human Health – Fish Fillets	**Reasonable Maximum Exposure**	
Mercury (as MeHg)[4]	0.2	
Total PCBs[5]	0.03 to 0.1	
PCDD/PCDFs (TEQ as 2,3,7,8-TCDD)[6]	4×10^{-7} to 1.3×10^{-6}	
Ecological Exposure Small Fish (3-18 cm) - Whole Fish	**NOAEL**	**LOAEL**
Mercury (as MeHg)	0.009	0.187
Total PCBs	0.013	3.15
DDT and metabolites (sum)	0.005	0.049
Ecological Exposure Large Fish (18-60 cm) - Whole Fish	**NOAEL**	**LOAEL**
Mercury (as MeHg)	0.014	0.341
Total PCBs	0.019	9.6
DDT and metabolites (sum)	0.014	0.15

Table 1a Notes:

1. NOAEL = no-observed-adverse-effect-level; LOAEL = lowest-observed-adverse-effect-level.
2. NOAELs and LOAELs for small (3 to 18 cm) fish are based on the belted kingfisher and mink. NOAELs and LOAELs for large (18 to 60 cm) fish are based on the great blue heron, osprey, and river otter.
3. Only avian fish target concentrations are presented for DDT and metabolites.
4. The human health target tissue concentration for mercury (0.2 mg/kg) is based on young child reasonable maximum exposure (RME) (non-cancer effects). The RME target concentration for adults is slightly higher (0.3 mg/kg).
5. The human health target tissue concentrations for total PCBs are based on RME carcinogenic risks at risk targets ranging from 1E-05 (0.03 mg/kg) to 1E-04 (0.3 mg/kg). The RME targets based on non-cancer effects of 0.04 mg/kg for high molecular weight PCBs and 0.1 mg/kg for low molecular weight PCBs fall within the range based on carcinogenic risks. A target concentration based on the 1E-06 risk level was not selected as a goal since it is much lower than mean background concentrations in US waters and may not be achievable (see Appendix G of the Onondaga Lake FS).
6. TEQ = toxicity equivalent (toxicity-weighted mass of dioxin mixtures). The human health target tissue concentrations for PCDD/PCDFs are based on RME carcinogenic risks at risk targets ranging from 1E-05 (4E-07 mg/kg) to 1E-04 (4E-06 mg/kg). Non-carcinogenic targets were not developed for PCDD/PCDFs prior to the issuance of the ROD. Subsequent to its issuance, a RME noncancer endpoint target of 1.3E-06 mg/kg was developed using the parameters presented in Appendix G of the FS for a target concentration for the non-cancer endpoint, and using the EPA 2012 reference dose of 7E-10 mg/kg-day. The RME target based on non-cancer effects PCDD/PCDFs fall within the range based on carcinogenic risks. A target concentration based on the 1E-06 risk level was not selected as a goal since it is much lower than mean background concentrations in US waters and may not be achievable (see Appendix G of the Onondaga Lake FS).

Table 1b: Sediment Probable Effect Concentrations (PECs)	
Contaminants of Concern	**Performance Criteria Micrograms per Kilogram (µg/kg)**
Mercury	2,200
Ethylbenzene	176
Xylenes	560.8
Chlorobenzene	428
Dichlorobenzenes	239
Trichlorobenzenes	347
Acenapthene	861
Acenaphthylene	1,301
Anthracene	207
Benz[a]anthracene	192
Benzo[a]pyrene	146
Benzo[b]fluoranthene	908
Benzo[ghi]perylene	780
Benzo[k]fluoranthene	203
Chrysene	253
Dibenz[a,h]anthracene	157
Fluoranthene	1,436
Fluorene	264
Indeno[1,2,3-cd]pyrene	183
Naphthalene	917
Phenanthrene	543
Pyrene	344
Total PCBs	295

Table 1b Notes: The 23 site-specific PECs developed during the RI phase which are included in this table were used in the calculations for the mean PECQ approach. In the littoral zone, sediment remediation goals include achieving the mean PECQ of 1 or lower and the mercury PEC of 2.2 mg/kg or lower. In the profundal zone, sediment remediation goals include achieving the mean PECQ of 1 or lower, and achieving the mercury PEC or lower on a point basis and a BSQV of 0.8 mg/kg or lower on an area-wide basis within 10 years following the remediation of upland sources, littoral sediments, and initial thin-layer capping. The 23 PECs and NYSDEC sediment screening criteria for benzene, toluene, and phenol are also chemical isolation performance criteria for capped areas in the Lake's littoral zone, the Wastebed B Outboard Area, and the Wastebeds 1-8 connected wetland. Performance criteria for the Spits at the mouth of Ninemile Creek are based on remedial goals specified in the Geddes Brook/ Ninemile Creek OU2 ROD and include the NYSDEC Lowest Effect Level of 0.15 mg/kg for mercury.

Table 1c: Remediation Goals for Surface Water	
Contaminants of Concern	**New York State Surface Water Quality Standards**
Dissolved Mercury	0.7 ng/L
Chlorobenzene	5 µg/L
Dichlorobenzenes	5 µg/L

Table 1c Notes: Remediation goals for surface water are based on the NYSDEC aquatic (chronic) (A[C]) water quality standard for chlorobenzene and dichlorobenzenes and human health fish consumption (H[FC]) for dissolved mercury.

TABLE 2
CAP MONITORING CHEMICAL PARAMETERS

Remediation Area	Cap Model Area (Inclusive of MPCS)	Chemical Groups That Determined GAC Application Rate	Indicator Chemical Groups	Additional Chemical Groups
A	A1	Sand Only	mercury	VOCs, PCBs, LPAHs, HPAHs
	A2[1]	VOCs	VOCs, LPAHs, mercury, pH	PCBs, HPAHs
B	B1	Phenol	VOCs, LPAHs, mercury, pH	PCBs, HPAHs
	B2	Phenol	VOCs[4], LPAHs, mercury, pH	PCBs, HPAHs
C	C1	Phenol	VOCs, LPAHs, mercury, pH	PCBs, HPAHs
	C2	LPAHs	VOCs, LPAHs, HPAHs, mercury, pH	PCBs
	C3	VOCs	VOCs, LPAHs, mercury, pH	PCBs, HPAHs
D	SMU 2	VOCs	VOCs, LPAHs, mercury, pH	PCBs, HPAHs
	West	Phenol	VOCs, LPAHs, HPAHs, mercury, pH	PCBs
	Center[2]	VOCs	VOCs, LPAHs, mercury, pH	PCBs, HPAHs
	East	VOCs	VOCs, LPAHs, mercury, pH	PCBs, HPAHs
E	E1A[3]	Sand Only	mercury	VOCs, PCBs, LPAHs, HPAHs
	E1B[3]	Sand Only	mercury	VOCs, PCBs, LPAHs, HPAHs
	E2	VOCs	VOCs, LPAHs, mercury	PCBs, HPAHs
	E3	VOCs	VOCs, mercury	PCBs, LPAHs, HPAHs
F	F	Sand Only	mercury	VOCs, PCBs, LPAHs, HPAHs
SMU 8 Amended TLCs and GAC Direct Application	SMU 8	Not Applicable	mean PECQ VOCs, PAHs, PCBs, mercury, pH	None
SMU 8 Unamended TLCs	SMU 8	Not Applicable	mean PECQ VOCs, PAHs, PCBs, mercury	None
Wetlands	WB1-8	VOCs	VOCs, LPAHs, mercury, pH	PCBs, HPAHs
	WBB-East	VOCs	VOCs, LPAHs, mercury	PCBs, HPAHs
	WBB-Center	VOCs	VOCs, LPAHs, HPAHs, mercury, pH	PCBs
	WBB-West	VOCs	VOCs, LPAHs, HPAHs, mercury, pH	PCBs

Notes: Naphthalene is included as a VOC.

LPAHs include fluorene, phenanthrene, acenaphthene, acenaphthylene and anthracene. Phenol is not a PAH but is included in the LPAH indicator and additional chemical group for convenience since PAHs and phenol are both analyzed by EPA Method 8270. HPAHs include fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3,-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

[1] Includes Ninemile Creek Spits and Model Area RA-A-40197.

[2] Includes Model Area OL-VC-10138/40.

[3] E1 consists of two separate areas that were modeled as one area.

[4] VOCs are not considered an indicator chemical group for Model Area B2 based on the original cap modeling but are included because they were modeled as part of the design for the MPCs within that area.

TABLE 3.1a
2017 MULTI-LAYER CAP THICKNESS MEASUREMENTS

Rem. Area	Model Area	Zone[1]	Location ID	Cap Type	Design[4]/Target[5] Thickness (inches): Habitat Layer	Erosion Protection Layer[2]	Chemical Isolation Layer	Total	Measured Thickness (inches): Core 1 Thickness: Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (y/n)[6]	Core 2 Thickness: Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (y/n)[6]	Comment
Remediation Area A	A1	1	OL-RAA-CAP-0001	Multi-layer	12 / 9		6	18 / 15	NM	NM	22	0.5	Y	NM	NM	22	0.5	Y	
Remediation Area A	A1	1	OL-RAA-CAP-0002	Multi-layer	12 / 9		6	18 / 15	NM	NM	21.5	0.5	Y	NA	NA	NA	NA	NA	
Remediation Area A	A1	1	OL-RAA-CAP-0003	Multi-layer	12 / 9		6	18 / 15	NM	NM	25.5	2	Y	NA	NA	NA	NA	NA	
Remediation Area A	A1	1	OL-RAA-CAP-0004	Multi-layer	12 / 9		6	18 / 15	NM	NM	25	1.5	Y	NA	NA	NA	NA	NA	
Remediation Area A	A1	1	OL-RAA-CAP-0005	Multi-layer	12 / 9		12	24 / 21	NM	NM	33	0.5	Y	NA	NA	NA	NA	NA	
Remediation Area A	A2	1	OL-RAA-CAP-0006	Multi-layer	12 / 9		12	24 / 21	NM	NM	34.5	0.75	Y	NM	NM	38	0.5	Y	
Remediation Area A	A1	1	OL-RAA-CAP-0007	Multi-layer	12 / 9		12	24 / 21	NM	NM	28.5	0.5	Y	NA	NA	NA	NA	NA	
Remediation Area A	A2	2	OL-RAA-CAP-0008	Multi-layer	18 / 9		12	30 / 21	13	20	33	0	Y	13	15	28	0	N	
Remediation Area A	A1	2	OL-RAA-CAP-0009	Multi-layer	18 / 9		12	30 / 21	25	18	43	0	Y	17	17	34	0	Y	
Remediation Area A	A2	2	OL-RAA-CAP-0010	Multi-layer	18 / 9		12	30 / 21	15	19	34	0.25	Y	13	13	26	0.5	N	
Remediation Area A	A2	2	OL-RAA-CAP-0022[3]	Multi-layer	18 / 9		12	30 / 21	10	14	24	0	Y	NA	NA	NA	NA	NA	
Remediation Area A	A2	2	OL-RAA-CAP-0023[3]	Multi-layer	18 / 9		12	30 / 21	12	14	26	0	Y	NA	NA	NA	NA	NA	
Remediation Area A	A2	3	OL-RAA-CAP-0011	Multi-layer	12 / 9	12	12	36 / 21	14.5	NM	NM	NM	N	NA	NA	NA	NA	NA	Thicknesses are topsoil habitat layer only
Remediation Area A	A2	3	OL-RAA-CAP-0012	Multi-layer	12 / 9	12	12	36 / 21	14.5	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area A	RA-A40197	3	OL-RAA-CAP-0013	Multi-layer	12 / 9	12	12	36 / 21	12	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area A	RA-A40197	3	OL-RAA-CAP-0014	Multi-layer	12 / 9	12	12	36 / 21	14	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area A	RA-A40197	3	OL-RAA-CAP-0014[7]	Multi-layer	12 / 9	12	12	36 / 21	10.5	NM	NM	NM	N	12.5	NM	NM	NM	N	
Remediation Area A	A1	3	OL-RAA-CAP-0015	Multi-layer	12 / 9	12	12	36 / 21	16	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area A	A2	3	OL-RAA-CAP-0016	Multi-layer	12 / 9	12	12	36 / 21	13	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area A	A2	3	OL-RAA-CAP-0016[7]	Multi-layer	12 / 9	12	12	36 / 21	13.5	NM	NM	NM	N	12	NM	NM	NM	N	
Remediation Area A	NMC Spits	3	OL-RAA-CAP-0017	Multi-layer	19.5 / 9	4.5	12	36 / 21	21.5	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area A	NMC Spits	3	OL-RAA-CAP-0018	Multi-layer	19.5 / 9	4.5	12	36 / 21	21	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area A	A1	3	OL-RAA-CAP-0019	Multi-layer	12 / 9	12	12	36 / 21	14.5	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area A	A1	3	OL-RAA-CAP-0020	Multi-layer	12 / 9	12	12	36 / 21	13.5	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area A	A1	3	OL-RAA-CAP-0021	Multi-layer	12 / 9	12	12	36 / 21	13	NM	NM	NM	N	NA	NA	NA	NA	NA	
Remediation Area B	B2	1	OL-RAB-CAP-0002	Multi-layer	12 / 9		12	24 / 21	NM	NM	36	0.5	Y	NM	NM	35	1	Y	
Remediation Area B	B1/C1	1	OL-RAB-CAP-0015	Multi-layer	12 / 9		12	24 / 21	NM	NM	30.5	0.5	Y	NM	NM	33	1	Y	
Remediation Area B	RA-B-1C (4-10)	2	OL-RAB-CAP-0008	MPC Multi-layer	12 / 9		9	21 / 18	11	15	26	0	Y	9	15	24	0	Y	
Remediation Area B	RA-B-1E (4-10)	2	OL-RAB-CAP-0016	MPC Multi-layer	12 / 9		12	24 / 21	9	23	32	0	Y	10	15	25	0	Y	
Remediation Area B	RA-B-1A	1	OL-RAB-CAP-0001	MPC Multi-layer	12 / 9		7.5	19.5 / 16.5	NM	NM	23.5	0.75	Y	NM	NM	26	0.25	Y	
Remediation Area B	RA-B-1A	1	OL-RAB-CAP-0003	MPC Multi-layer	12 / 9		7.5	19.5 / 16.5	NM	NM	22	0.5	Y	NM	NM	24	0.5	Y	
Remediation Area B	RA-B-1B	1	OL-RAB-CAP-0004	MPC Multi-layer	6 / 3		3	9 / 6	NM	NM	17.5	0.5	Y	NA	NA	NA	NA	NA	
Remediation Area B	RA-B-1E (10-30)	1	OL-RAB-CAP-0014	MPC Multi-layer	12 / 9		6	18 / 15	NM	NM	24.5	0.5	Y	NM	NM	26	0.25	Y	
Remediation Area B	WB 1-8 Wetland	3	OL-RAB-CAP-0006	Multi-layer	19.5 / 9	4.5	12	36 / 21	21.5	NM	NM	0	N	NA	NA	NA	NA	NA	Thicknesses are topsoil habitat layer only
Remediation Area B	WB 1-8 Wetland	3	OL-RAB-CAP-0006[7]	Multi-layer	19.5 / 9	4.5	12	36 / 21	21.5	NM	NM	0	N	16	NM	NM	NM	N	
Remediation Area B	WB 1-8 Wetland	3	OL-RAB-CAP-0009	Multi-layer	19.5 / 9	4.5	12	36 / 21	19.5	NM	NM	0	N	NA	NA	NA	NA	NA	
Remediation Area B	WB 1-8 Wetland	3	OL-RAB-CAP-0019	Multi-layer	19.5 / 9	4.5	12	36 / 21	21	NM	NM	0	N	NA	NA	NA	NA	NA	

TABLE 3.1a (CONTINUED)
2017 MULTI-LAYER CAP THICKNESS MEASUREMENTS

Rem. Area	Model Area	Zone[1]	Location ID	Cap Type	Design[4]/Target[5] Thickness (inches): Habitat Layer	Design/Target: Erosion Protection Layer[2]	Design/Target: Chemical Isolation Layer	Design/Target: Total	Core 1: Habitat Layer	Core 1: Chemical Isolation Layer	Core 1: Total	Core 1: Overlying Sediment	Core 1: Native Plug (y/n)[6]	Core 2: Habitat Layer	Core 2: Chemical Isolation Layer	Core 2: Total	Core 2: Overlying Sediment	Core 2: Native Plug (y/n)[6]	Comment
Remediation Area C	B1/C1	1	OL-RAC-CAP-0002	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**27.5**	**0.5**	**Y**	NM	NM	**36**	**0.5**	**Y**	
	C2	1	OL-RAC-CAP-0003	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**40.5**	**0**	**Y**	NM	NM	**31**	**0**	**Y**	
	C2	1	OL-RAC-CAP-0004	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**35**	**0.25**	**Y**	NM	NM	**41**	**0**	**Y**	
	C3	1	OL-RAC-CAP-0020	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**30.5**	**0.25**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	C3	1	OL-RAC-CAP-0021	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**40**	**0.5**	**Y**	NM	NM	**40.5**	**0.5**	**Y**	
	C3	1	OL-RAC-CAP-0023	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**41**	**0.75**	**Y**	NM	NM	**40**	**0.5**	**Y**	
	B1/C1	2	OL-RAC-CAP-0001	Multi-layer	18 / 9		12	**30 / 21**	21	24	**45**	**0**	**Y**	24	19	**43**	**0**	**Y**	
	C3	2	OL-RAC-CAP-0022	Multi-layer	18 / 9		12	**30 / 21**	24 sand	48+ sand w/ trace fine gravel	**72+**	**0.5**	**N**	17 sand	17 gravel, then 9+ sand	**43+**	**0**	**N**	
	C3	2	OL-RAC-CAP-0022	Multi-layer	18 / 9		12	**30 / 21**	NM	NM	**40**	**0**	**Y**	17	24	**41**	**0.5**	**Y**	
	RA-C-2A (10-30)	1	OL-RAC-CAP-0005	MPC Multi-layer	12 / 9		4.5	**16.5 / 13.5**	NM	NM	**18.5**	**0.5**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-2A (10-30)	1	OL-RAC-CAP-0009	MPC Multi-layer	12 / 9		4.5	**16.5 / 13.5**	NM	NM	**15**	**0.25**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-1A	1	OL-RAC-CAP-0016	MPC Multi-layer	9 / 6		4.5	**13.5 / 10.5**	NM	NM	**20**	**1**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-1A	1	OL-RAC-CAP-0017	MPC Multi-layer	9 / 6		4.5	**13.5 / 10.5**	NM	NM	**13**	**0.5**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-2A (4-10)	2	OL-RAC-CAP-0007 (North)	MPC Multi-layer	10 / 7		4.5	**14.5 / 11.5**	7	15	**22**	**0**	**Y**	8	13	**21**	**0**	**Y**	
	RA-C-2A (4-10)	2	OL-RAC-CAP-0007	MPC Multi-layer	10 / 7		4.5	**14.5 / 11.5**	6	17	**23**	**0**	**Y**	6	15	**21**	**0**	**Y**	
Remediation Area D	D-SMU-2	1	OL-RAD-CAP-0001	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**33.5**	**1**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	D-SMU-2	1	OL-RAD-CAP-0006	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**30.5**	**0.5**	**Y**	NM	NM	**30.5**	**0**	**Y**	
	D-Addendum East	1	OL-RAD-CAP-0007	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**39.5**	**0.75**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	D-SMU-2	1	OL-RAD-CAP-0009	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**39.5**	**1**	**Y**	NM	NM	**43**	**0**	**Y**	
	D-West	1	OL-RAD-CAP-0010	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**34.5**	**0.25**	**Y**	NM	NM	**37.5**	**0.5**	**Y**	
	D-Center	1	OL-RAD-CAP-0012	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**36.5**	**0.75**	**Y**	NM	NM	**47**	**0.75**	**Y**	
	D-Center	1	OL-RAD-CAP-0013	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**38.5**	**0.5**	**Y**	NM	NM	**39**	**0**	**Y**	
	D-East	1	OL-RAD-CAP-0014	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**48**	**1**	**Y**	NM	NM	**32**	**0**	**Y**	
	D-East	1	OL-RAD-CAP-0014[7]	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**36**	**0**	**Y**	NM	NM	**43**	**0**	**Y**	
	D-West	1	OL-RAD-CAP-0015	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**36.5**	**0**	**Y**	NM	NM	**37.5**	**0**	**Y**	
	D-SMU-2	1	OL-RAD-CAP-0016	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**34.5**	**0.5**	**Y**	NM	NM	**40.5**	**0.5**	**Y**	
	D-West	1	OL-RAD-CAP-0020	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**39.5**	**0**	**Y**	NM	NM	**36.5**	**0**	**Y**	
	D-East	1	OL-RAD-CAP-0021	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**34.5**	**0**	**Y**	NM	NM	**36**	**0**	**Y**	
	D-East	1	OL-RAD-CAP-0025	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**35**	**0.5**	**Y**	NM	NM	**36**	**0**	**Y**	
	D-East	1	OL-RAD-CAP-0028	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**28**	**0.75**	**Y**	NM	NM	**27.5**	**0.25**	**Y**	
	D-East	1	OL-RAD-CAP-0028[7]	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**31**	**0.25**	**Y**	NM	NM	**30**	**0.25**	**Y**	
	D-East	1	OL-RAD-CAP-0031	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**38**	**0.25**	**Y**	NM	NM	**40**	**0**	**Y**	
	D-East	1	OL-RAD-CAP-0032	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**36.5**	**0.5**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	D-East	1	OL-RAD-CAP-0033	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**37**	**0.25**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	D-East	1	OL-RAD-CAP-0038	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**35**	**0.25**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	D-East	1	OL-RAD-CAP-0040	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**31.75**	**0**	**Y**	NM	NM	**34.5**	**0.5**	**Y**	

Honeywell

TABLE 3.1a (CONTINUED)
2017 MULTI-LAYER CAP THICKNESS
MEASUREMENTS

Rem. Area	Model Area	Zone[1]	Location ID	Cap Type	Design[4]/Target[5] Thickness (inches)				Measured Thickness (inches)										Comment
					Habitat Layer	Erosion Protection Layer[2]	Chemical Isolation Layer	Total	Core 1 Thickness					Core 2 Thickness					
									Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (y/n)[6]	Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (y/n)[6]	
Remediation Area D	D-Center	2	OL-RAD-CAP-0023	Multi-layer	18 / 9		12	30 / 21	24	20	44	0	Y	NA	NA	NA	NA	NA	
	D-Center	2	OL-RAD-CAP-0034	Multi-layer	18 / 9		12	30 / 21	23	28	51	0.5	Y	12	24	36	0	Y	
	D-East	2	OL-RAD-CAP-0036	Multi-layer	12 / 9		12	24 / 21	36	24	60	0.25	Y	NA	NA	NA	NA	NA	
	RA-D-1A	1	OL-RAD-CAP-0002	MPC Multi-layer	12 / 9		6	18 / 15	NM	NM	47	1	Y	NA	NA	NA	NA	NA	
	RA-D-1A	1	OL-RAD-CAP-0003	MPC Multi-layer	12 / 9		6	18 / 15	NM	NM	27	0.25	Y	NM	NM	26.5	0	Y	
	RA-D-1A	1	OL-RAD-CAP-0004	MPC Multi-layer	12 / 9		6	18 / 15	NM	NM	31	2.5	Y	NA	NA	NA	NA	NA	
	RA-D-1A	1	OL-RAD-CAP-0004[7]	MPC Multi-layer	12 / 9		6	18 / 15	NM	NM	48	0.5	Y	NM	NM	48	0	Y	
	RA-D-2	1	OL-RAD-CAP-0008	MPC Multi-layer	10.5 / 7.5		7.5	18 / 15	NM	NM	24	0.25	Y	NA	NA	NA	NA	NA	
	RA-D-2	1	OL-RAD-CAP-0019	MPC Multi-layer	10.5 / 7.5		7.5	18 / 15	NM	NM	18	0.25	Y	NA	NA	NA	NA	NA	
	Outboard West	3	OL-RAD-CAP-0027	Multi-layer	19.5 / 9	4.5	12	36 / 21	22.5	NM	NM	0	N	NA	NA	NA	NA	NA	Thicknesses are topsoil habitat layer only
	Outboard West	3	OL-RAD-CAP-0030	Multi-layer	19.5 / 9	4.5	12	36/21	19	NM	NM	0	N	NA	NA	NA	NA	NA	
	Outboard West	3	OL-RAD-CAP-0035	Multi-layer	19.5 / 9	4.5	12	36/21	19	NM	NM	0	N	NA	NA	NA	NA	NA	
	Outboard Center	3	OL-RAD-CAP-0037	Multi-layer	19.5 / 9	4.5	12	36/21	21	NM	NM	0	N	NA	NA	NA	NA	NA	
	Outboard Center	3	OL-RAD-CAP-0039	Multi-layer	19.5 / 9	4.5	12	36/21	20.5	NM	NM	0	N	NA	NA	NA	NA	NA	
	Outboard Center	3	OL-RAD-CAP-0041	Multi-layer	19.5 / 9	4.5	12	36/21	20.5	NM	NM	0	N	NA	NA	NA	NA	NA	
	Outboard East	3	OL-RAD-CAP-0042	Multi-layer	19.5 / 9	4.5	12	36/21	24.5	NM	NM	0	N	NA	NA	NA	NA	NA	
	Outboard East	3	OL-RAD-CAP-0043	Multi-layer	19.5 / 9	4.5	12	36/21	19	NM	NM	0	N	NA	NA	NA	NA	NA	
	Outboard East	3	OL-RAD-CAP-0044[7]	Multi-layer	19.4 / 9	4.5	12	36/21	27	NM	NM	0	N	22	NM	NM	0	N	
	Outboard East	3	OL-RAD-CAP-0044	Multi-layer	19.5 / 9	4.5	12	36/21	20	NM	NM	0	N	18.5	NM	18.5	0	N	
	Outboard East	3	OL-RAD-CAP-0045	Multi-layer	19.5 / 9	4.5	12	36/21	22	NM	NM	0	N	NA	NA	NA	NA	NA	
	Outboard East	3	OL-RAD-CAP-0046	Multi-layer	19.5 / 9	4.5	12	36 / 21	19	NM	NM	0	N	NA	NA	NA	NA	NA	

TABLE 3.1a (CONTINUED)
2017 MULTI-LAYER CAP THICKNESS
MEASUREMENTS

Rem. Area	Model Area	Zone[1]	Location ID	Cap Type	Design[4]/Target[5] Thickness (inches): Habitat Layer	Erosion Protection Layer[2]	Chemical Isolation Layer	Total	Measured Thickness (inches): Core 1 Thickness: Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (y/n)[6]	Core 2 Thickness: Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (y/n)[6]	Comment
Remediation Area E	E-1 (B)	1	OL-RAE-CAP-0017	Multi-layer	12 / 9		6	**18 / 15**	NM	NM	**25**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	E-1 (B)	1	OL-RAE-CAP-0018	Multi-layer	12 / 9		6	**18 / 15**	NM	NM	**28**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	E-1 (B)	1	OL-RAE-CAP-0021	Multi-layer	12 / 9		6	**18 / 15**	NM	NM	**24**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	E-3	1	OL-RAE-CAP-0025	Multi-layer	12 / 9		6	**18 / 15**	NM	NM	**22**	**0.5**	**Y**	NM	NM	**32.5**	**0**	**Y**	
	E-3	1	OL-RAE-CAP-0027	Multi-layer	12 / 9		6	**18 / 15**	NM	NM	**27**	**0.25**	**Y**	NM	NM	**22**	**0**	**Y**	
	E-3	1	OL-RAE-CAP-0030	Multi-layer	12 / 9		6	**18 / 15**	NM	NM	**49**	**0.25**	**Y**	NM	NM	**54**	**0.25**	**Y**	
	E-2	1	OL-RAE-CAP-0031	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**30**	**0.5**	**Y**	NM	NM	**29**	**0**	**Y**	
	E-2	1	OL-RAE-CAP-0033	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**24**	**0.5**	**Y**	NM	NM	**24.5**	**0.5**	**Y**	
	E-2	1	OL-RAE-CAP-0033[7]	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**26**	**0.5**	**Y**	NM	NM	**36**	**0.75**	**Y**	
	E-1 (B)	2	OL-RAE-CAP-0019	Multi-layer	12 / 9		12	**24 / 21**	16	20	**36**	**0.25**	**Y**	9	16+	**25+**	**0**	**N**	
	E-1 (B)	2	OL-RAE-CAP-0020	Multi-layer	12 / 9		12	**24 / 21**	16	17	**33**	**0**	**Y**	17	16+	**33+**	**0**	**N**	
	E-1 (B)	2	OL-RAE-CAP-0022	Multi-layer	12 / 9		12	**24 / 21**	18.5	12	**33**	**0**	**Y**	26	13	**42**	**0**	**Y**	
	E-3	2	OL-RAE-CAP-0023	Multi-layer	12 / 9		12	**24 / 21**	28	12	**40**	**0.5**	**Y**	24	14	**38**	**0**	**Y**	
	E-3	2	OL-RAE-CAP-0029	Multi-layer	12 / 9		12	**24 / 21**	42	0	**42**	**0**	**N**	31	18	**49**	**0**	**Y**	
	E-3	2	OL-RAE-CAP-0035	Multi-layer	12 / 9		12	**24 / 21**	25	27	**52**	**0**	**Y**	14	26	**40**	**0**	**Y**	
	E-2	2	OL-RAE-CAP-0039	Multi-layer	12 / 9		12	**24 / 21**	16	22	**38**	**0**	**Y**	16	11	**27**	**0**	**Y**	
	E-2	2	OL-RAE-CAP-0040	Multi-layer	12 / 9		12	**24 / 21**	9	22	**31**	**0**	**Y**	20	22	**50**	**0**	**Y**	
	E-3	2	OL-RAE-CAP-0046[3]	Multi-layer	12 / 9		12	**24 / 21**	31+	NM	**NM**	**0**	**N**	NA	NA	**NA**	**NA**	**NA**	
	E-3	2	OL-RAE-CAP-0026	Multi-layer	12 / 9		12	**24 / 21**	21	14	**35**	**0.5**	**Y**	24	18	**42**	**0**	**Y**	
RA-F	RAF	1	OL-RAF-CAP-0001	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**27**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RAF	1	OL-RAF-CAP-0002	Multi-layer	12 / 9		12	**24 / 21**	NM	NM	**24**	**0**	**Y**	NM	NM	**38**	**0**	**Y**	

[box] Measured thickness is less than the minimum target thickness specified in the OLMMP.

[1] The coarsest substrates in Zones 1, 2, and 3 are sand, fine gravel and coarse gravel/cobble, respectively.

[2] When the habitat and erosion protection layer are the same substrate, the total thickness of the habitat/erosion protection layer is listed under the habitat layer.

[3] Samples collected from locations for additional physical monitoring based upon elevations observed during bathymetric survey.

[4] Design thickness specified as a minimum.

[5] Listed thickness is the target minimum thickness specified in the OLMMP.

[6] The presence of a plug of native sediment in the bottom of the core indicates the core fully penetrated the cap material, allowing measurement of the total cap thickness.

[7] Cap thickness data collected in April 2018 during cap resampling.

NA - Not applicable, core was not required or collected.

NM - Not measured. When the entire cap consists of sand, it is not possible to differentiate the different layers, therefore only the total thickness is provided. When the cap design consists of topsoil overlying coarse gravel, the core can be advanced through the topsoil but not the coarse gravel, therefore only the topsoil thickness is provided.

Honeywell

TABLE 3.1b

2017 MONO-LAYER CAP THICKNESS MEASUREMENTS

						Measured Thickness (inches)								
Rem. Area	**Model Area**	**Zone**	**Location ID**	**Cap Type**	**Design Thickness (inches)[1]**	**Core 1 Thickness**		**Core 2 Thickness**		**Core 3 Thickness**		**Core 4 Thickness**		**Comment**
						Cap	**Overlying Sediment**	**Cap**	**Overlying Sediment**	**Cap**	**Overlying Sediment**	**Cap**	**Overlying Sediment**	
RA-B	RA-B-1C (10-20)	1	OL-RAB-CAP-0010	MPC Monolayer	8	13.25	0	NA	NA	NA	NA	NA	NA	
	RA-B-1D (20-30)	1	OL-RAB-CAP-0011	MPC Monolayer	7.5	9	0	NA	NA	NA	NA	NA	NA	
	RA-B-1D (10-20)	1	OL-RAB-CAP-0013	MPC Monolayer	12	13.5	0	NA	NA	NA	NA	NA	NA	
	RA-B-1C	1	OL-RAB-CAP-0005	MPC Monolayer	2	4.5	0.25	4	0	3.5	0	3.5	1	
	RA-B-1C	1	OL-RAB-CAP-0007	MPC Monolayer	2	5	0	4	0	5	0	5.5	0	
RA-C	RA-C-1B	1	OL-RAC-CAP-0014	GAC Direct App.	0	5	0.25	5	0.25	3	0.25	6	0.25	
	RA-C-1B	1	OL-RAC-CAP-0018	GAC Direct App.	0	5	0	4	0	4	0	6	0	
	RA-C-1C	1	OL-RAC-CAP-0015	GAC Direct App.	0	8	0	NA	NA	NA	NA	NA	NA	
	RA-C-1D	1	OL-RAC-CAP-0019	MPC Monolayer	9	11.5	0.5	NA	NA	NA	NA	NA	NA	
	RA-C-2B	1	OL-RAC-CAP-0006	MPC Monolayer	2	3	0	3	0	3	0	3.5	0.25	
	RA-C-2B	1	OL-RAC-CAP-0008	MPC Monolayer	2	3.75	0	4	0	3	0	3	0	
	RA-C-2C	1	OL-RAC-CAP-0011	MPC Monolayer	13.5	12	0	8	0	NA	NA	NA	NA	
	RA-C-2C	1	OL-RAC-CAP-0011[2]	MPC Monolayer	13.5	9	1.75	11.5	0.5	12	0	17	0	
	RA-C-2C	1	OL-RAC-CAP-0013	MPC Monolayer	13.5	20	0	NA	NA	NA	NA	NA	NA	
	RA-C-2C	1	OL-RAC-CAP-0013[2]	MPC Monolayer	13.5	14	0.5	11	0.25	NA	NA	NA	NA	
	RA-C-2D	1	OL-RAC-CAP-0010	GAC Direct App.	0	5	0.25	7.5	0.25	10	0.25	6	0.25	
	RA-C-2D	1	OL-RAC-CAP-0012	GAC Direct App.	0	4.25	0.25	4.5	0	6	0	5	0.25	
RA-D	RA-D-1B	1	OL-RAD-CAP-0005	MPC Monolayer	4.5	6	0.25	5.5	0.25	5.5	0	8.5	0.25	
	RA-D-1B	1	OL-RAD-CAP-0011	MPC Monolayer	4.5	15	2.5	5.5	1	7.5	0.5	8	0.5	
	RA-D-1B	1	OL-RAD-CAP-0011[2]	MPC Monolayer	4.5	8	0	6.5	0.5	NA	NA	NA	NA	
RA-E	MERC E2	1	OL-RAE-CAP-0036	MERC	6	6	0	10	0.5	10.5	0.25	NA	NA	
	MERC E2	1	OL-RA3-CAP-0036[2]	MERC	6	14	0.75	9	0.25	NA	NA	NA	NA	
	MERC E3	1	OL-RAE-CAP-0038	MERC	6	12	0	6.5	0.5	6	1	NA	NA	
	MERC E3	1	OL-RAE-CAP-0038[2]	MERC	6	18	0.25	17.5	0	NA	NA	NA	NA	
	MERC E1	1	OL-RAE-CAP-0042	MERC	6	6.5	1.5	12	1	0	NA	NA	NA	
	MERC E1	1	OL-RAE-CAP-0042[2]	MERC	6	6	0.5	5.5	0.5	NA	NA	NA	NA	

TABLE 3.1b (CONTINUED)

2017 MONO-LAYER CAP THICKNESS MEASUREMENTS

						Measured Thickness (inches)								
Rem. Area	Model Area	Zone	Location ID	Cap Type	Design Thickness (inches)[1]	Core 1 Thickness		Core 2 Thickness		Core 3 Thickness		Core 4 Thickness		Comment
						Cap	Overlying Sediment	Cap	Overlying Sediment	Cap	Overlying Sediment	Cap	Overlying Sediment	
SMU 8	TLC	SMU 8	OL-SMU 8-CAP-0014	TLC	2	5	2.5	6.5	2	NA	NA	NA	NA	Adjacent to RA-D
	TLC	SMU 8	OL-SMU 8-CAP-0017	TLC	2	7.5	0.25	8	0.25	8.5	0.25	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0018	TLC	2	6.5	0	NA	NA	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0019	TLC	2	5	0.25	8.5	0	8	0.1	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0020	TLC	2	5	0.5	9	0.75	6	1	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0008	Amended TLC	4.5	7.5	0	4	0	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0009	Amended TLC	4.5	5.5	0	NM	0	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0010	Amended TLC	4.5	4.5	0	4.5	0	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0011	Amended TLC	4.5	11	0	16	0	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0012	Amended TLC	4.5	5	0	9	0	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0013	Amended TLC	4.5	7	0	5.5	0	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0015	Amended TLC	4.5	10	0	9	0	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0016	Amended TLC	4.5	14	0	10	0	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0001	TLC	4.5	3.5	0.1	3.5	0.1	3.5	0	NA	NA	Adjacent to RA-C
	TLC	SMU 8	OL-SMU 8-CAP-0002	TLC	4.5	4.5	0.25	5	0.25	5	0.5	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0003	TLC	4.5	4.25	0	NA	NA	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0004	GAC Direct App.	0	5	0.25	4	0.25	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0005	GAC Direct App.	0	7	0	9	0	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0006	Transition Zone	4.5	7	0.25	6	0.25	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0007	Transition Zone	4.5	6	0.5	7.5	0.5	NA	NA	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0021	TLC	2	9	0.5	7.5	0.75	6.5	0.5	NA	NA	Adjacent to RA-E
	TLC	SMU 8	OL-SMU 8-CAP-0022	TLC	2	7	0.25	6.5	0.25	7.5	0	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0023	TLC	2	6.25	1	4	1	6	1.5	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0024	TLC	2	7.5	0	8.5	0	8	0	NA	NA	
	TLC	SMU 8	OL-SMU 8-CAP-0025	TLC	2	9.5	0.1	8.5	0.25	6.5	0.25	NA	NA	

[1] The design thickness is specified as an average thickness over the model area, except for the unamended TLCs adjacent to remediation areas D and E, which are specificed as a minimum thickness.

[2] Cap thickness data collected in April 2018 during cap resampling.

NA - Not applicable, core not required or collected.

Table 3.2

2018 Cap Thickness Measurements

					Design[2]/Target[3] Thickness (inches)				Measured Thickness (inches)										
Rem. Area		Zone[1]	Location ID	Cap Type	Habitat Layer	Erosion Protection Layer[4]	Chemical Isolation Layer	Total	Core A Thickness					Core B Thickness					Comment
									Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (Y/N)[5]	Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (y/n)[5]	
Remediation Area B	RA-B-1C (4 - 10 ft of Water)	2	OL-RAB-0008	MPC-Multilayer	12 / 9		9	**21 / 18**	10	17	**27**	**0**	**Y**	10	16	**26**	**0**	**Y**	
	RA-B-1C (4 - 10 ft of Water)	2	OL-RAB-0020	MPC-Multilayer	12 / 9		9	**21 / 18**	9	4	**13**	**0**	**Y**	7	20	**27**	**0**	**Y**	
	RA-B-1C (4 - 10 ft of Water)	2	OL-RAB-0024	MPC-Multilayer	12 / 9		9	**21 / 18**	9	13	**22**	**0**	**Y**	8	12	**20**	**0**	**Y**	
	RA-B-1C (4 - 10 ft of Water)	2	OL-RAB-0025	MPC-Multilayer	12 / 9		9	**21 / 18**	7	17	**24**	**0**	**Y**	4	14	**18**	**0**	**Y**	
	RA-B-1D (4 - 10 ft of Water)	2	OL-RAB-0021	MPC-Multilayer	12 / 9		4.5	**16.5 / 13.5**	3	10	**13**	**0.5**	**Y**	5	12	**17**	**1**	**Y**	
	RA-B-1D (4 - 10 ft of Water)	2	OL-RAB-0022	MPC-Multilayer	12 / 9		4.5	**16.5 / 13.5**	6	23+	**29+**	**0**	**N**	8	12	**20**	**0**	**Y**	
	RA-B-1E (4 - 10 ft of Water)	2	OL-RAB-0023	MPC-Multilayer	12 / 9		12	**24 / 21**	6	16	**22**	**0**	**Y**	9	16	**25**	**0**	**Y**	
	RA-B-1E (4 - 10 ft of Water)	2	OL-RAB-0026	MPC-Multilayer	12 / 9		12	**24 / 21**	6	8+	**14+**	**0**	**N**	5	20	**25**	**0**	**Y**	
	RA-B-1E (4 - 10 ft of Water)	2	OL-RAB-0016	MPC-Multilayer	12 / 9		12	**24 / 21**	6	15	**21**	**0**	**Y**	6	17	**23**	**0**	**Y**	
	RA-B-1E (4 - 10 ft of Water)	2	OL-RAB-0016C	MPC-Multilayer	12 / 9		12	**24 / 21**	16	15	**31**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-B-1E (4 - 10 ft of Water)	2	OL-RAB-0016D	MPC-Multilayer	12 / 9		12	**24 / 21**	5	19+	**24+**	**0**	**N**	NA	NA	**NA**	**NA**	**NA**	
	RA-B-1E (4 - 10 ft of Water)	2	OL-RAB-0016E	MPC-Multilayer	12 / 9		12	**24 / 21**	8	12	**20**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-B-1E (4 - 10 ft of Water)	2	OL-RAB-0016F	MPC-Multilayer	12 / 9		12	**24 / 21**	5	18	**23**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-B-1E (4 - 10 ft of Water)	2	OL-RAB-0016N	MPC-Multilayer	12 / 9		12	**24 / 21**	7.5	12.5	**20**	**0**	**Y**	7	18	**25**	**0**	**Y**	
Remediation Area C	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0007	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	3.5	13.5	**17**	**0**	**Y**	4	10	**14**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0007C	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	8	14	**22**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0007D	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	12	11	**23**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0007E	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	5	11	**16**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0007F	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	0	17	**17**	**1**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0007F Retake	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	0	15	**15**	**0**	**Y**	0	13	**13**	**0.5**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0007N	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	7	13	**20**	**0**	**Y**	8	12	**20**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0007S	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	7	8	**15**	**0**	**Y**	4	8	**12**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0024	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	4	8	**12**	**0.5**	**Y**	4	3	**7**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0025	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	7	7	**14**	**0**	**Y**	6	4	**10**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0026	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	6	8	**14**	**0**	**Y**	10	2	**12**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0027	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	0	11	**11**	**0.5**	**Y**	0	18	**18**	**0.5**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0027 Retake	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	2	9	**11**	**0**	**Y**	3	10	**13**	**0.25**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0028	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	4	11	**15**	**0**	**Y**	6	7	**13**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0029	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	8	8	**16**	**1.5**	**Y**	7	7+	**14+**	**1.5**	**N**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0030	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	4	10+	**14+**	**0**	**N**	5	12	**17**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0031	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	8	6	**14**	**1**	**Y**	7	10	**17**	**1**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0032	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	7	16	**23**	**0**	**Y**	7	13	**20**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0033	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	10	13+	**23+**	**0**	**N**	8	11	**19**	**0**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0034	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	10	26	**36**	**2**	**Y**	8	11	**19**	**1.5**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0035	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	9	9	**18**	**3**	**Y**	9	10	**19**	**2**	**Y**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0036	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	2	12	**14**	**0.5**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0037	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	3	9	**12**	**0.25**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	RA-C-2A (4 - 10 ft of Water)	2	OL-RAC-0038	MPC-Multilayer	10 / 7		4.5	**14.5 / 11.5**	5	11	**16**	**2.5**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	C3	2	OL-RAC-0022	Multilayer	18 / 9		12	**30 / 21**	13	23+	**36+**	**0**	**N**	14	19.5+	**33.5+**	**0**	**N**	

Table 3.2
(Continued)
2018 Cap Thickness Measurements

					Design[2]/Target[3] Thickness (inches)				Measured Thickness (inches)										
Rem. Area		Zone[1]	Location ID	Cap Type	Habitat Layer	Erosion Protection Layer[4]	Chemical Isolation Layer	Total	Core A Thickness					Core B Thickness					Comment
									Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (Y/N)[5]	Habitat Layer	Chemical Isolation Layer	Total	Overlying Sediment	Native Plug (y/n)[5]	
Remediation Area D	D-Center	2	OL-RAD-0017	Multilayer	12 / 9		12	**24 / 21**	11	19	**30**	**0**	**Y**	9	20.5	**29.5**	**0**	**Y**	
	D-Center	2	OL-RAD-0018	Multilayer	12 / 9		12	**24 / 21**	12	13	**25**	**0**	**Y**	10	12	**22**	**0**	**Y**	
	D-Center	2	OL-RAD-0026	Multilayer	12 / 9		12	**24 / 21**	13	13	**26**	**0**	**Y**	11.5	13.5	**25**	**0**	**Y**	
	D-Center	2	OL-RAD-0026 Recoring	Multilayer	12 / 9		12	**24 / 21**	12	18	**30**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	D-Center	2	OL-RAD-0029	Multilayer	18 / 9		12	**30 / 21**	14	17	**31**	**0**	**Y**	14	18	**32**	**0**	**Y**	
	D-Center	2	OL-RAD-0049	Multilayer	12 / 9		12	**24 / 21**	28	1+	**29+**	**0.5**	**N**	28	1+	**29+**	**1.5**	**N**	
	D-Center	2	OL-RAD-0050	Multilayer	12 / 9		12	**24 / 21**	21	21+	**42+**	**3**	**N**	31	2+	**22+**	**3**	**N**	
	D-West	2	OL-RAD-0022	Multilayer	18 / 9		12	**30 / 21**	12	15	**27**	**0**	**Y**	12	13.5	**25.5**	**0**	**Y**	
	D-West	2	OL-RAD-0022 Recoring	Multilayer	18 / 9		12	**30 / 21**	16	20	**36**	**0**	**Y**	14	18	**32**	**0**	**Y**	
	OL-VC-10138/40	2	OL-RAD-0024	Multilayer	12 / 9		12	**24 / 21**	10.5	22.5	**33**	**0**	**Y**	14	12+	**26+**	**0**	**N**	
	OL-VC-10138/40	2	OL-RAD-0048	Multilayer	18 / 9		12	**30 / 21**	31	11+	**42+**	**0**	**N**	30	20+	**50+**	**0**	**N**	
	D-East	1	OL-RAD-0047	Multilayer	12 / 9		12	**24 / 21**	NA	45	**45**	**2**	**Y**	NA	46	**46**	**2**	**Y**	
Remediation Area E	E-2	2	OL-RAE-0040	Multilayer	12 / 9		12	**24 / 21**	14	26	**40**	**0**	**Y**	12	27	**39**	**0**	**Y**	
	E-3	2	OL-RAE-0023	Multilayer	12 / 9		12	**24 / 21**	29	22	**51**	**0**	**Y**	15	17	**32**	**0**	**Y**	
	E-3	2	OL-RAE-0023 Recoring	Multilayer	12 / 9		12	**24 / 21**	25	17	**42**	**0**	**Y**	NA	NA	**NA**	**NA**	**NA**	
	E-3	2	OL-RAE-0029	Multilayer	12 / 9		12	**24 / 21**	14.5	15.5	**30**	**0**	**Y**	14	15	**29**	**3**	**Y**	
	E-3	2	OL-RAE-0029 Recoring	Multilayer	12 / 9		12	**24 / 21**	41+		**41+**	**0**	**N**	NA	NA	**NA**	**NA**	**NA**	
	MERC[6]	NA	OL-RAE-0047	Monolayer	NA		NA	**6**	NA	11	**11**	**1**	**Y**	NA	10	**10**	**0**	**Y**	
	MERC[6]	NA	OL-RAE-0048	Monolayer	NA		NA	**6**	NA	7	**7**	**2**	**Y**	NA	11	**11**	**1**	**Y**	

Measured thickness is less than the minimum target thickness specified in the OLMMP.

[1] The coarsest substrates in Zones 1, 2, and 3 are sand, fine gravel and coarse gravel/cobble, respectively.
[2] Design thickness specified as a minimum.
[3] Listed thickness is the target minimum thickness specified in the OLMMP
[4] When the habitat and erosion protection layer are the same substrate, the total thickness of this habitat/erosion protection layer is listed under the habitat layer.
[5] The presence of a plug of native sediment in the bottom of the core indicates the core fully penetrated the cap material, allowing measurement of the total cap thickness.
[6]Design thickness for MERC monolayer caps is specified as an average thickness over the cap area.
NA - Not applicable

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Table 4.1
2017 Cap Monitoring Exceedances

Station	Contaminant	Depth (in)	Cap Layer	Measured Result		Units	Calculated Result		Units	Criteria	Units	Notes
OL-RAA-CAP-0018	Mercury	3-6	H	0.047		mg/kg	NA			0.15	mg/kg	Topsoil in Ninemile Creek spits. Mercury criteria for the spits is 0.15 mg/kg consistent with the Ninemile Creek remedy rather than 2.2 mg/kg which applies to the cap throughout the lake. May have been impacted by adjacent sediments during construction. No CI sample. The exceedance was from a sample at the bottom of the habitat layer below the majority of the ecological exposure for the area.
		18-21	H	0.353		mg/kg	NA			0.15	mg/kg	
OL-RAA-CAP-0011	Benzo(a)pyrene	3-6	H	200		ug/kg	NA			146	ug/kg	Topsoil. No CI layer sample. The concentration in the upper sample was greater than the concentration in the lower sample, indicating exceedance is not due to chemical migration. Exceedance likely due to topsoil source.
		11.5-14.5	H	76		ug/kg	NA			146	ug/kg	
OL-RAA-CAP-0014	Toluene	3-6	H	1500		ug/kg	546		ug/L	480	ug/L	Topsoil. No CI layer sample. The concentration in the upper sample was greater than the concentration in the lower sample, indicating exceedance is not due to chemical migration. Resampled in April 2018 and concentrations were very low.
		11-14	H	180		ug/kg	62		ug/L	480	ug/L	
		3-6 (2018 resample)	H	3.6	J	ug/kg	1.3	J	ug/L	480	ug/L	
		7.5-10.5 (2018 resample)	H	3.7	J	ug/kg	1.3	J	ug/L	480	ug/L	
OL-RAA-CAP-0016	Toluene	3-6	H	150	J	ug/kg	44	J	ug/L	480	ug/L	Topsoil. No CI layer sample. Resampled in April 2018 and results did not exceed criteria.
		10-13	H	2100		ug/kg	650		ug/L	480	ug/L	
		3-6 (2018 resample)	H	110		ug/kg	32		ug/L	480	ug/L	
		10.5-13.5 (2018 resample)	H	1100	J	ug/kg	341	J	ug/L	480	ug/L	
OL-RAB-CAP-0006	Toluene	3-6	H	2000		ug/kg	844		ug/L	480	ug/L	Topsoil. No CI layer sample. The concentration in the upper sample was greater than the concentration in the lower sample, indicating exceedance is not due to chemical migration. Resampled in April 2018 and concentrations were very low.
		18.5-21.5	H	0.87	J	ug/kg	2.2	J	ug/L	480	ug/L	
		3-6 (2018 resample)	H	8.6	U	ug/kg	3.7	U	ug/L	480	ug/L	
		18-25 (2018 resample)	H	4.4	J	ug/kg	11.2	J	ug/L	480	ug/L	
OL-RAD-CAP-0010-H	Phenol	3-6	H	17	U	ug/kg	531	U	ug/L	250	ug/L	The listed porewater sample result of 7.1 ug/L in the CI layer was determined to be not usable (NU) due to high turbidity which biased the results high. However, even with this high bias, the concentration in the CI layer was less than the concentration in the H layer, indicating exceedance in the H layer is likely not due to chemical migration.
		9-12	H	15	J	ug/kg	268	J	ug/L	250	ug/L	
		12-15	CI	7.1	NU	ug/L	NA			250	ug/L	
OL-RAD-CAP-0022-H	Phenol	9-12	H	20		ug/kg	333		ug/L	250	ug/L	Sampling port. Phenol slightly exceeded the cap criteria in the 9 to 12 inch sampling interval, which was the only interval sampled at this location. Sampling ports could not be sampled via coring at all intervals due to the condition of the sampling ports. As detailed in Attachment F of Appendix D of the final OLMMP, it is uncertain whether 12 inches of sand H layer is present in any of the sample ports. Therefore, the solid phase sample may have contained GAC with sorbed phase phenol, which would result in a falsely-high calculated porewater concentration.
OL-RAE-CAP-0034-H	Toluene	3-6	H	0.79	J	ug/L	NA			480	ug/L	Peeper. Toluene exceeded the criteria in the lower (15 to 18 inch) H layer sample and was detected at a slightly lower concentration in the CI layer. This result is considered anomalous because the maximum underlying sediment porewater toluene concentration measured in this area during the PDI was more than an order of magnitude lower than what was measured in the cap porewater sample. Toluene was detected at a very low level, and well below the cap criteria, in the upper (3 to 6 inch) H layer where there would be potential for greater exposure.
		15-18	H	550		ug/L	NA			480	ug/L	
		18-21	CI	484		ug/L	NA			480	ug/L	

H - Habitat
CI - Chemical Isolation
NA - Not applicable
U - Undetected at the listed detection limit

J - Estimated value
NU - Not usable
[shaded cell] Measured concentration exceeds cap H layer criteria

Table 4.2
2018 Cap Monitoring Exceedances

Station	Contaminant	Depth (in)	Cap Layer	Measured Result		Units	Calculated Results		Units	Criteria	Units	Notes
OL-RAD-CAP-0026	Toluene	3-6	H	0.22	U	ug/L	NA			480	ug/L	Peeper. Exceedances in lower (9" to 12") H layer sample in June 2018. The concentration in the CI layer was less than the concentration in the H layer, indicating exceedance in the H layer is not due to chemical migration. This location was resampled in October 2018 and toluene was not detected in any habitat or chemical isolation layer samples using 2 labs (< 1 ug/L).
		9-12	H	1760		ug/L	NA			480	ug/L	
		12-15	CI	121		ug/L	NA			480	ug/L	
OL-RAE-CAP-0023-H	Toluene	3-6	H	0.22	U	ug/L	NA			480	ug/L	Peeper. Exceedances in lower (9" to 12") H layer sample in June 2018. The concentration in the CI layer was less than the concentration in the H layer, indicating exceedance in the H layer is not due to chemical migration. This location was resampled in October 2018 and toluene was not detected in any habitat or chemical isolation layer samples using 2 labs (< 1 ug/L).
		9-12	H	1320		ug/L	NA			480	ug/L	
		12-15	CI	132		ug/L	NA			480	ug/L	

H - Habitat
CI - Chemical Isolation
NA - Not applicable
U - Undetected at the listed detection limit
J - Estimated value
(shaded) Measured concentration exceeds cap H layer criteria

Table 5.1
Mercury Results for 2017 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	Dissolved Mercury[1,2]		Total Mercury		Methylmercury	
Pre-Turnover	North Deep	09/21/2017	6.0	ng/L	0.11	J	0.48	J	0.11	
	South Deep	09/21/2017	6.0	ng/L	0.08	J	0.43	J	0.11	J
	OL-RAA-SW-01	09/21/2017	1.5	ng/L	0.10	J	2.29		0.21	
	OL-RAB-SW-01	09/21/2017	1.5	ng/L	0.10	J	0.52		0.07	
	OL-RAB-SW-02	09/21/2017	1.5	ng/L	0.21	J	0.71		0.06	
	OL-RAC-SW-01	09/21/2017	1.5	ng/L	0.08	U	0.53		0.11	
	OL-RAC-SW-02	09/21/2017	1.5	ng/L	0.10	J	1.16		0.09	
	OL-RAD-SW-01	09/21/2017	1.5	ng/L	0.08	J	0.50		0.10	
	OL-RAD-SW-02	09/21/2017	1.5	ng/L	0.08	U	1.07		0.10	
	OL-RAE-SW-01	09/21/2017	1.0	ng/L	0.22	J	1.11		0.16	
	OL-RAE-SW-02	09/21/2017	1.5	ng/L	0.14	J	0.59		0.11	
	OL-RAE-SW-03	09/21/2017	1.5	ng/L	0.20	J	0.64		0.13	
Post-Turnover	North Deep	11/13/2017	1.5	ng/L	0.25	J	1.24		0.04	J
	South Deep	11/13/2017	1.5	ng/L	0.24	J	1.40		0.06	
	OL-RAA-SW-01	11/13/2017	1.5	ng/L	0.27	J	1.75		0.11	
	OL-RAB-SW-01	11/13/2017	1.5	ng/L	0.25	J	1.23		0.05	
	OL-RAB-SW-02	11/13/2017	1.5	ng/L	0.29	J	0.58		0.05	
	OL-RAC-SW-01	11/13/2017	1.5	ng/L	0.25	J	1.07		0.06	
	OL-RAC-SW-02	11/13/2017	1.5	ng/L	0.29	J	0.96		0.05	J
	OL-RAD-SW-01	11/13/2017	1.5	ng/L	0.25	J	1.27		0.05	
	OL-RAD-SW-02	11/13/2017	1.5	ng/L	0.25	J	1.27		0.05	J
	OL-RAE-SW-01	11/13/2017	1.0	ng/L	0.37	J	1.44		0.03	U
	OL-RAE-SW-02	11/13/2017	1.5	ng/L	0.24	J	1.11		0.04	J
	OL-RAE-SW-03	11/30/2017	1.5	ng/L	0.29	J	1.07		0.20	

Notes:
1. Goal for dissolved mercury concentrations for the protection of wildlife is 2.6 ng/L or lower
2. Goal for dissolved mercury concenrtations for human health via fish consumption is 0.7 ng/L or lower
U: not detected at specified reporting limit
J: estimated concentration

Table 5.2
Mercury Results for 2018 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	Dissolved Mercury[1,2]		Total Mercury		Methylmercury	
Pre-Turnover	North Deep	09/20/2018	6.6	ng/L	0.18	J	0.98	J	0.026	UJ
	South Deep	09/20/2018	6.6	ng/L	0.12	J	0.43	J	0.033	J
	OL-RAA-SW-01	09/20/2018	0.33	ng/L	0.26	J	1.00		0.090	
	OL-RAB-SW-01	09/20/2018	1.65	ng/L	0.16	J	0.88		0.043	J
	OL-RAB-SW-02	09/20/2018	1.65	ng/L	0.18	J	0.59		0.111	
	OL-RAC-SW-01	09/20/2018	1.65	ng/L	0.16	J	0.44	J	0.026	U
	OL-RAC-SW-02	09/20/2018	1.65	ng/L	0.26	J	0.66		0.070	
	OL-RAD-SW-01	09/20/2018	1.65	ng/L	0.20	J	0.77		0.047	J
	OL-RAD-SW-02	09/20/2018	1.65	ng/L	0.15	J	1.04		0.029	J
	OL-RAE-SW-01	09/20/2018	0.66	ng/L	0.34	J	1.80		0.154	
	OL-RAE-SW-02	09/20/2018	1.65	ng/L	0.19	J	1.34		0.083	
	OL-RAE-SW-03	09/20/2018	1.65	ng/L	0.22	J	0.64		0.064	
Post-Turnover	North Deep	11/08/2018	6.6	ng/L	0.34	J	1.27		0.026	U
	South Deep	11/08/2018	6.6	ng/L	0.30	J	1.24		0.026	U
	OL-RAA-SW-01	11/08/2018	1.65	ng/L	0.40	J	1.65		0.070	
	OL-RAB-SW-01	11/08/2018	1.65	ng/L	0.24	J	0.79		0.026	U
	OL-RAB-SW-02	11/08/2018	0.99	ng/L	0.22	J	0.72		0.026	U
	OL-RAC-SW-01	11/08/2018	1.65	ng/L	0.20	J	0.96		0.026	U
	OL-RAC-SW-02	11/08/2018	1.65	ng/L	0.20	J	0.85		0.026	U
	OL-RAD-SW-01	11/08/2018	1.65	ng/L	0.22	J	0.87		0.026	U
	OL-RAD-SW-02	11/08/2018	1.65	ng/L	0.20	J	0.69		0.026	U
	OL-RAE-SW-01	11/08/2018	1.65	ng/L	0.22	J	0.58		0.026	U
	OL-RAE-SW-02	11/08/2018	1.65	ng/L	0.40	J	2.88		0.026	U
	OL-RAE-SW-03	11/08/2018	1.65	ng/L	0.32	J	2.35		0.045	J

Notes:
1. Goal for dissolved mercury concentrations for the protection of wildlife is 2.6 ng/L or lower
2. Goal for dissolved mercury concenrtations for human health via fish consumption is 0.7 ng/L or lower
3. U: not detected at specified reporting limit
4. J: estimated concentration

Honeywell

Table 6.1
VOC and SVOC Results for 2017 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	1,2,3-TRICHLOROBENZENE		1,3,5-TRICHLOROBENZENE		BENZENE		CHLOROBENZENE	
Surface Water Quality Standards/Guidance Values				ug/L	**5**		**5**		**10** [1]		**5** [1]	
Pre-Turnover	North Deep	09/21/2017	6.0	ug/L	5	U	5	U	1	U	1	U
	South Deep	09/21/2017	6.0	ug/L	5	U	5	U	1	U	1	U
	OL-RAA-SW-01	09/21/2017	1.5	ug/L	5	U	5	U	1	U	1	U
	OL-RAB-SW-01	09/21/2017	1.5	ug/L	5	U	5	U	1	U	1	U
	OL-RAB-SW-02	09/21/2017	1.5	ug/L	5	U	5	U	1	U	1	U
	OL-RAC-SW-01	09/21/2017	1.5	ug/L	5	U	5	U	1	U	1	U
	OL-RAC-SW-02	09/21/2017	1.5	ug/L	5	U	5	U	1	U	1	U
	OL-RAD-SW-01	09/21/2017	1.5	ug/L	5	U	5	U	1	U	1	U
	OL-RAD-SW-02	09/21/2017	1.5	ug/L	5	U	5	U	1	U	1	U
	OL-RAE-SW-01	09/21/2017	1.0	ug/L	5	U	5	U	1	U	1	U
	OL-RAE-SW-02	09/21/2017	1.5	ug/L	5	U	5	U	1	U	1	U
	OL-RAE-SW-03	09/21/2017	1.5	ug/L	5	U	5	U	1	U	1	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.

U: not detected at specified reporting limit

J: estimated concentration

Table 6.1
(Continued)
VOC and SVOC Results for 2017 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	ETHYLBENZENE		O-XYLENE		M&P-XYLENE		TOLUENE		XYLENES, TOTAL	
Surface Water Quality Standards/Guidance Values				ug/L	**17 [1]**		**65 [1]**		**65 [1]**		**100 [1]**		**65 [1]**	
Pre-Turnover	North Deep	09/21/2017	6.0	ug/L	1	U	1	U	1	U	1	U	1	U
	South Deep	09/21/2017	6.0	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAA-SW-01	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAB-SW-01	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAB-SW-02	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAC-SW-01	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAC-SW-02	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAD-SW-01	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAD-SW-02	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAE-SW-01	09/21/2017	1.0	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAE-SW-02	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U	1	U
	OL-RAE-SW-03	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U	1	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.

U: not detected at specified reporting limit

J: estimated concentration

Table 6.1
(Continued)
VOC and SVOC Results for 2017 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	1,2,4-TRICHLOROBENZENE		1,2-DICHLOROBENZENE		1,3-DICHLOROBENZENE		1,4-DICHLOROBENZENE	
Surface Water Quality Standards/Guidance Values				ug/L	**5** [1]		**5** [1]		**5** [1]		**5** [1]	
Pre-Turnover	North Deep	09/21/2017	6.0	ug/L	1	U	1	U	1	U	1	U
	South Deep	09/21/2017	6.0	ug/L	1	U	1	U	1	U	1	U
	OL-RAA-SW-01	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U
	OL-RAB-SW-01	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U
	OL-RAB-SW-02	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U
	OL-RAC-SW-01	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U
	OL-RAC-SW-02	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U
	OL-RAD-SW-01	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U
	OL-RAD-SW-02	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U
	OL-RAE-SW-01	09/21/2017	1.0	ug/L	1	U	1	U	1	U	1	U
	OL-RAE-SW-02	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U
	OL-RAE-SW-03	09/21/2017	1.5	ug/L	1	U	1	U	1	U	1	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.

U: not detected at specified reporting limit

J: estimated concentration

Table 6.1
(Continued)
VOC and SVOC Results for 2017 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	ACENAPHTHENE		ANTHRACENE		BENZO(A)ANTHRACENE		BENZO(A)PYRENE	
Surface Water Quality Standards/Guidance Values				ug/L	**5.3** [1]		**3.8** [1]		**0.03** [1]		**0.0012** [1]	
Pre-Turnover	North Deep	09/21/2017	6.0	ug/L	0.51	U	0.51	U	0.51	U	0.51	U
	South Deep	09/21/2017	6.0	ug/L	0.51	U	0.51	U	0.51	U	0.51	U
	OL-RAA-SW-01	09/21/2017	1.5	ug/L	0.52	U	0.52	U	0.52	U	0.52	U
	OL-RAB-SW-01	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	0.51	U
	OL-RAB-SW-02	09/21/2017	1.5	ug/L	0.52	U	0.52	U	0.52	U	0.52	U
	OL-RAC-SW-01	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	0.51	U
	OL-RAC-SW-02	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	0.51	U
	OL-RAD-SW-01	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	0.51	U
	OL-RAD-SW-02	09/21/2017	1.5	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAE-SW-01	09/21/2017	1.0	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAE-SW-02	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	0.51	U
	OL-RAE-SW-03	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	0.51	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.

U: not detected at specified reporting limit

J: estimated concentration

Table 6.1
(Continued)
VOC and SVOC Results for 2017 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	FLUORENE		NAPHTHALENE		PHENANTHRENE		PHENOL		PYRENE	
Surface Water Quality Standards/Guidance Values				ug/L	**0.54** [1]		**13** [1]		**5** [1]		**5**		**4.6** [1]	
Pre-Turnover	North Deep	09/21/2017	6.0	ug/L	0.51	U	0.51	U	0.51	U	1	U	0.51	U
	South Deep	09/21/2017	6.0	ug/L	0.51	U	0.51	U	0.51	U	1	U	0.51	U
	OL-RAA-SW-01	09/21/2017	1.5	ug/L	0.52	U	0.52	U	0.52	U	1	U	0.52	U
	OL-RAB-SW-01	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	1	U	0.51	U
	OL-RAB-SW-02	09/21/2017	1.5	ug/L	0.52	U	0.52	U	0.52	U	1	U	0.52	U
	OL-RAC-SW-01	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	1	U	0.51	U
	OL-RAC-SW-02	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	1	U	0.51	U
	OL-RAD-SW-01	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	1	U	0.51	U
	OL-RAD-SW-02	09/21/2017	1.5	ug/L	0.5	U	0.5	U	0.5	U	1	U	0.5	U
	OL-RAE-SW-01	09/21/2017	1.0	ug/L	0.5	U	0.5	U	0.5	U	1	U	0.5	U
	OL-RAE-SW-02	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	1	U	0.51	U
	OL-RAE-SW-03	09/21/2017	1.5	ug/L	0.51	U	0.51	U	0.51	U	1	U	0.51	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.

U: not detected at specified reporting limit

J: estimated concentration

Honeywell

Table 6.2
VOC and SVOC Results for 2018 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	1,2,3-TRICHLOROBENZENE		1,3,5-TRICHLOROBENZENE		BENZENE		CHLOROBENZENE	
Surface Water Quality Standards/Guidance Values				ug/L	**5**		**5**		**10** [1]		**5** [1]	
Pre-Turnover	North Deep	09/14/2018	6.6	ug/L	5	U	5	U	1	U	1	U
	South Deep	09/14/2018	6.6	ug/L	5	U	5	U	1	U	1	U
	OL-RAA-SW-01	09/14/2018	0.66	ug/L	5	U	5	U	0.2	J	0.3	J
	OL-RAB-SW-01	09/14/2018	1.65	ug/L	5	U	5	U	1	U	1	U
	OL-RAB-SW-02	09/14/2018	1.65	ug/L	5	U	5	U	1	U	1	U
	OL-RAC-SW-01	09/14/2018	1.65	ug/L	5	U	5	U	1	U	1	U
	OL-RAC-SW-02	09/14/2018	1.65	ug/L	5	U	5	U	1	U	1	U
	OL-RAD-SW-01	09/14/2018	1.65	ug/L	5	U	5	U	1	U	1	U
	OL-RAD-SW-02	09/14/2018	1.65	ug/L	5	U	5	U	1	U	1	U
	OL-RAE-SW-01	09/14/2018	0.99	ug/L	5	U	5	U	1	U	1	U
	OL-RAE-SW-02	09/14/2018	1.65	ug/L	5	U	5	U	1	U	1	U
	OL-RAE-SW-03	09/14/2018	2.31	ug/L	5	U	5	U	1	U	1	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.
U: not detected at specified reporting limit
J: estimated concentration

PARSONS

Table 6.2
(Continued)
VOC and SVOC Results for 2018 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	ETHYLBENZENE		O-XYLENE		M&P-XYLENE		TOLUENE		XYLENES, TOTAL	
Surface Water Quality Standards/Guidance Values				ug/L	**17** [1]		**65** [1]		**65** [1]		**100** [1]		**65** [1]	
Pre-Turnover	North Deep	09/14/2018	6.6	ug/L	1	U	1	U	5	U	1	U	5	U
	South Deep	09/14/2018	6.6	ug/L	1	U	1	U	5	U	1	U	5	U
	OL-RAA-SW-01	09/14/2018	0.66	ug/L	1	U	1	U	5	U	1	U	5	U
	OL-RAB-SW-01	09/14/2018	1.65	ug/L	1	U	1	U	5	U	1	U	5	U
	OL-RAB-SW-02	09/14/2018	1.65	ug/L	1	U	1	U	5	U	1	U	5	U
	OL-RAC-SW-01	09/14/2018	1.65	ug/L	1	U	1	U	5	U	1	U	5	U
	OL-RAC-SW-02	09/14/2018	1.65	ug/L	1	U	1	U	5	U	1	U	5	U
	OL-RAD-SW-01	09/14/2018	1.65	ug/L	1	U	1	U	5	U	1	U	5	U
	OL-RAD-SW-02	09/14/2018	1.65	ug/L	1	U	1	U	5	U	1	U	5	U
	OL-RAE-SW-01	09/14/2018	0.99	ug/L	1	U	1	U	5	U	0.3	J	5	U
	OL-RAE-SW-02	09/14/2018	1.65	ug/L	1	U	1	U	5	U	1	U	5	U
	OL-RAE-SW-03	09/14/2018	2.31	ug/L	1	U	1	U	5	U	1	U	5	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.
U: not detected at specified reporting limit
J: estimated concentration

Table 6.2
(Continued)
VOC and SVOC Results for 2018 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	1,2,4-TRICHLOROBENZENE		1,2-DICHLOROBENZENE		1,3-DICHLOROBENZENE		1,4-DICHLOROBENZENE	
Surface Water Quality Standards/Guidance Values				ug/L	**5** [1]		**5** [1]		**5** [1]		**5** [1]	
Pre-Turnover	North Deep	09/14/2018	6.6	ug/L	2	U	2	U	2	U	2	U
	South Deep	09/14/2018	6.6	ug/L	2	U	2	U	2	U	2	U
	OL-RAA-SW-01	09/14/2018	0.66	ug/L	2	U	2	U	2	U	2	U
	OL-RAB-SW-01	09/14/2018	1.65	ug/L	2	U	2	U	2	U	2	U
	OL-RAB-SW-02	09/14/2018	1.65	ug/L	2	U	2	U	2	U	2	U
	OL-RAC-SW-01	09/14/2018	1.65	ug/L	2	U	2	U	2	U	2	U
	OL-RAC-SW-02	09/14/2018	1.65	ug/L	2	U	2	U	2	U	2	U
	OL-RAD-SW-01	09/14/2018	1.65	ug/L	2	U	2	U	2	U	2	U
	OL-RAD-SW-02	09/14/2018	1.65	ug/L	2	U	2	U	2	U	2	U
	OL-RAE-SW-01	09/14/2018	0.99	ug/L	2	U	2	U	2	U	2	U
	OL-RAE-SW-02	09/14/2018	1.65	ug/L	2	U	2	U	2	U	2	U
	OL-RAE-SW-03	09/14/2018	2.31	ug/L	2	U	2	U	2	U	2	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.
U: not detected at specified reporting limit
J: estimated concentration

Table 6.2
(Continued)
VOC and SVOC Results for 2018 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	ACENAPHTHENE		ANTHRACENE		BENZO(A)ANTHRACENE		BENZO(A)PYRENE	
Surface Water Quality Standards/Guidance Values				ug/L	**5.3** [1]		**3.8** [1]		**0.03** [1]		**0.0012** [1]	
Pre-Turnover	North Deep	09/14/2018	6.6	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	South Deep	09/14/2018	6.6	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAA-SW-01	09/14/2018	0.66	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAB-SW-01	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAB-SW-02	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAC-SW-01	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAC-SW-02	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAD-SW-01	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAD-SW-02	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAE-SW-01	09/14/2018	0.99	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAE-SW-02	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	0.5	U
	OL-RAE-SW-03	09/14/2018	2.31	ug/L	0.5	U	0.5	U	0.5	U	0.5	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.
U: not detected at specified reporting limit
J: estimated concentration

Table 6.2
(Continued)
VOC and SVOC Results for 2018 Surface Water Compliance Sampling

Period	Location	Sample Date	Sample Depth (ft)	Units	FLUORENE		NAPHTHALENE		PHENANTHRENE		PHENOL		PYRENE	
Surface Water Quality Standards/Guidance Values				ug/L	**0.54 [1]**		**13 [1]**		**5 [1]**		**5**		**4.6 [1]**	
Pre-Turnover	North Deep	09/14/2018	6.6	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	South Deep	09/14/2018	6.6	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAA-SW-01	09/14/2018	0.66	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAB-SW-01	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAB-SW-02	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAC-SW-01	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAC-SW-02	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAD-SW-01	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAD-SW-02	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAE-SW-01	09/14/2018	0.99	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAE-SW-02	09/14/2018	1.65	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U
	OL-RAE-SW-03	09/14/2018	2.31	ug/L	0.5	U	0.5	U	0.5	U	2	U	0.5	U

1. Lowest SWQS as presented on Table 5.1 of the OLMMP.
U: not detected at specified reporting limit
J: estimated concentration

Table 7
Summary of Surface Water Total PCB Concentrations in 2017 and 2018

Total PCBs in Onondaga Lake (ng/L)				
Location	2017		2018	
	Pre	Post	Pre	Post
DEEP_N	0.46	1.16	0.36	1.07
DEEP_S	0.44	1.93	0.54	1.06
OL-RAA-SW-01	0.97	0.43	0.36	0.39
OL-RAB-SW-01	0.93	1.62	0.33	0.83
OL-RAB-SW-02	0.74	0.83	0.17	0.63
OL-RAC-SW-01	0.43	1.76	0.36	0.90
OL-RAC-SW-02	1.77	1.27	1.19	0.82
OL-RAD-SW-01	0.67	1.64	0.13	0.86
OL-RAD-SW-02	0.44	2.01	0.15	0.72
OL-RAE-SW-01	0.75	1.10	1.14	0.62
OL-RAE-SW-02	1.31	2.47	0.90	1.08
OL-RAE-SW-03	4.91	1.17	2.60	5.44
Average	1.15	1.45	0.69	1.20

Notes:
1. When calculating Total PCBs, ND=0
2. Goals for PCB concentration of 0.12 ng/L for the Protection of Wildlife and 0.001 ng/L for the protection of human health via fish consumption

TABLE 8

2014 & 2017 SMU 8 MERCURY CONCENTRATIONS INCLUDING COMPARISON OF PREDICTED AND ACTUAL 2017 SMU 8 SURFACE (0 to 4 cm) SEDIMENT MERCURY CONCENTRATIONS

Location ID (North to South)	Measured 2014 Sediment Concentration (mg/kg)		Measured 2017 Sediment Concentration (mg/kg)		2017 Model Predicted Value (mg/kg)
	0 to 4 cm	4 to 10 cm	0 to 4 cm	4 to 10 cm	0 to 4 cm
North Basin					
OL-STA-80068	0.71	1.4	0.57	1.19	1.0 – 1.02
OL-STA-80069	0.71	1.2	0.66	1.23	1.05 – 1.12
OL-STA-80225	0.65	1.1	0.70	1.06	NA
OL-VC-80157	0.66	1.48	0.58	1.16	1.07 – 1.16
Ninemile Creek Outlet Area					
OL-STA-80073	0.87	1.5	0.44	1.09	1.4 – 1.42
OL-STA-80226	0.94	1.5	1.12	1.29	NA
OL-STA-80227	1.2	1.5	0.78	1.40	NA
Saddle					
OL-STA-80075	0.69	1.2	0.55	0.98	1.46 – 1.55
OL-STA-80103	0.96	1.95	0.62	1.39	1.43 – 1.44
OL-STA-80234	0.69	1.4	1.04	2.26	NA
South Basin					
OL-STA-80076	0.93	0.81	0.57	1.4	1.44 – 1.47
OL-STA-80078	1	1.7	0.80	0.93	1.45 – 1.52
OL-STA-80080	0.8	1.75	0.91	1.43	1.44 – 1.48
OL-STA-80082	0.94	1.6	0.81	1.66	1.46 – 1.54
OL-STA-80084	1.15	1.1	0.82	1.66	1.48 – 1.6
OL-STA-80229	0.82	1.3	0.70	1.46	NA
South Corner					
OL-STA-80085	1.26	1.6	0.50	1.01	1.93 – 1.95
OL-STA-80236	NA	NA	1.40	2.01	NA
OL-STA-80237	NA	NA	0.41	0.23	NA
OL-STA-80238	NA	NA	0.44	2.55	NA
OL-VC-80172	1.2	1.8	1.07	1.36	1.77 – 1.87
OL-VC-80177	1.25	1.7	0.69	1.45	1.84 – 1.89

Notes:

1 - Sediment concentrations are in milligrams per kilogram (mg/kg). For the 2014 event, concentrations are averages of data from the 0 to 2 cm and 2 to 4 cm intervals.

2 - The MNR model in the design (Parsons et al. 2012) simulates surface mercury concentrations at specific SMU 8 locations. For locations not included in the final design, an NA is indicated.

3 - Predicted concentration ranges are based on the MNR model applied in the design for two different sedimentation rates and a four centimeter mixing depth.

TABLE 9

PERCENT REDUCTIONS IN SMU 8 SEDIMENT MERCURY CONCENTRATIONS (0 to 4 cm) FROM PDI TO 2017

Location ID (North to South)	Most Recent (nearby station)	Initial Concentration (mg/kg)	Measured 2014 Sediment Concentration (mg/kg)	Measured 2017 Sediment Concentration (mg/kg)	2017 Model Predicted Value (mg/kg)	Percent Reduction in Measured Concentration By Location	Percent Reduction By Zone
		0 to 4 cm	0 to 4 cm	0 to 4 cm	0 to 4 cm		
North Basin							
OL-STA-80068		0.84 (2008)	0.71	0.57	1.0-1.02	32%	38%
OL-STA-80069		1.2 (2007)	0.71	0.66	1.05-1.12	45%	
OL-STA-80225	OL-VC-80199	0.87 (2010)	0.65	0.70	NA	20%	
OL-VC-80157		1.3 (2010)	0.66	0.58	1.07-1.16	54%	
Ninemile Creek Outlet Area							
OL-STA-80073		1.3 (2008)	0.87	0.44	1.4-1.42	69%	61%
OL-STA-80226	OL-STA-80160	2.4 (2010)	0.94	1.12	NA	54%	
OL-STA-80227	OL-VC-80161	2.0 (2010)	1.2	0.78	NA	60%	
Saddle							
OL-STA-80075		1.7 (2007)	0.69	0.55	1.46-1.55	68%	51%
OL-STA-80103		1.4 (2008)	0.96	0.62	1.43-1.44	56%	
OL-STA-80234	OL-VC-80103	1.4 (2008)	0.69	1.0	NA	29%	
South Basin							
OL-STA-80076		1.4 (2008)	0.93	0.57	1.44-1.47	59%	55%
OL-STA-80078		1.6 (2007)	1.0	0.80	1.45-1.52	50%	
OL-STA-80080		1.5 (2007)	0.80	0.91	1.44-1.48	39%	
OL-STA-80082		1.7 (2007)	0.94	0.81	1.46-1.54	52%	
OL-STA-80084		1.9 (2007)	1.2	0.82	1.48-1.6	57%	
OL-STA-80229	OL-VC-80168	2.3 (2010)	0.82	0.70	NA	70%	
South Corner							
OL-STA-80085		1.9 (2007)	1.3	0.50	1.93-1.95	74%	60%
OL-STA-80236	OL-STA-80088	2.3 (2007)	NA	1.40	NA	39%	
OL-STA-80237	OL-VC-80184	2.3 (2010)	NA	0.41	NA	82%	
OL-STA-80238	OL-VC-80197	3.4 (2010)	NA	0.44	NA	87%	
OL-VC-80172		1.4 (2010)	1.2	1.1	1.77-1.87	21%	
OL-VC-80177		1.6 (2010)	1.3	0.69	1.84-1.89	57%	

Notes:

1 - Sediment concentrations are in milligrams per kilogram (mg/kg). For the 2014 event, concentrations are averages of data from the 0 to 2 cm and 2 to 4 cm intervals

2 - The MNR model in the design (Parsons et al. 2012) simulates surface mercury concentrations at specific SMU 8 locations. For locations not included in the final design, an NA is indicated.

3 - Predicted concentration ranges are based on the MNR model applied in the design for two different sedimentation rates and a four centimeter mixing depth.

4 - Percent reductions were calculated from PDI concentrations rounded to two significant digits and 2017 measured concentrations rounded to two significant digits.

TABLE 10
SURFACE SEDIMENT AREA-WEIGHTED AVERAGE MERCURY CONCENTRATION

Sub-Basin	Model-Predicted Surface Sediment Area-Weighted Average Mercury Concentration (2017) (mg/kg)	Calculated Surface Sediment Area-Weighted Average Mercury Concentration (mg/kg)	
		Method 1	Method 2
North Basin	0.92	0.75	0.79
Ninemile Creek Outlet Area	0.79	0.53	0.47
Saddle	0.96	0.67	0.57
South Basin	1.08	0.70	0.64
South Corner	0.89	0.54	0.54

Notes:

1. Model-predicted surface sediment area-weighted average mercury concentrations are reported for the end of 2017.
2. Method 1 relied on the 2017 SMU 8 surface sediment samples only to calculate area-weighted average concentrations in the SMU 8 portion of each sub-basin.
3. Method 2 supplements the 2017 data from the 22 locations in SMU 8 along with the SMU 8 data from the final design and assigned a mercury concentration to each location not sampled in 2017 based on a percent reduction that has occurred since that time.

TABLE 11

SUMMARY OF SMU 8 FROZEN CORE OBSERVATIONS (2014, 2015 and 2017)

Location	Water Depth (ft)	Year	Depth to First Varve / Layer (cm) Based on Observations of Frozen Cores	Depth to Sand Microbead Marker (cm)[1, 2]	Approximate Sedimentation Rate based on microbead depth (cm per year)	Approximate Sedimentation Rate based on microbead depth (g per cm^2 per year)
North Basin						
OL-MB-80094-14-01	54	2014	0.5	NA	NA	NA
OL-MB-80069-14-01	51	2014	7	7	1	0.24
OL-MB-80094-15-01	50.3	2015	NA	2.7	0.45	0.11
OL-MB-80094-15-02	50.3	2015	NA	2-7.5[3]	0.33, 1.25	0.08, 0.30
East-01-10-15	32.7	2015	4	NA	NA	NA
East-01-13-15	43.4	2015	1.5	NA	NA	NA
East-01-15-15	49.1	2015	1.5	NA	NA	NA
East-01-DEEP-15	59.3	2015	2.5	NA	NA	NA
OL-MB-80093-A	47	2017	0.4	3.5	0.44	0.11
OL-MB-80093-B	45	2017	1	1.5	0.19	0.05
OL-MB-80094-A	56	2017	2.5	3	0.38	0.09
OL-MB-80094-B	56	2017	0.7	1.2	0.15	0.04
OL-MB-80095-A	65	2017	1	2.5	0.31	0.08
OL-MB-80095-B	68.2	2017	0.1	2.5	0.31	0.08
OL-MB-80096-A	57	2017	0.1	3.7	0.46	0.11
OL-MB-80096-B	57.8	2017	0.2	6	0.75	0.18
South Basin						
OL-MB-80098-14-01	62	2014	1.75	NA	NA	NA
OL-MB-80101-14-01	49	2014	1	NA	NA	NA
OL-MB-80101-15-01	48.3	2015	NA	6-6.5	1.0, 1.1	0.24, 0.26
OL-MB-80101-15-02	48.1	2015	NA	7.5-8[3]	1.25, 1.33	0.30, 0.32
OL-MB-80098-15-01	61.6	2015	NA	8-9.5[3]	1.33, 1.58	0.32, 0.38
OL-MB-80098-15-02	61.2	2015	NA	3	0.50	0.12
WB1-8-02-10-15	32.3	2015	4	NA	NA	NA
WB1-8-02-13-15	44.8	2015	4	NA	NA	NA
WB1-8-02-15-15	49.9	2015	3	NA	NA	NA
WB1-8-02-DEEP-15	62.7	2015	2.5	NA	NA	NA
RAD-D-03-10-15	31.4	2015	2	NA	NA	NA
RAD-D-03-13-15	42.2	2015	2	NA	NA	NA
RAD-D-03-15-15	49.2	2015	1	NA	NA	NA
OL-MB-80097-A	66	2017	3	4.5	0.56	0.14
OL-MB-80097-B	66	2017	1	4.3	0.54	0.13
OL-MB-80098-A	64	2017	1	6.7	0.84	0.20
OL-MB-80098-B	63.6	2017	0.2	5.5	0.69	0.17
OL-MB-80099-A	68	2017	0.1	6	0.75	0.18
OL-MB-80099-B	68.7	2017	0.1	6.5, 10.4[4]	0.81, 1.30	0.20, 0.32
OL-MB-80100-A	61.4	2017	0.1	8	1.00	0.24
OL-MB-80100-B	60.5	2017	0.1	5.8	0.73	0.18
OL-MB-80101-A	56	2017	0.4	7, 7.4 [4]	0.88, 0.93	0.21, 0.22
OL-MB-80101-B	56	2017	0.1	7.5	0.94	0.23

Notes:
1 - 1 centimeter = 0.033 ft.
2 - The sand microbead marker was placed at nine localized SMU 8 plots in late June 2009.
3 - The core tube likely entered the sediment at an angle and, therefore, the depth of the accumulated sediment above the microbeads is uncertain.
4 - Multiple values indicate separate, distinct microbead marker layers.

TABLE 12

AVERAGE MID-MAY TO MID-NOVEMBER 2014-2018 SOLIDS DEPOSITION AT THE SOUTH DEEP LOCATION IN ONONDAGA LAKE BASED ON SEDIMENT TRAP RESULTS

Year	Number of Sediment Traps Deployed with Mercury Measured in Settling Sediment	Average Solids Deposition/Settling Rate (milligrams per square meter per day)	Average Mercury Concentration in Settling Sediment (mg/kg or part per million)
2014	19	17,800	0.91
2015	20	13,200	0.44
2016	20	11,158	0.43
2017	21	11,494	0.21
2018	20	11,788	0.18

Notes:

1 - Each sediment trap was typically deployed for seven days.

2 - Average solids deposition from June through September when traps are below the thermocline as follows for 2014-2018, respectively: 15,000, 11,633, 8,745, 10,817, and 8,974 milligrams per square meter per day.

3 – Modeling conducted during the final design assumed mercury concentrations on depositing particles ranged from 1.0 to 1.9 mg/kg for the period prior to completion of remediation, and 0.4 mg/kg for the period following remediation.

TABLE 13

FISH TISSUE REMEDIAL GOALS (MERCURY) AND TARGET CONCENTRATIONS (ORGANIC CHEMICALS)

	Human Health	**Ecological[a]**
Remedial Goals		
Mercury (mg/kg)	0.2 to 0.3[b]	0.14[c] for small and large prey fish
Target Concentrations		
PCBs (mg/kg)	0.04 to 0.3[d]	0.19[c] for small and large prey fish
Dioxin/furan TEQ (ng/kg)	1.3 to 4[e]	NA
DDT and Metabolites (mg/kg)	NA	0.049[f] for small prey fish 0.14[g] for large prey fish

Notes:

- Contaminant concentrations in fillet samples of sportfish (i.e., identified as Smallmouth Bass, Walleye, Pumpkinseed, and Common Carp in the OLMMP) are compared to remedial goals and target concentration ranges for protection of human health.
- Contaminant concentrations in 1) whole body samples of large prey fish, 2) composite whole body samples of small prey fish, and 3) whole-body concentrations in sportfish of appropriate sizes calculated from fillet concentrations are compared to remedial goals and target concentrations for protection of ecological receptors. The OLMMP identifies White Sucker and Banded Killifish for large and small prey fish, but states that other comparable species may be substituted if these species are difficult to obtain.
- Concentrations are on a wet-weight basis.
- While not collected as prey fish, remedial goals and target concentrations may be compared to contaminant concentrations in whole body sportfish (i.e., specifically Smallmouth Bass, Walleye, Pumpkinseed, and Common Carp in the OLMMP) where fillet data is converted to whole body data using "conversion factors developed in the Onondaga Lake Baseline Ecological Risk Assessment (BERA) (i.e., 0.7 for mercury, 2.5 for PCBs, and 2.3 for DDTs and hexachlorobenzene) (TAMS, 2002)," For these calculations, fish with lengths 180-600 mm and 30-180 mm are compared to goal and target concentrations for large and small prey fish, respectively.

NA – not applicable. Dioxin/furans and DDT were not identified as posing risk to ecological receptors and human health, respectively.

a – Ecological remedial goals and targets based on lowest observed adverse effect levels presented in Appendix G of the FS (Parsons et al. 2004). Protection of ecological receptors (wildlife) based on the exposure assumptions from the Onondaga Lake Baseline Ecological Risk Assessment (BERA) (TAMS, 2002). No-observed-adverse-effect-levels were not identified as ecological remedial goals or targets as they are below background levels identified in the ROD and may not be achievable.

b – Lower end of the mercury range is based on reasonable maximum exposure (RME), non-carcinogenic risk. The higher end of the range is EPA's methylmercury National Recommended Water Quality criterion for the protection of human health for the consumption of organisms and is expressed as mg/kg in fish tissue.

c – Protection of river otter.

d – Lower end of PCB range represents the RME non-carcinogenic target for high molecular weight PCBs and is approximately equal to the target for $1x10^{-5}$ carcinogenic risk (0.03 mg/kg). Upper end of range is the RME target for 1×10^{-4} carcinogenic risk.

e – Although non-carcinogenic targets were not developed for dioxin/furans at the time of the ROD (2005), using the parameters presented in Appendix G of the FS (Parsons et al. 2004) for a target concentration for the noncancer endpoint, and using the USEPA 2012 reference dose of 7E-10 mg/kg-day, the non-cancer target at a hazard quotient of 1 was determined by USEPA to be 1.3E-06 mg/kg (or 1.3 ng/kg) and is the lower end of the range. The upper end of the range is for protection of carcinogenic risk of $1x10^{-4}$, reasonable maximum exposure (RME).

f – Protection of belted kingfisher

g – Protection of osprey

Attachment 1 – List of Figures

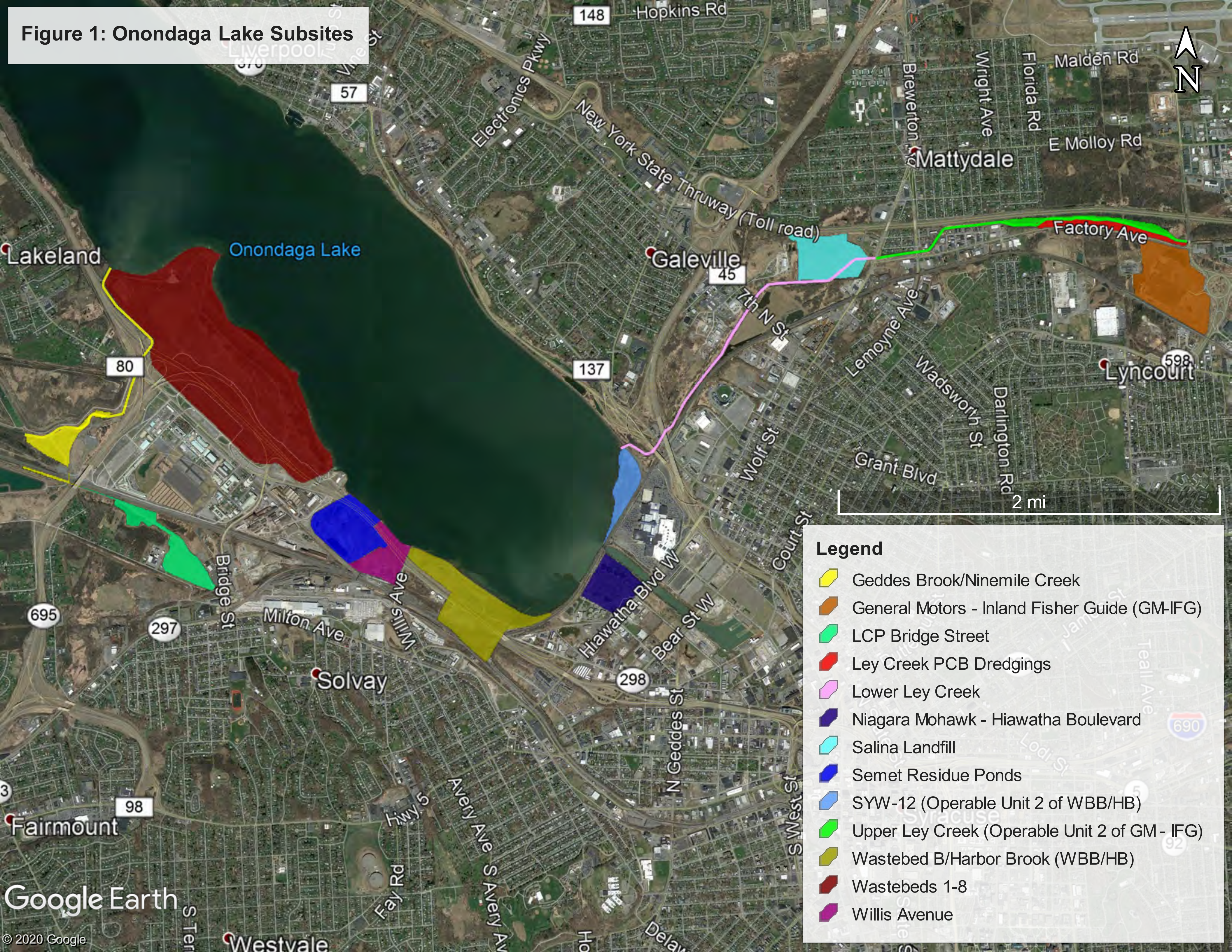


Figure 1: Onondaga Lake Subsites

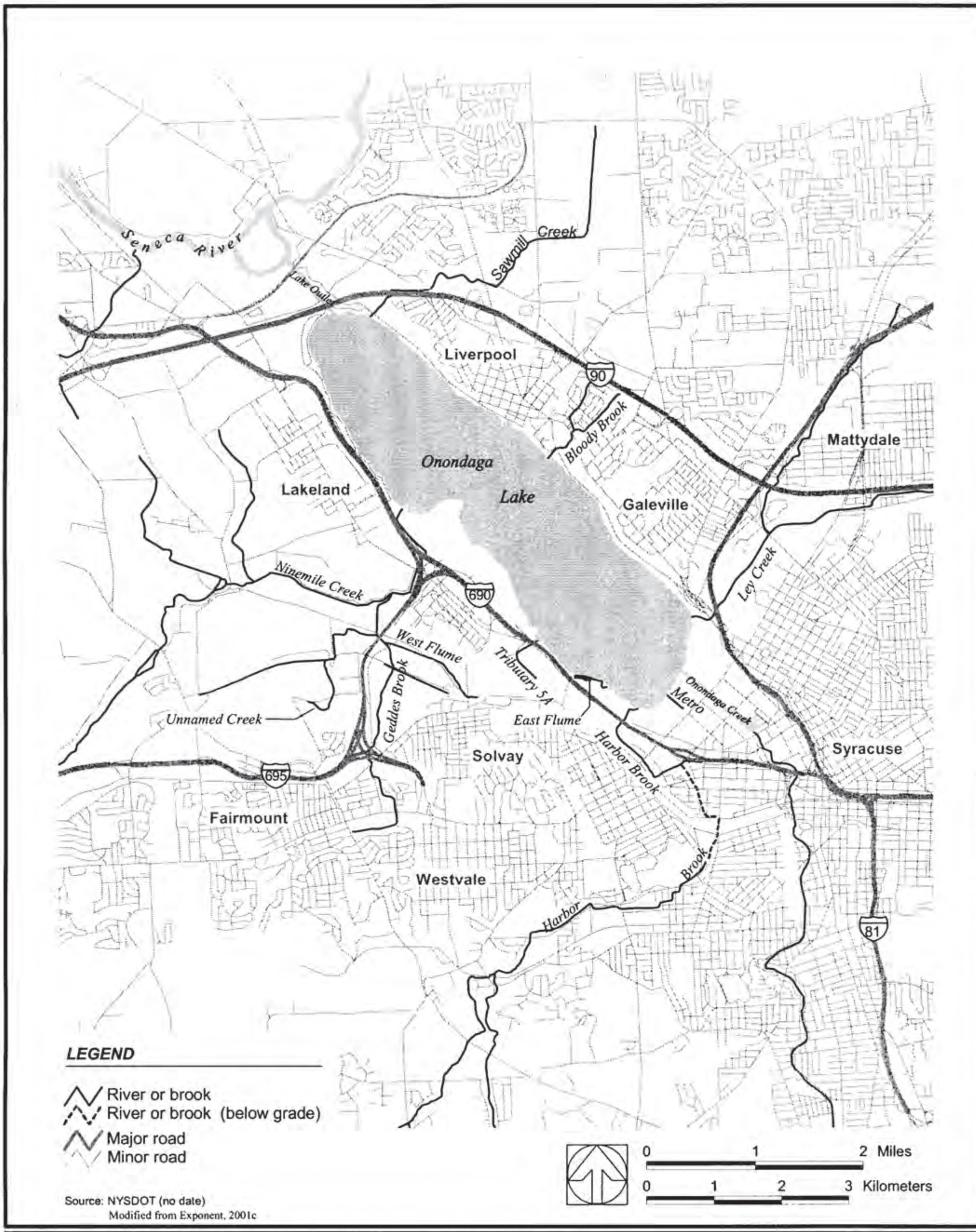


Figure 2 Onondaga Lake Area Tributaries and Roads

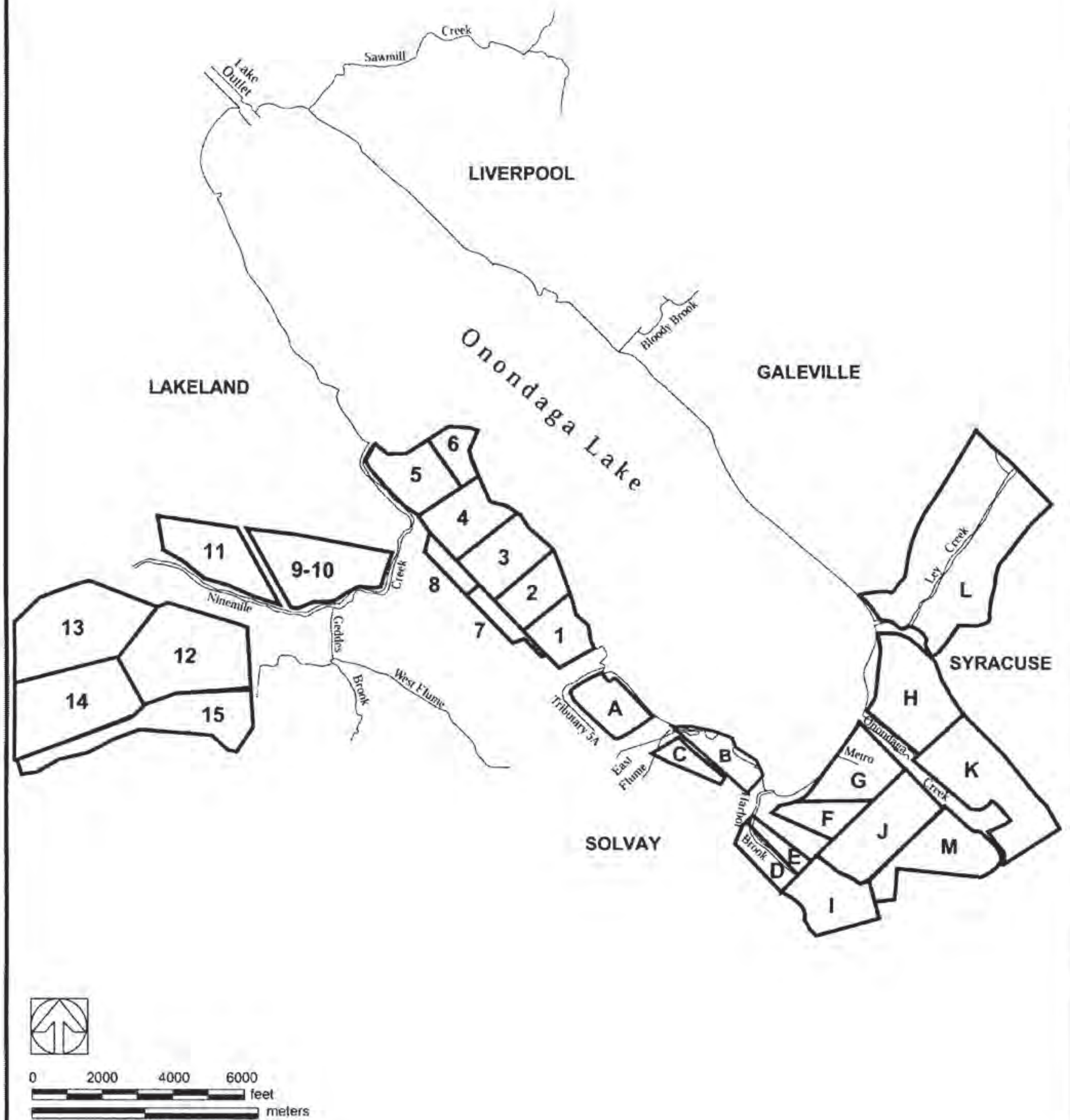
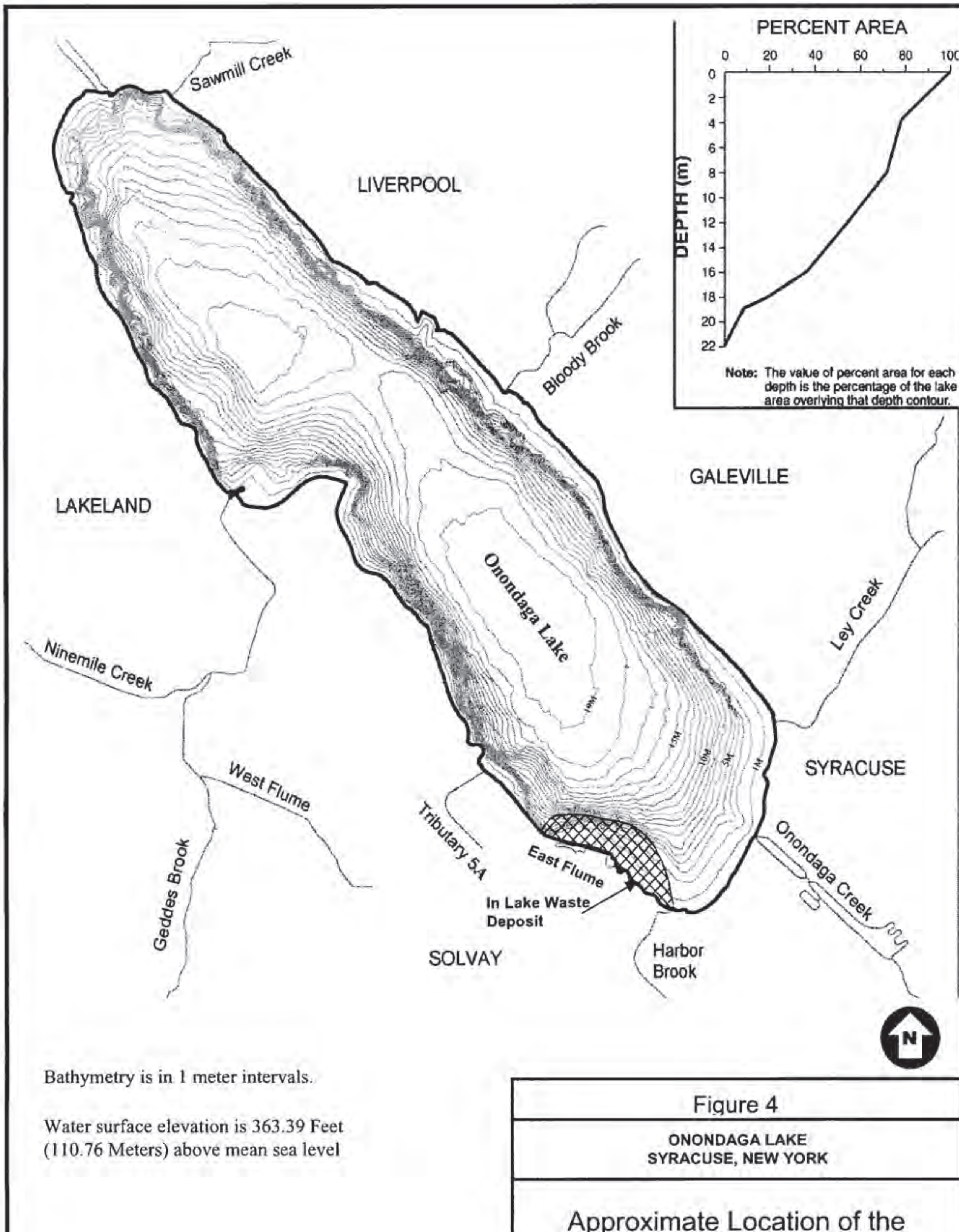


Figure 3 Historical Locations of Solvay Wastebeds



Bathymetry is in 1 meter intervals.

Water surface elevation is 363.39 Feet (110.76 Meters) above mean sea level

Figure 4

ONONDAGA LAKE
SYRACUSE, NEW YORK

Approximate Location of the In-Lake Waste Deposit

Remediation Area Boundary

Sediment Management Unit (SMU) Boundary

Extent of ILWD in Littoral Zone

Willis/Semet IRM Barrier Wall

West Wall Portion of the WB-B/HB IRM

East Wall Portion of the WB-B/HB IRM

New York State Digital Orthoimagery from 2009

1,800 900 0 1,800

Feet

FIGURE 5

Honeywell Onondaga Lake Syracuse, New York

SMU Boundaries and Remediation Areas

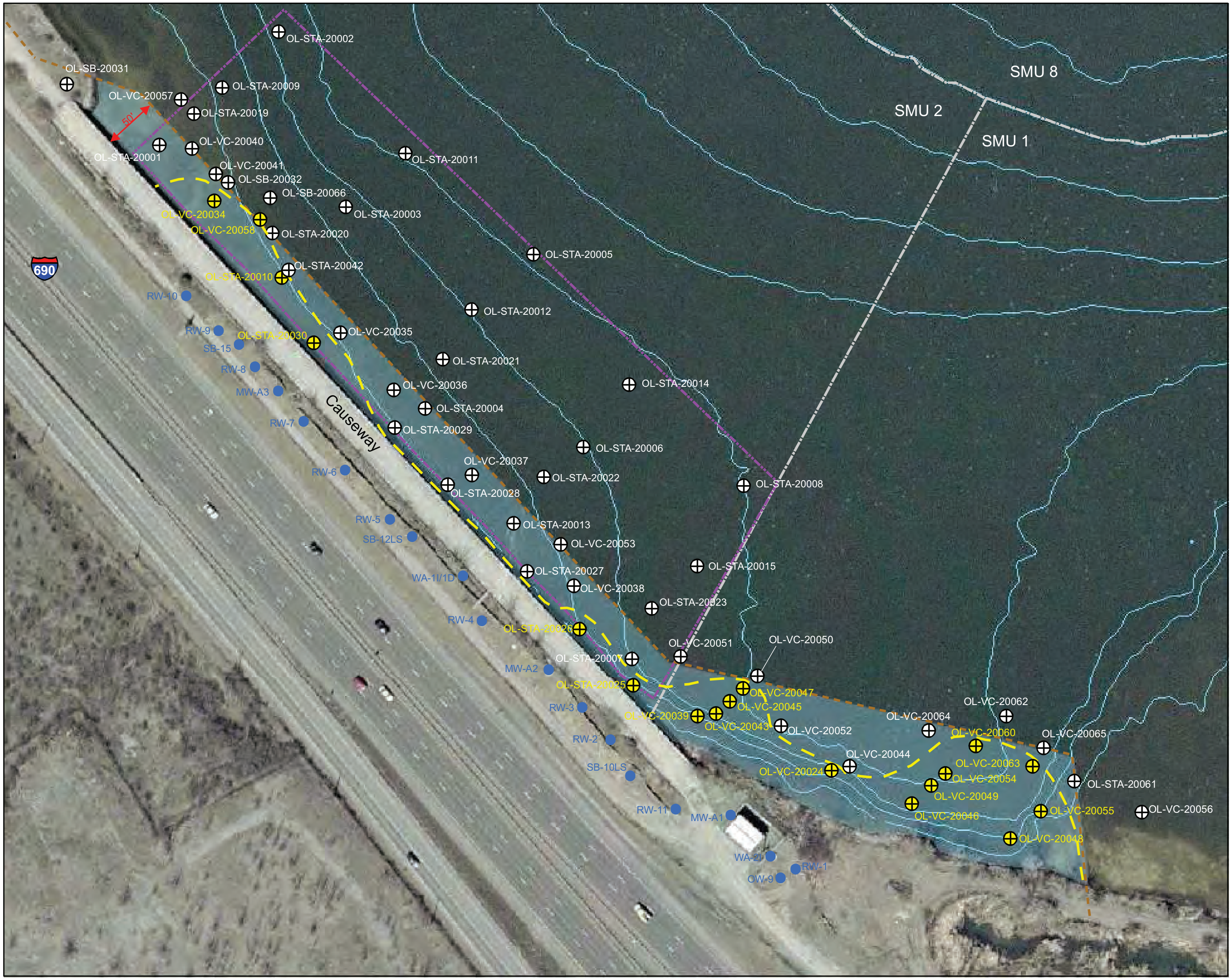
PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

User: p0013927

Date Revised: 2/15/2012 11:16:50 AM

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



● Existing Onshore NAPL Recovery Well

⊕ 2005/2006 Core does not contain pooled NAPL but may contain isolated NAPL stringers, seams and/or globules in Solvay Waste (see text in ESD)

⊕ 2005/2006 Core Contains pooled NAPL (see text in ESD)

Barrier Wall Alignment (Approximate)

Extent of Pooled NAPL

Extent of Pooled NAPL Removal Area Assumed in the FS/ROD

Notes:

1. Bathymetry is shown in 4' intervals.

90 45 0 90
Feet

FIGURE 6

Honeywell

Onondaga Lake
Syracuse, New York

Pooled NAPL Extent and Barrier Wall Alignment

PARSONS

290 ELWOOD DAVIS RD, SUITE 312, LIVERPOOL, NY 13088 Phone:(315)451-9560

Q:\GIS\GIS_Lake\dnapl_invest\pooled_napl_barr_wall_101306.mxd

User: 40189

Date Revised: 6/20/2014 1:11:42 PM

Path: Q:\GIS\GIS_Lake\CAP\MXD\2014\RemsCDE_Dredge_Cap.mxd

Remediation Area Boundary

Offset/Buffer Area

Isolation Cap Area

SMU 8 Thin-layer Cap Area

Dredge Area

Sediment Management Unit (SMU) Boundary

Wave Damper (Approximate Location)

Willis/Semet IRM Barrier Wall

West Wall Portion of the WB-B/HB IRM

East Wall Portion of the WB-B/HB IRM

Eastern Shoreline Groundwater Collection Trench

N

New York State Digital Orthoimagery from 2009

650 325 0 650

Feet

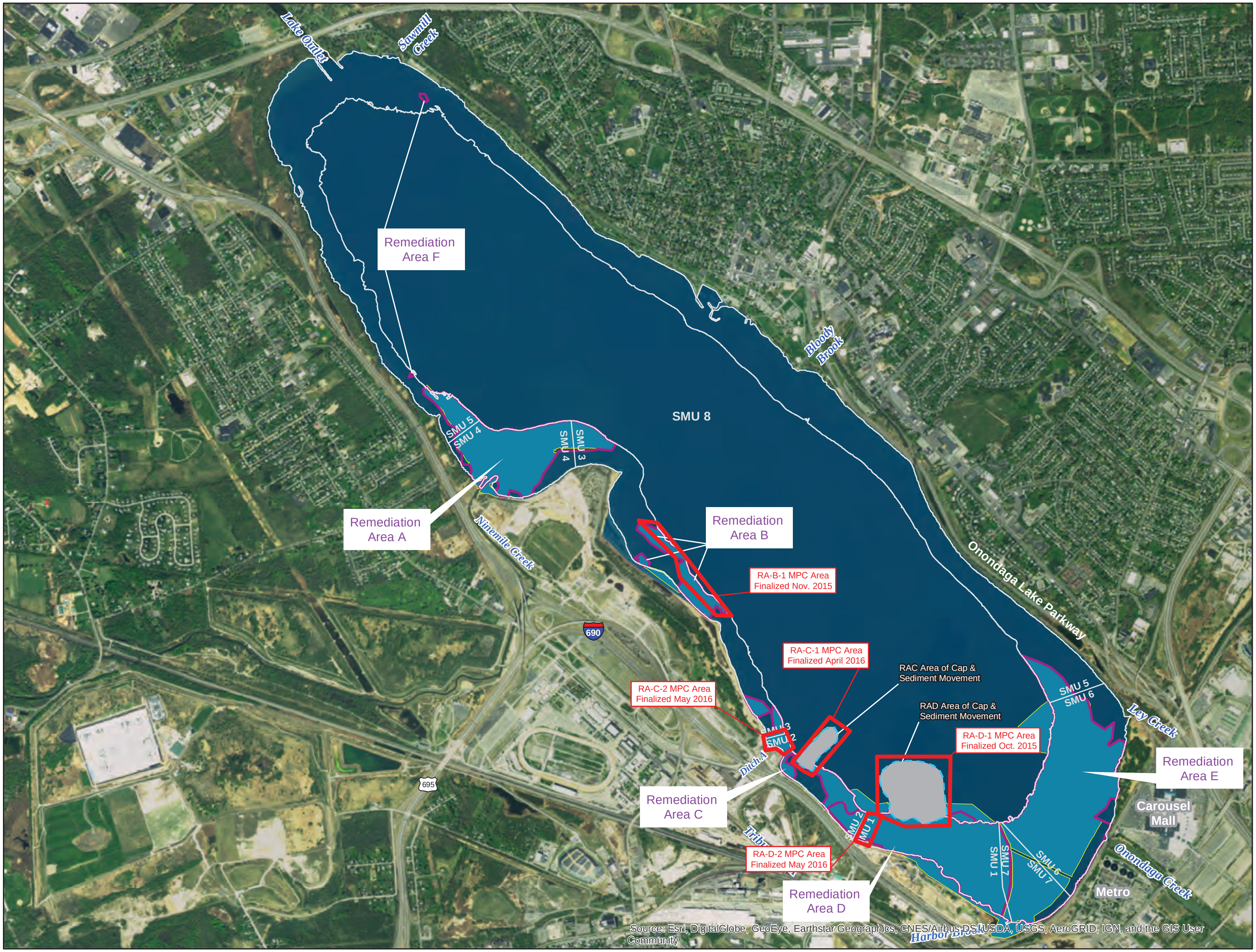
FIGURE 7

Honeywell Onondaga Lake Syracuse, New York

Remediation Area E Shoreline Offset and Wave Damper

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212



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

1,800 900 0 1,800

Feet

FIGURE 8

Honeywell Onondaga Lake Syracuse, New York

ESD AREAS OF INTEREST

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

User: 40189

Date Revised: 12/19/2017 2:58:32 PM

Path: Q:\GIS\GIS_Lake\CAP\MXD\2017\SMUs_Rem_Areas-2017.mxd

REMEDIATION AREA BOUNDARY

SMU BOUNDARY

DREDGE AREAS

CAPPED AREAS (INCLUDES ALL ISOLATION, THIN LAYER, AND MODIFIED PROTECTIVE CAPS)

DREDGE AND CAP RAILROAD ACCESS

FIGURE 9

Honeywell

ONONDAGA LAKE
SYRACUSE, NEW YORK

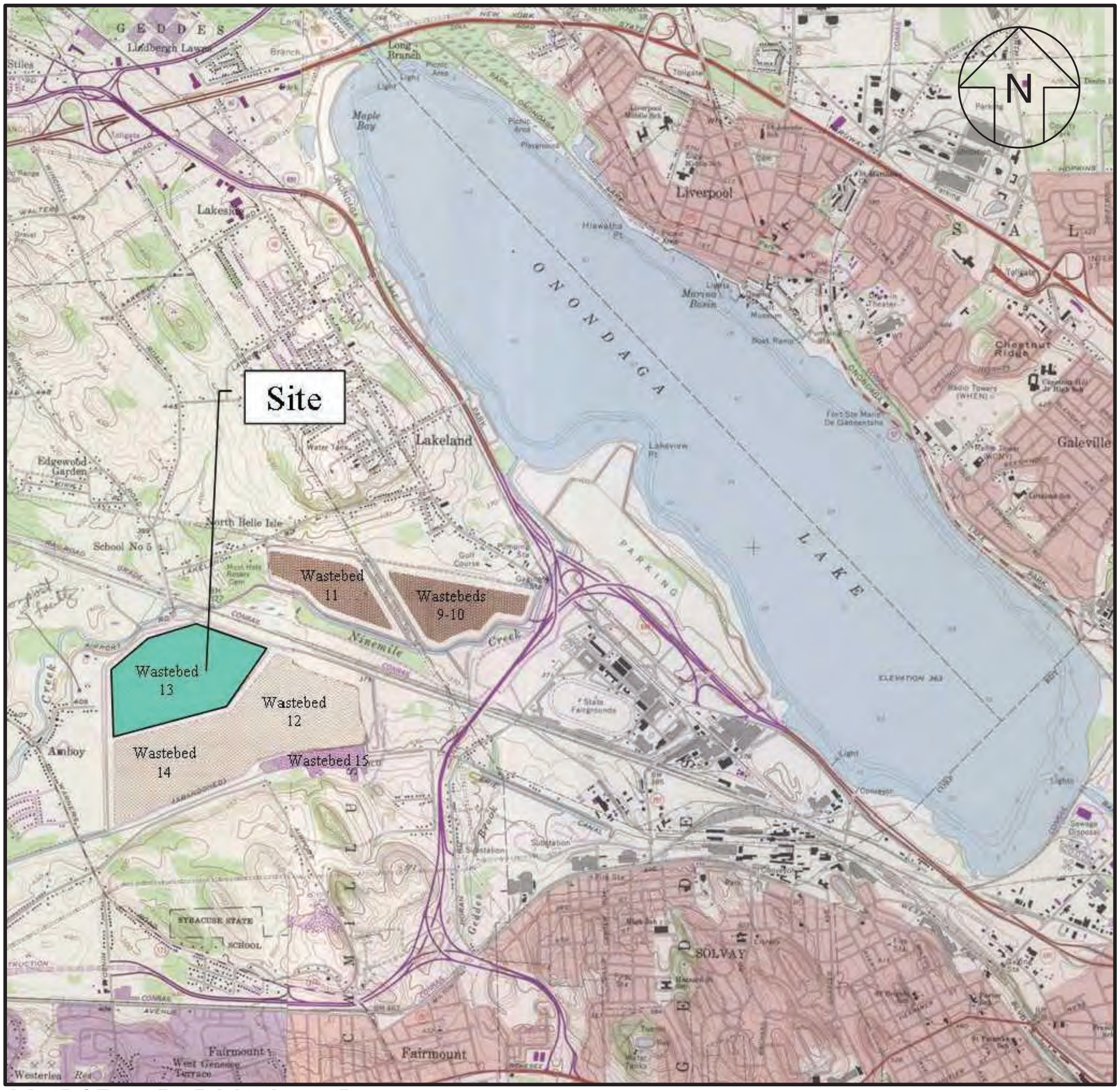
ONONDAGA LAKE DREDGE AND CAP

PARSONS

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, N.Y. 13212, PHONE: 315-451-9560

FILE NAME: P:\HONEYWELL -SYR\449883 GB NMC FER\10.0 TECHNICAL CATEGORIES\GRAPHICS\449883-LAKE CAPPING.DWG
PLOT DATE: 10/25/2018 11:37 AM PLOTTED BY: RUSSO, JILL

WASTEBED 13 LOCATION MAP



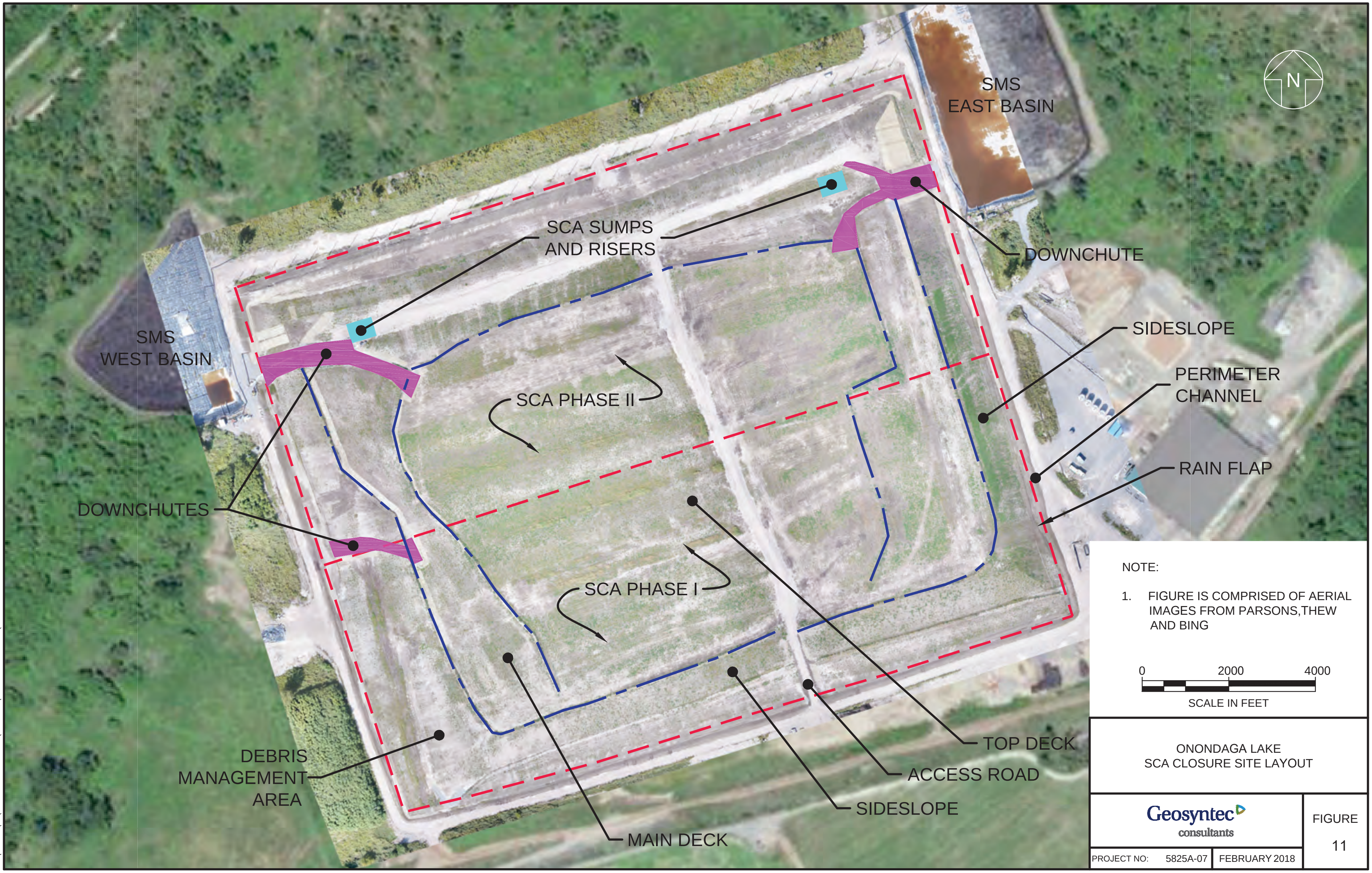
SOURCE: PARSONS MAP

L:\CADD\O\ONONDAGA LAKE\PERMIT\SCA GEOTUBES\ISSUED FOR CONSTRUCTION REV-0\REDUCED SET (NO FINAL COVER)\4706F001

Geosyntec consultants

KENNESAW, GA

DATE:	January 2018	SCALE:	NTS
PROJECT NO.	GQ5825A	FILE NO.	4706f001
DOCUMENT NO.	—	FIGURE NO.	10



NOTE:

1. FIGURE IS COMPRISED OF AERIAL IMAGES FROM PARSONS,THEW AND BING

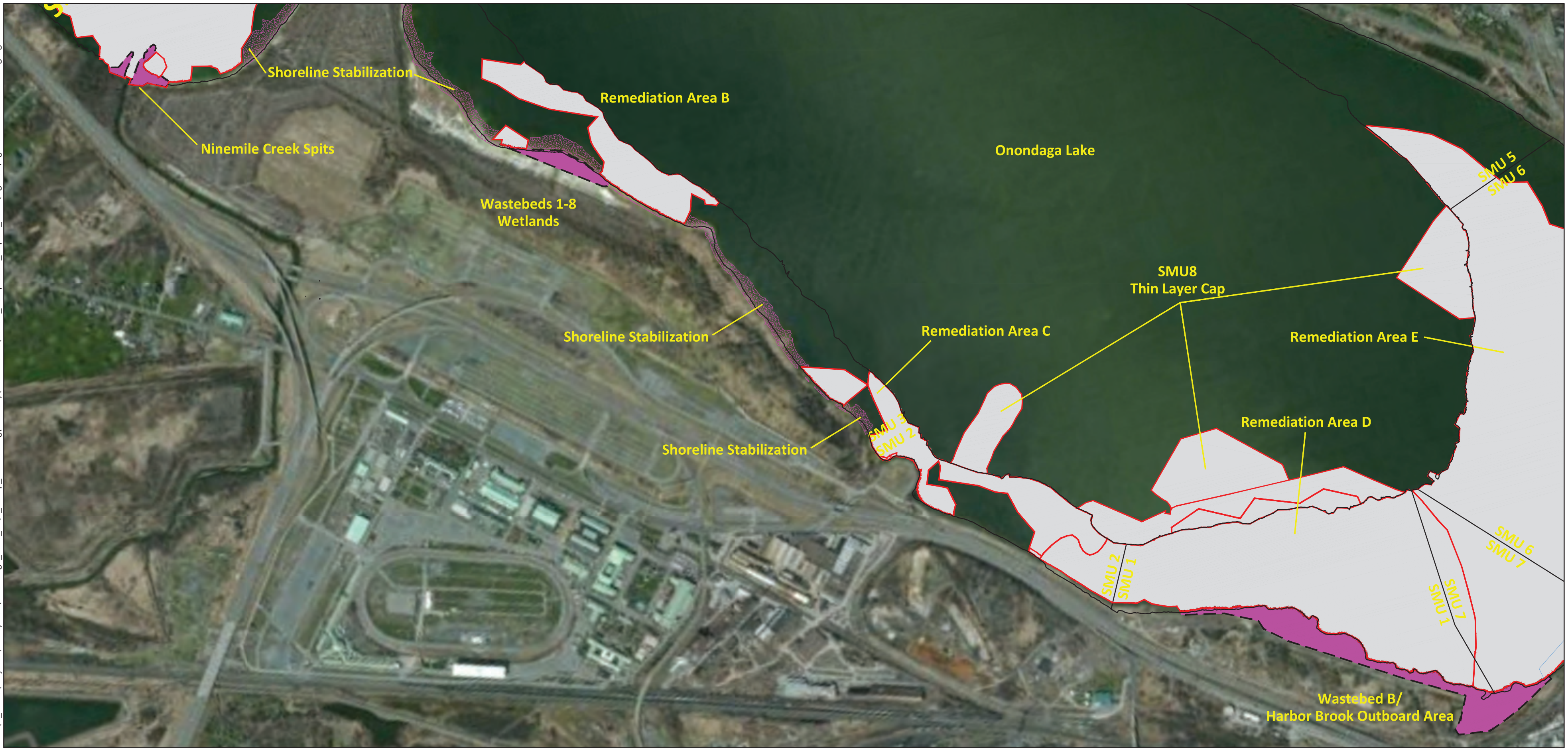
ONONDAGA LAKE
SCA CLOSURE SITE LAYOUT

Geosyntec consultants

FIGURE 11

PROJECT NO: 5825A-07 | FEBRUARY 2018

L:\CADD\O\ONONDAGA LAKE\PERMIT\SCA GEOTUBES\FIGURE 2



H:\D_Drive\Projects\Honeywell\Onondaga_Lake_CQA_Comp_Monitoring(120287)\Documents\Constr_Completion_Report_2016\Figures\Figure 2.1-01013902.dwg Figure 2.1

Aug 20, 2017 7:25am cyard

SOURCE: Aerial Source: Bing Maps
HORIZONTAL DATUM: New York State Plane, Central Zone, North American Datum 1983 (NAD83), U.S. Feet
VERTICAL DATUM: North American Vertical Datum 1988 (NAVD88)

LEGEND:

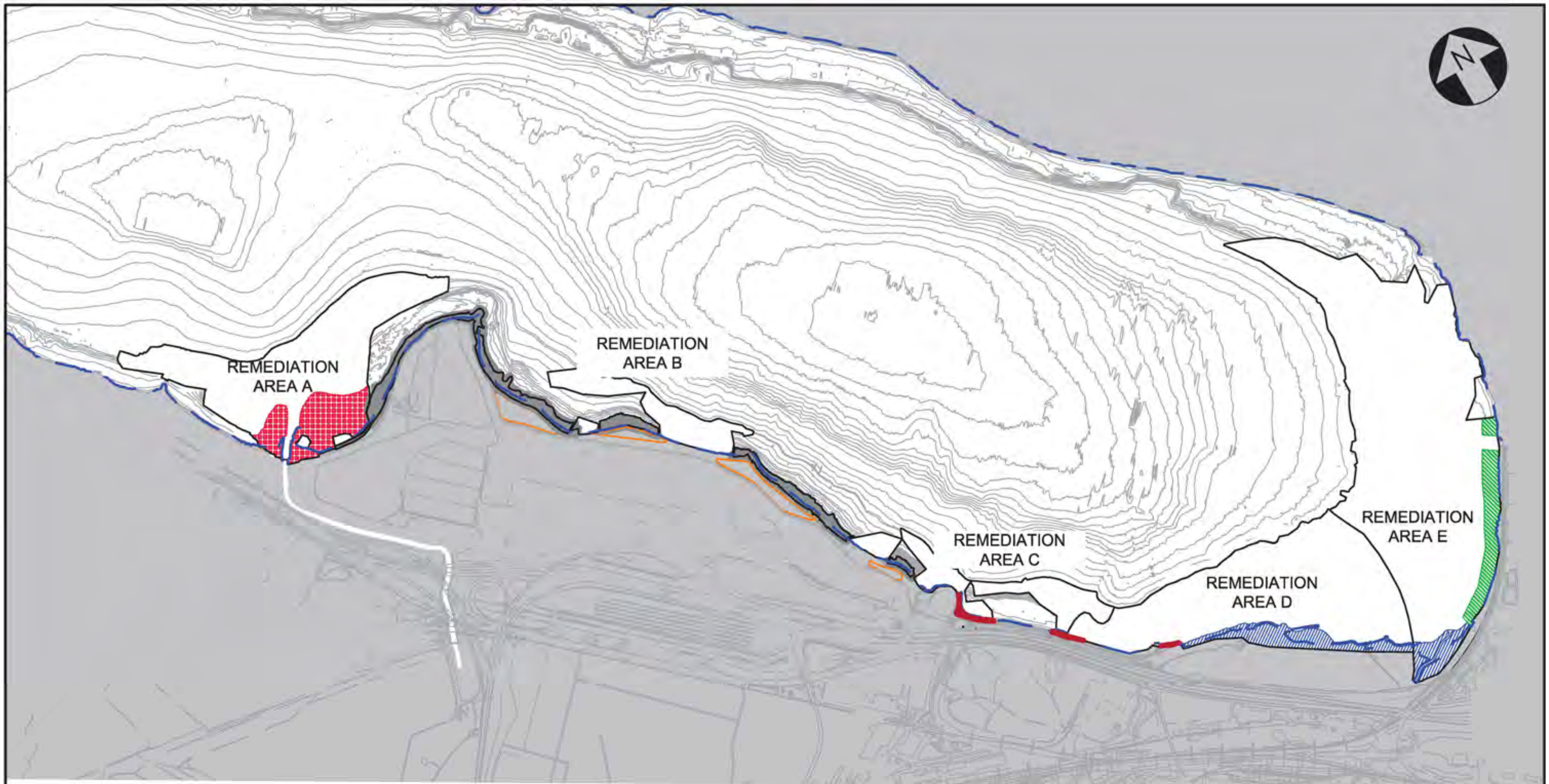
- Adjacent Remedial Area
- SMU Boundary
- Remediation Area Boundary
- Shoreline Stabilization Area

0 1000
Scale in Feet

Honeywell

ANCHOR QEA

Figure 12
Adjacent Remediation Areas
Construction Completion Report
Onondaga Lake Capping and Dredging



LEGEND:

- NINEMILE CREEK SPITS AND ADJACENT PLANTED AREA
- WASTEBED B/HARBOR BROOK OUTBOARD PLANTED AREA
- SMU 3 & 4 SHORELINE HABITAT ENHANCEMENT AREAS
- WASTEBED 1–8 IRM WETLANDS
- SPECIAL SHORELINE TRANSITION AREA
- CSX SHORELINE
- REMEDIATION AREA BOUNDARIES
- SHORELINE

NOTE:

1. FIGURE TAKEN FROM ONONDAGA LAKE CAPPING, DREDGING, HABITAT AND PROFUNDAL ZONE (SMU 8) FINAL DESIGN ADDENDUM.

2000 1000 0 2000 4000

SCALE: 1"=2000'

FIGURE 13

Honeywell

ONONDAGA LAKE HABITAT CONSTRUCTION REPORT

HABITAT RESTORATION, REMEDIATION, AND ENHANCEMENT AREAS

PARSONS

301 PLAINFIELD ROAD * SUITE 350 * SYRACUSE, NY 13212 * 315/451–9560
OFFICES IN PRINCIPAL CITIES

FILE NAME: P:\HONEYWELL –SYR\450550 2017 HABITAT WORK\10.0 TECHNICAL CATAGORIES\10.1 CAD\FIGURES\450550–100–SK–001.DWG
PLOT DATE: 4/11/2018 9:37 AM PLOTTED BY: RUSSO, JILL

SCALE: 1"=250'

FIGURE 14

Honeywell

ONONDAGA LAKE
SYRACUSE, NEW YORK

OUTBOARD AREA BERM PLAN VIEW

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

Date Revised: 5/31/2019 2:41:58 PM

Path: Q:\GIS\GIS_Lake\Baseline_Monitor\MXDs\2018_NitrateInjectLocs.mxd

2018 Nitrate Application Locations

Bathymetry Contours For Water Depth

10 Foot Intervals

30 Foot Water Depth Contour

0 1,200 2,400 4,800 7,200

Feet

Figure 15

Honeywell

Onondaga Lake
Syracuse, New York

2018 Nitrate Application Locations

PARSONS

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

LEGEND:

DEMARCATION FOR BSQV SUBAREAS (DELINEATION IS APPROXIMATE AND MAY BE MODIFIED BASED ON DEVELOPMENT OF FINAL THIESSEN POLYGONS FOR BSQV EVALUATION)

LITTORAL REMEDIATION AREA BOUNDARY

SMU BOUNDARY

CAPPED AREAS (INCLUDES ALL ISOLATION, THIN LAYER, AND MODIFIED PROTECTIVE CAPS)

NOTES:

1. WATER DEPTH CONTOUR INTERVAL IS 5 FT. (PRE–REMEDY CONTOURS SHOWN)
2. WATER DEPTH BASED ON AVERAGE LAKE ELEVATION OF 362.5 FT.

2000 1000 0 2000 4000

SCALE: 1"=2000'

FIGURE 16

Honeywell

ONONDAGA LAKE SUBAREAS FOR EVALUATION OF BSQV COMPLIANCE

PARSONS

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, N.Y. 13212, PHONE: 315–451–9560

FILE NAME: P:\HONEYWELL -SYR\450102 - 2016 OL REMEDIAL GOAL MONITORING\10 TECHNICAL CATEGORIES\CAD\2016\450102-MNR-015.DWG
PLOT DATE: 10/9/2017 11:52 AM PLOTTED BY: RUSSO, JILL

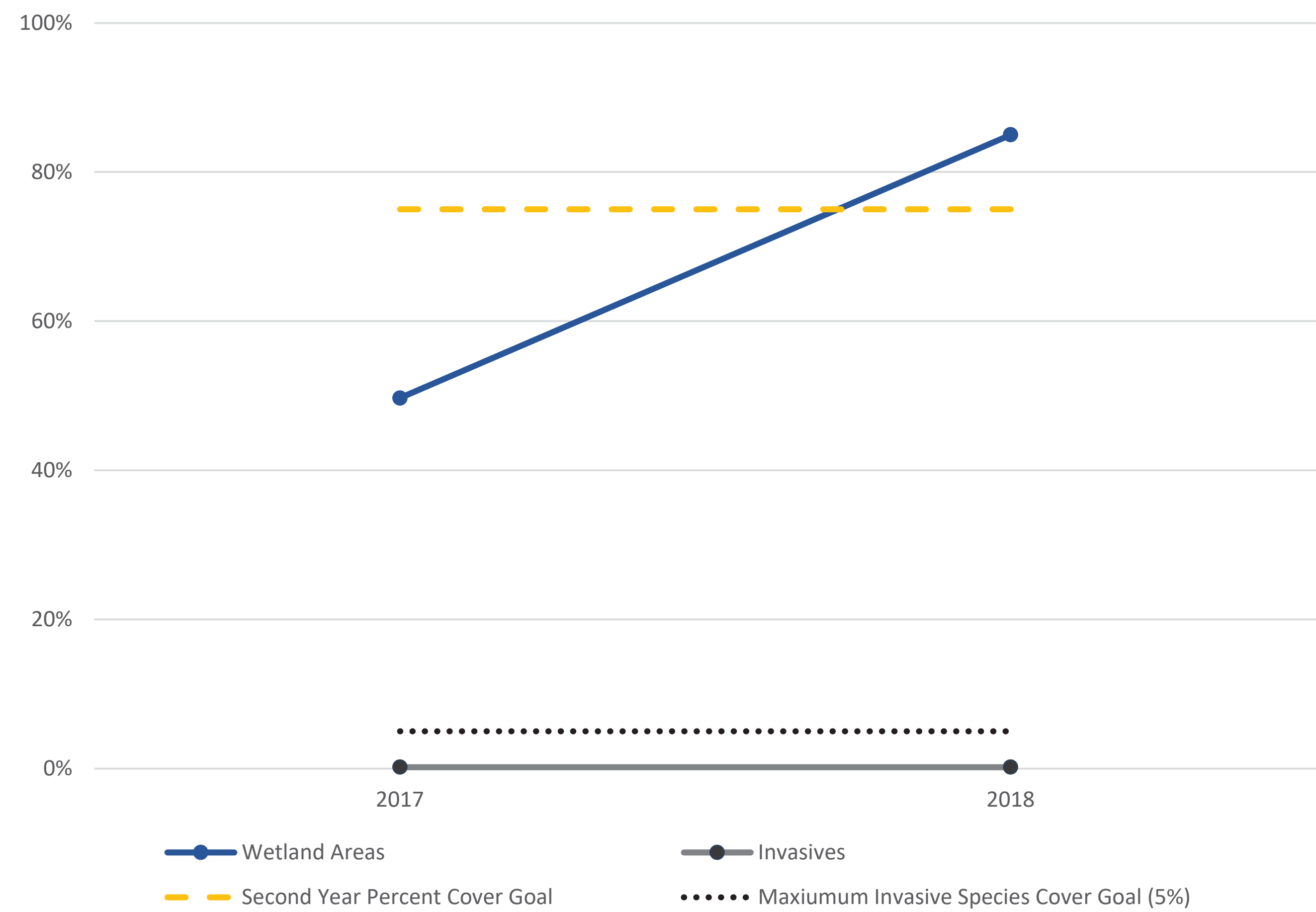


FIGURE 17

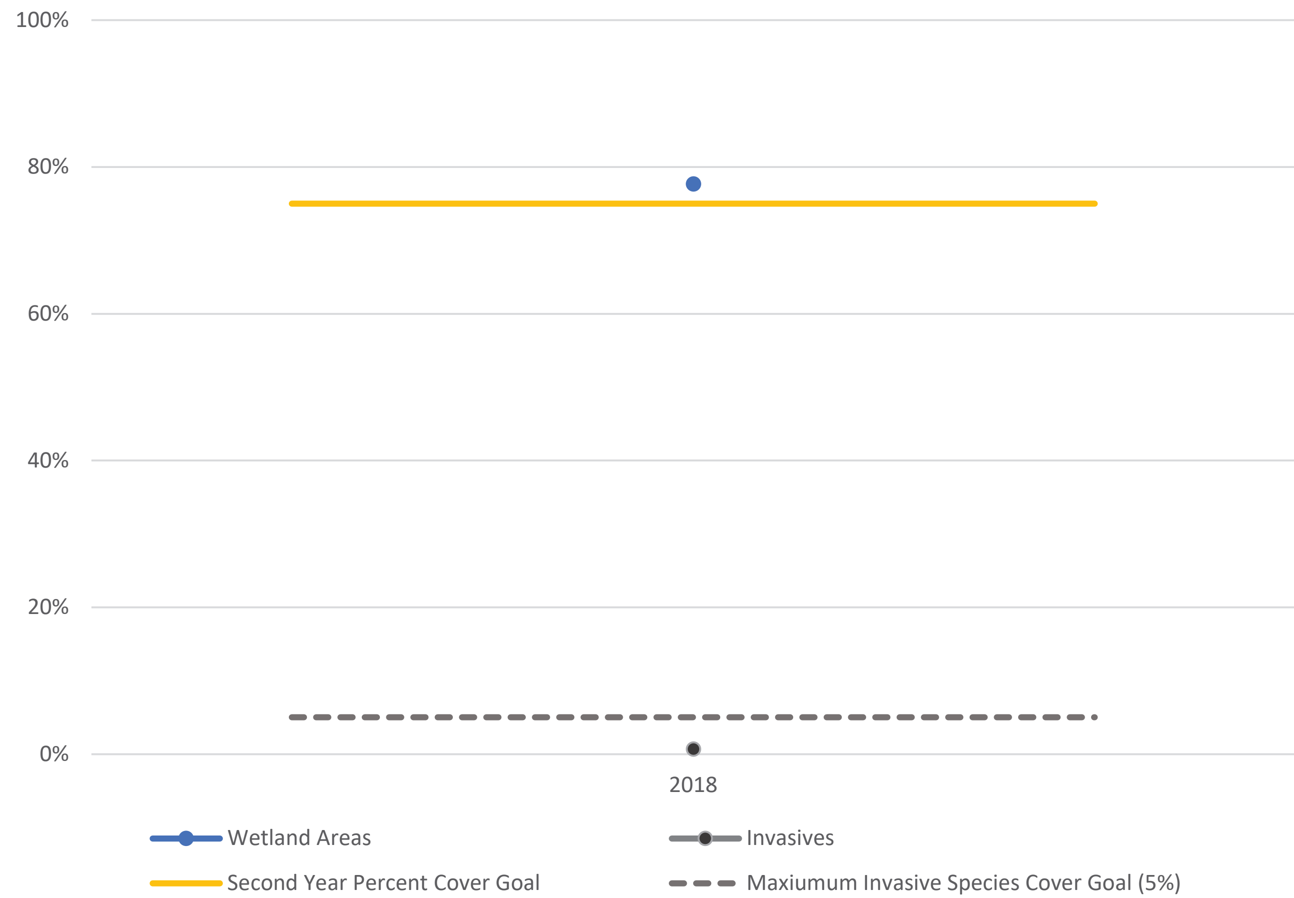
Honeywell

Onondaga Lake
Syracuse, New York

Mouth of Ninemile Creek Vegetation Trends

PARSONS

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



Note: First year target is for expansion from initial plantings. Second year goal is shown for context

FIGURE 18

Honeywell

Onondaga Lake
Syracuse, New York

Wastebed B/Harbor Brook Vegetation Trends

PARSONS

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

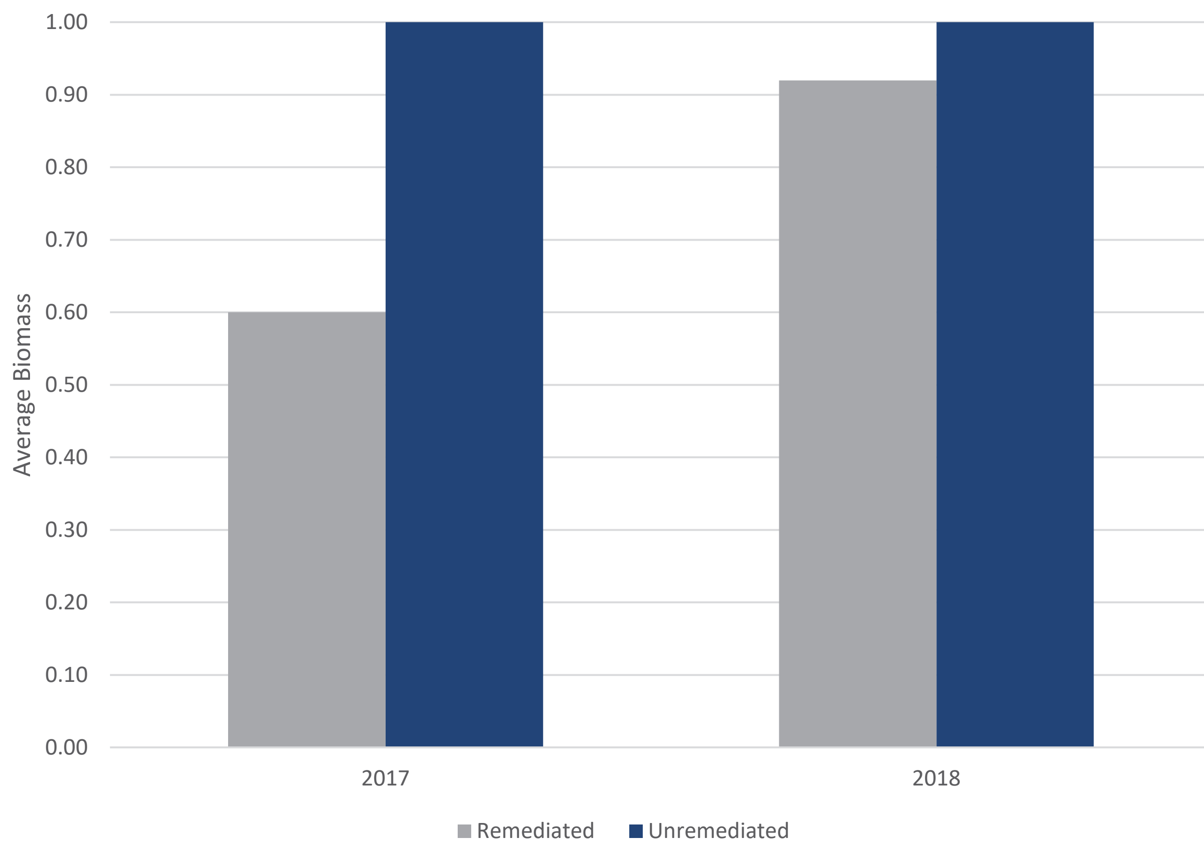


FIGURE 19

Honeywell

Onondaga Lake
Syracuse, New York

Onondaga Lake Macrophyte Cover Trends

PARSONS

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

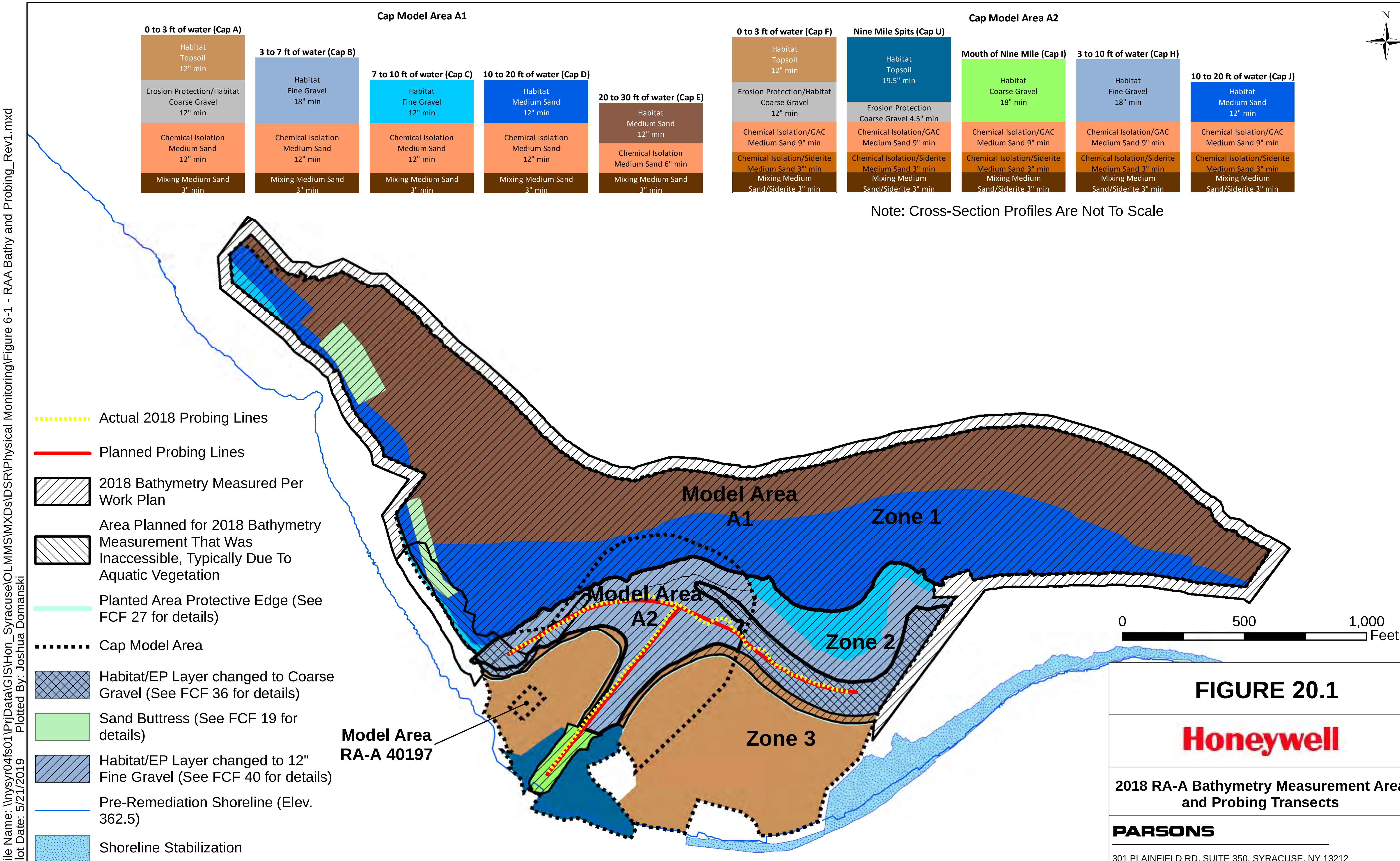


FIGURE 20.1

2018 RA-A Bathymetry Measurement Area and Probing Transects

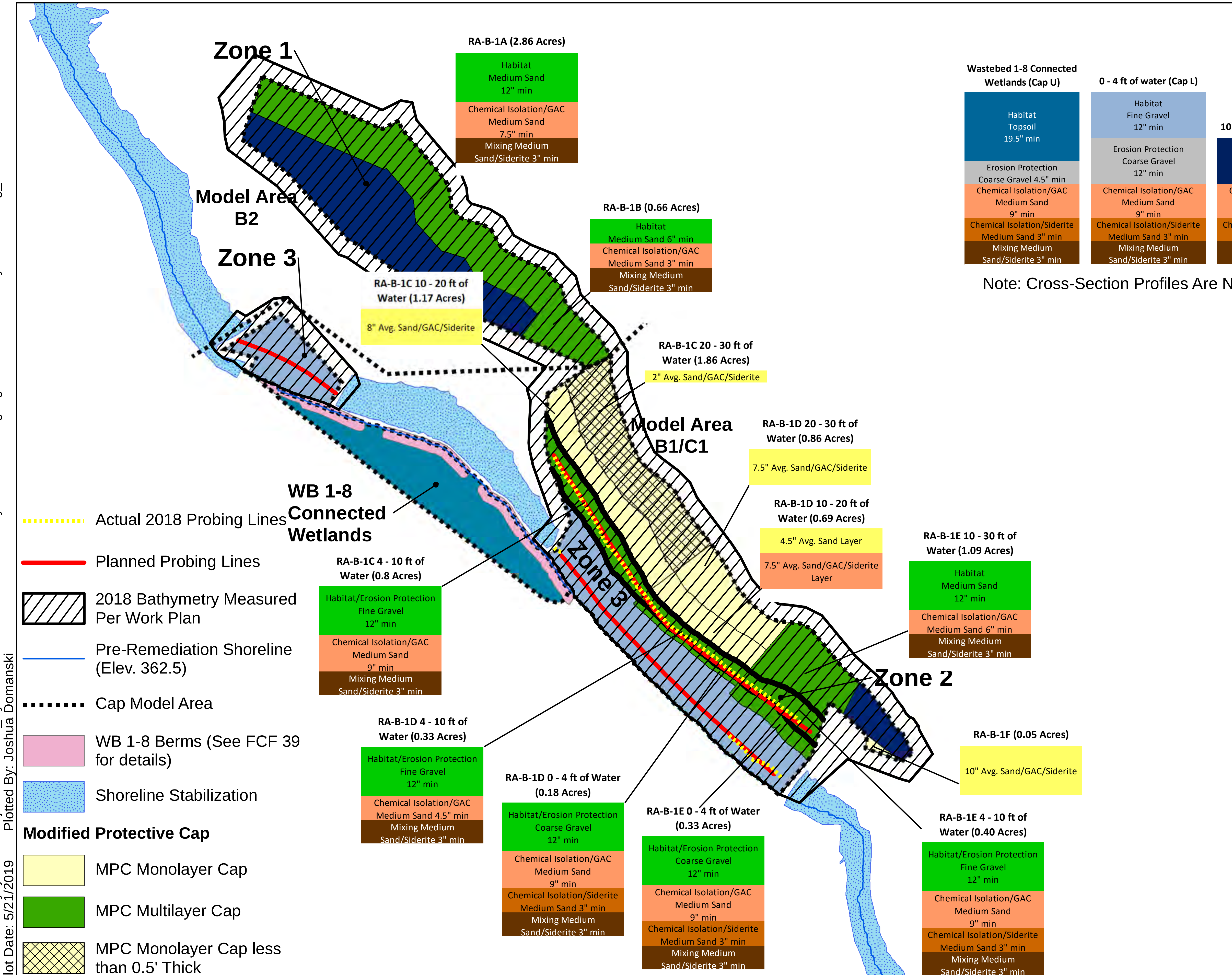


FIGURE 20.2

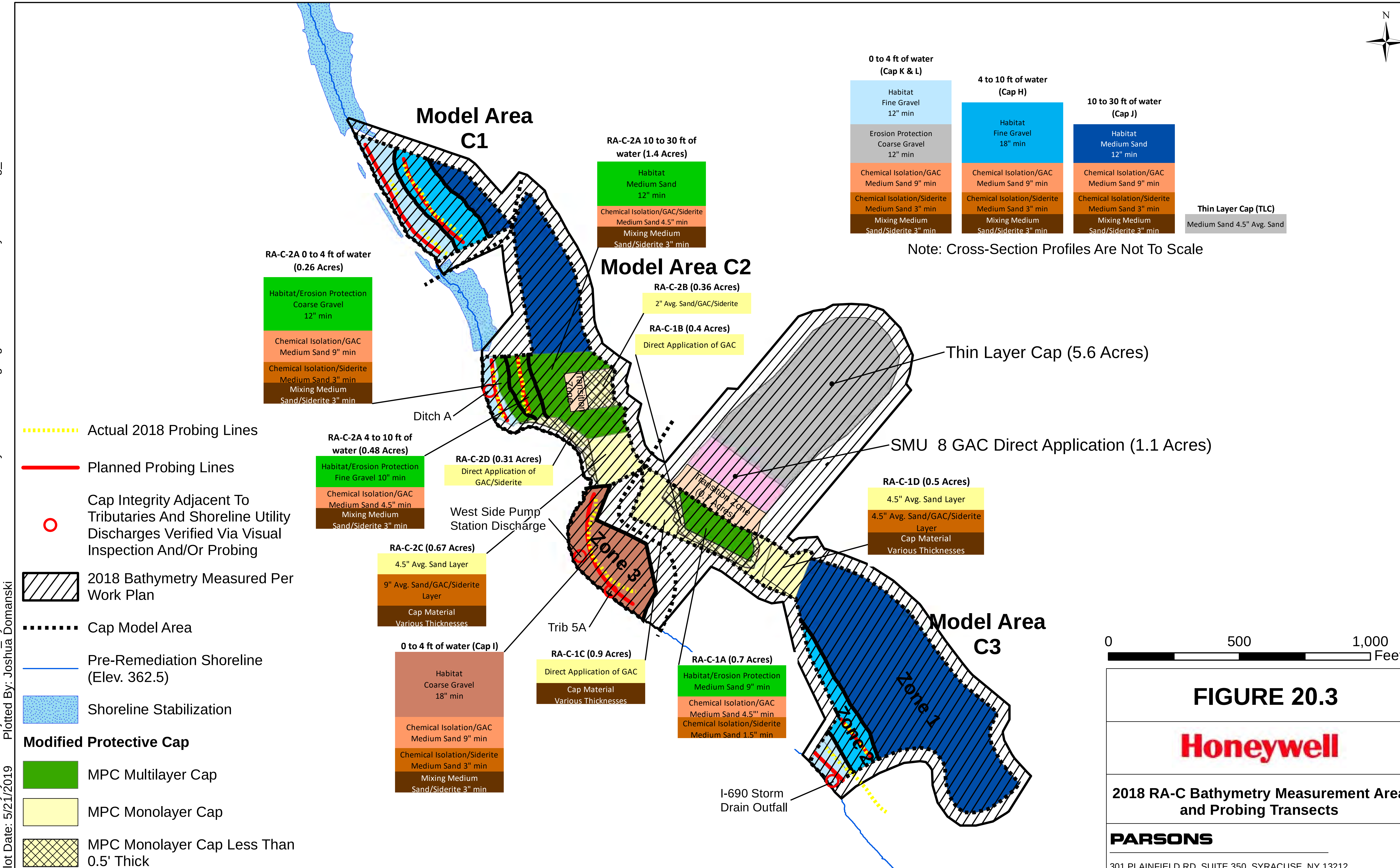
Honeywell

2018 RA-B Bathymetry Measurement Area and Probing Transects

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

File Name: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\MXDs\DSR\Physical Monitoring\Figure 6-2 - RAB Bathy and Probing_Rev1.mxd
Plotted By: Joshua Domanski
Plot Date: 5/21/2019



File Name: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\MXDs\DSR\Physical Monitoring\Figure 6-3 - RAC Bathy and Probing_Rev1.mxd
Plotted By: Joshua Domanski
Plot Date: 5/21/2019

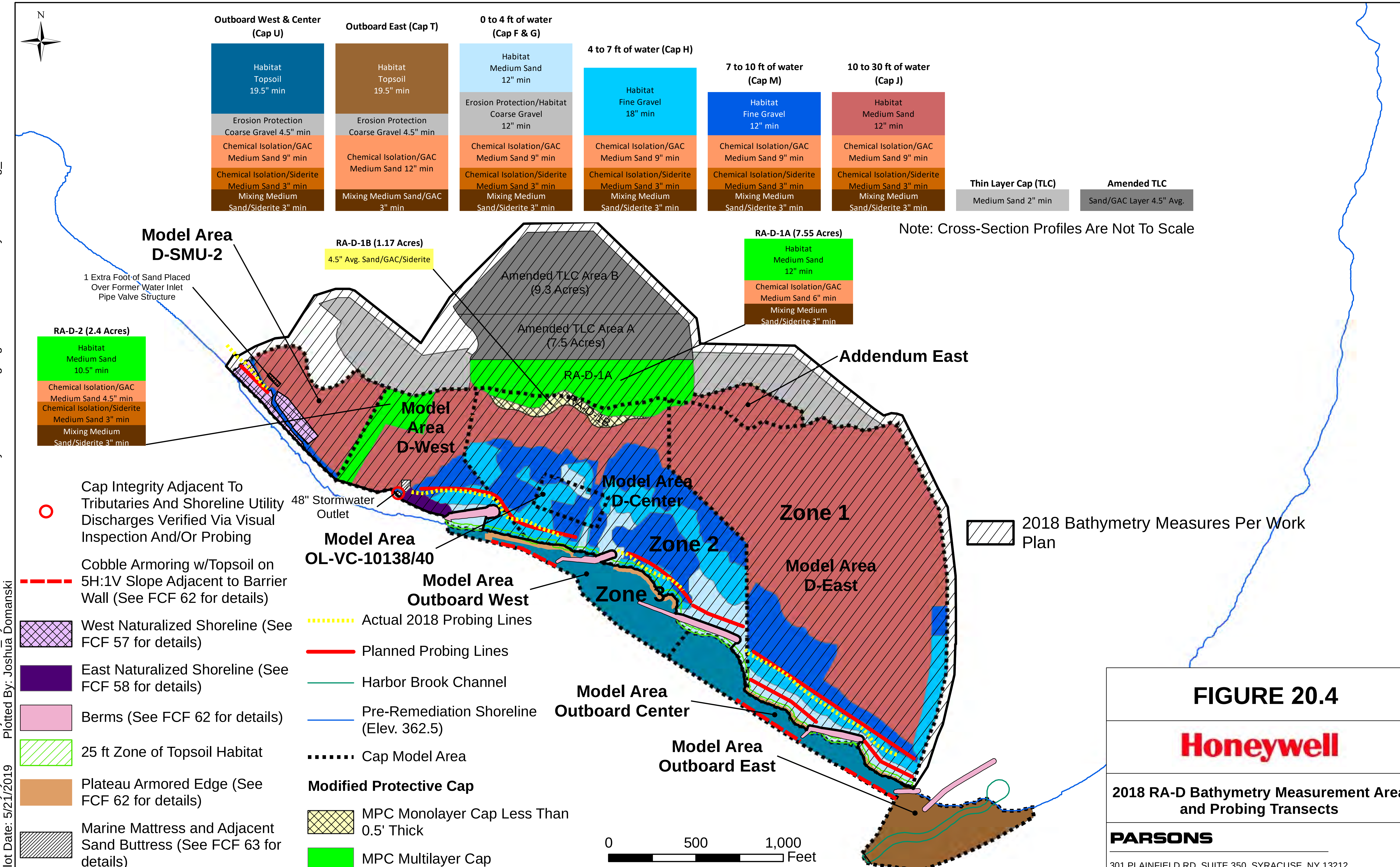
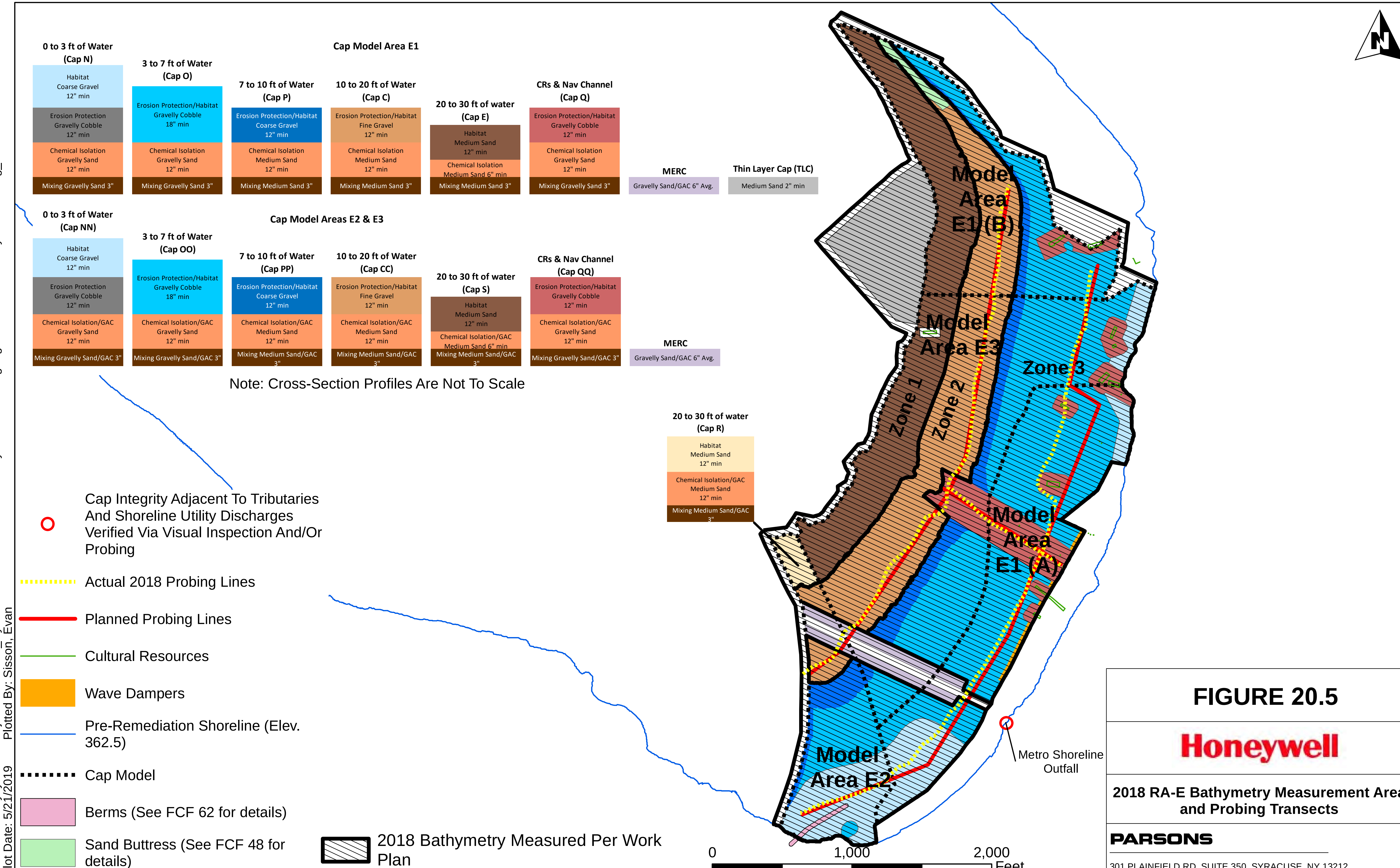


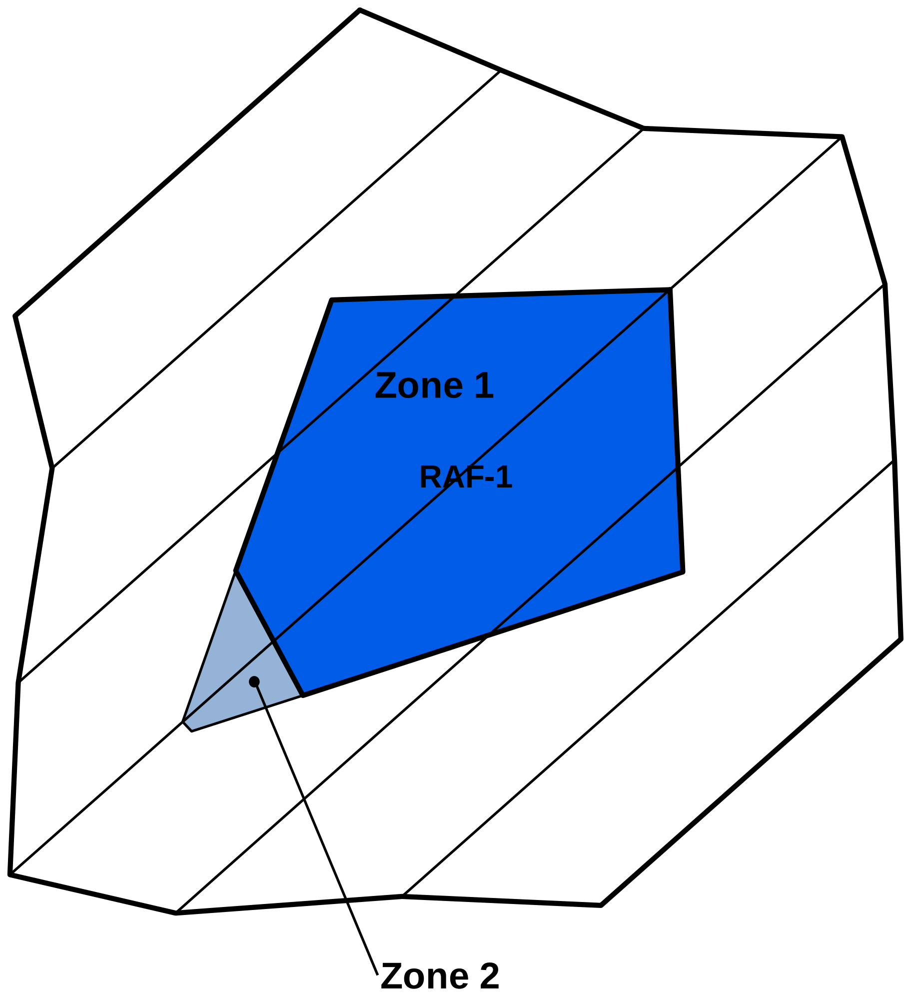
FIGURE 20.4

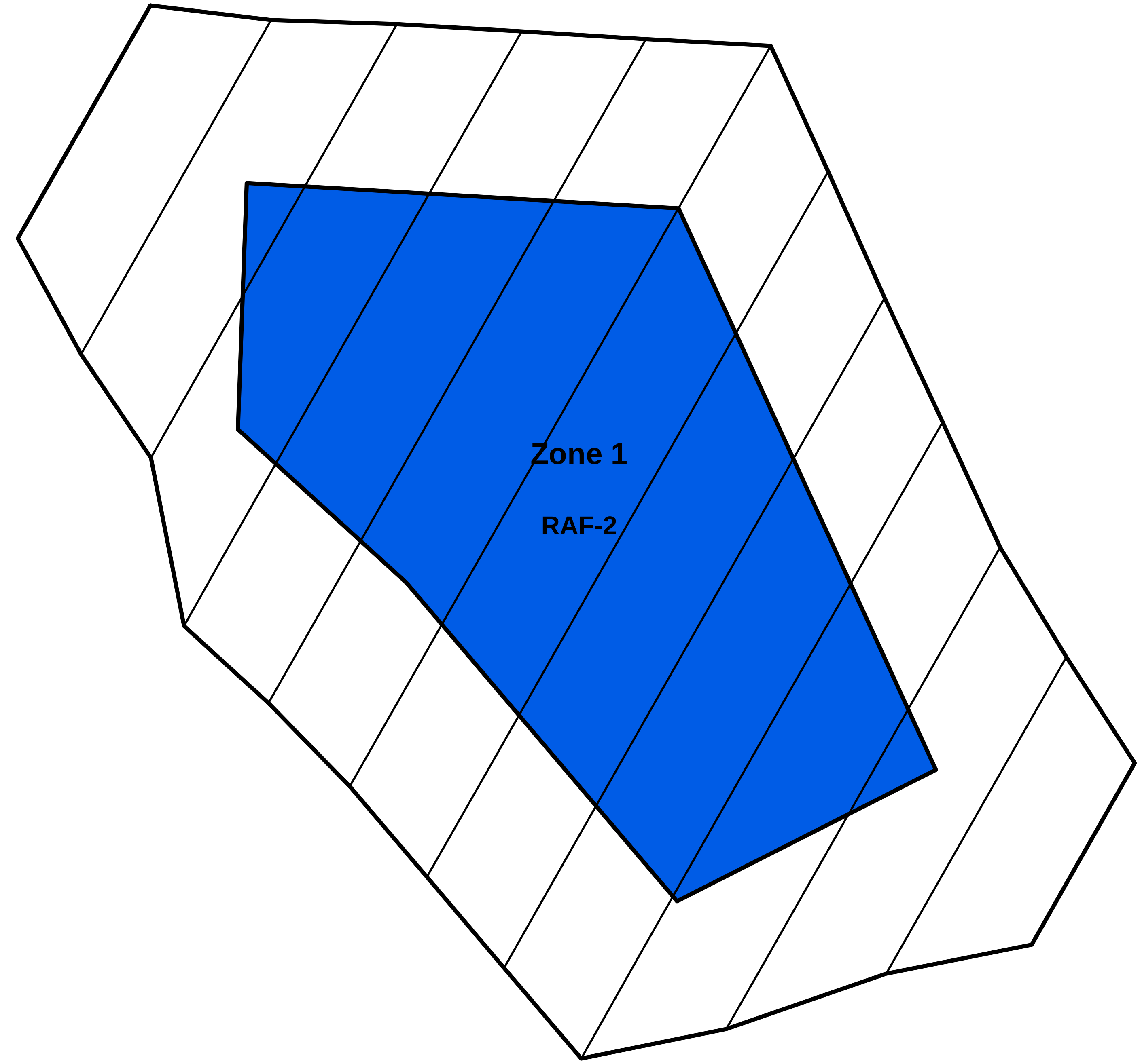
2018 RA-D Bathymetry Measurement Area and Probing Transects

File Name: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\MXDs\DSR\Physical Monitoring\Figure 6-4 - RAD Bathy and Probing_Rev1.mxd
Plot Date: 5/21/2019 Plotted By: Joshua Domanski

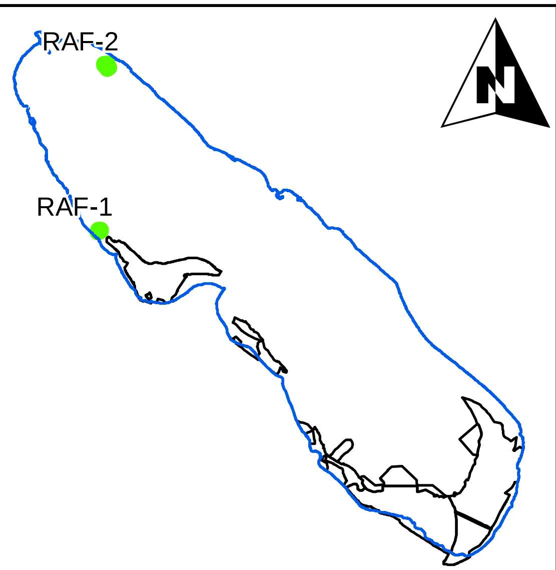


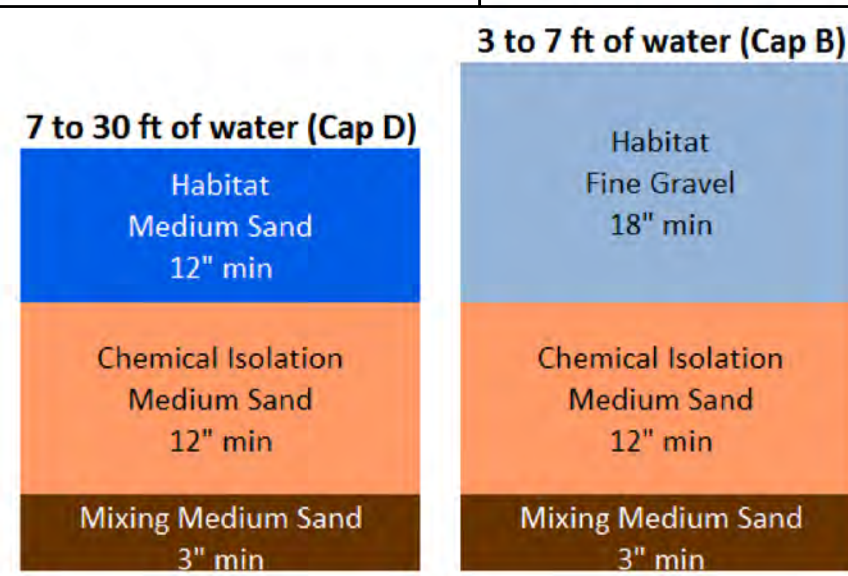
File Name: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\MXDs\DSR\Physical Monitoring\Figure 6-5 - RAE Bathy and Probing_Rev1.mxd
Plot Date: 5/21/2019 Plotted By: Sisson, Evan





2018 Bathymetry Measured Per Work Plan





Note: Cross-Section Profiles Are Not To Scale

0 50 100 Feet

FIGURE 20.6

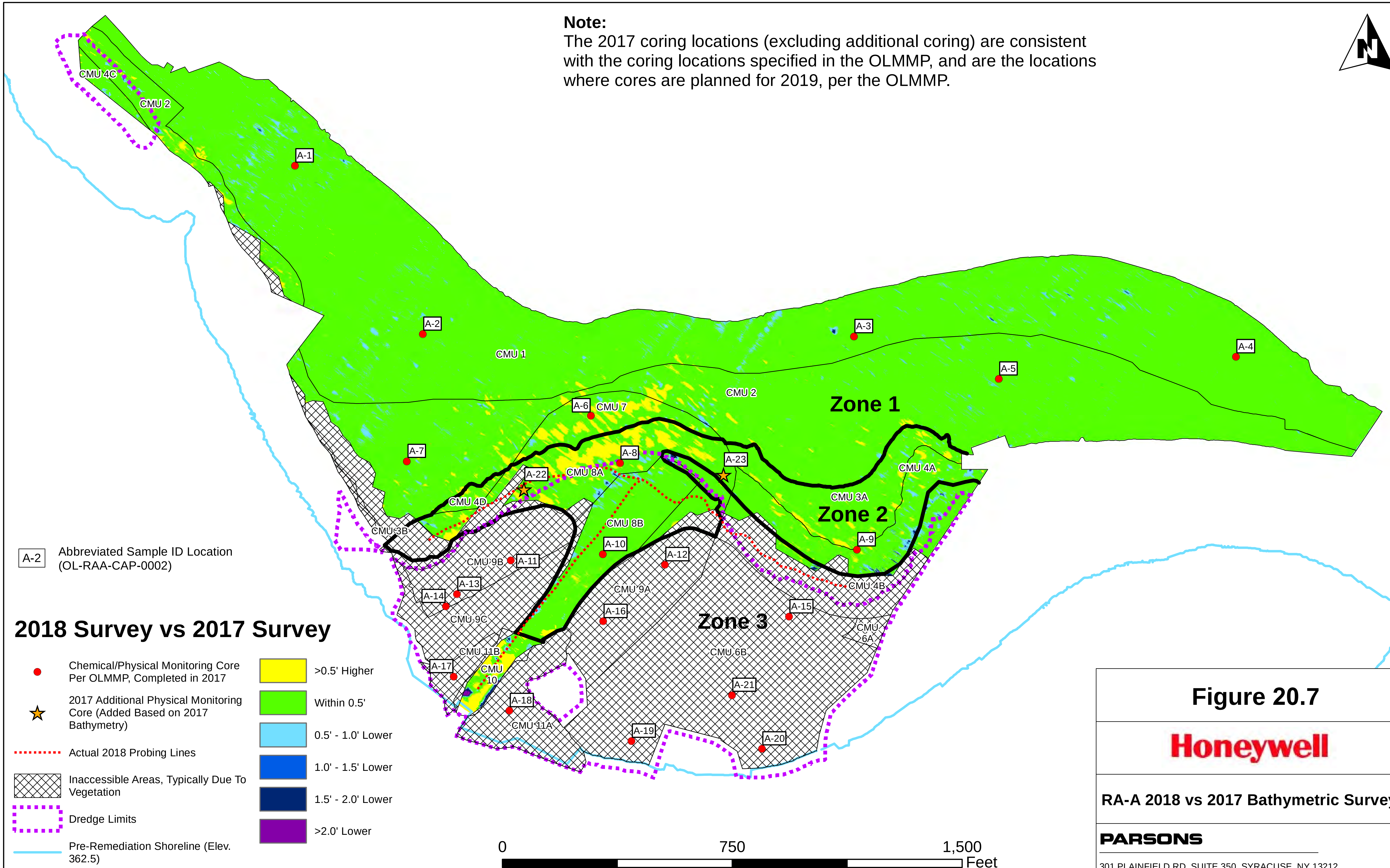
Honeywell

2018 RA-F Bathymetry Measurement Area

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

File Name: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\MXDs\DSR\Physical Monitoring\Figure 6-6 - RAF Bathy and Probing_Rev1.mxd
Plot Date: 4/18/2019 Plotted By: Joshua Domanski



Plot Date: 1/24/2020 Plotted By: Joshua Domanski

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAA OMM Survey 2017 v 2018_Rev1.mxd

Assessment Area Summary and 2019 Recommendations

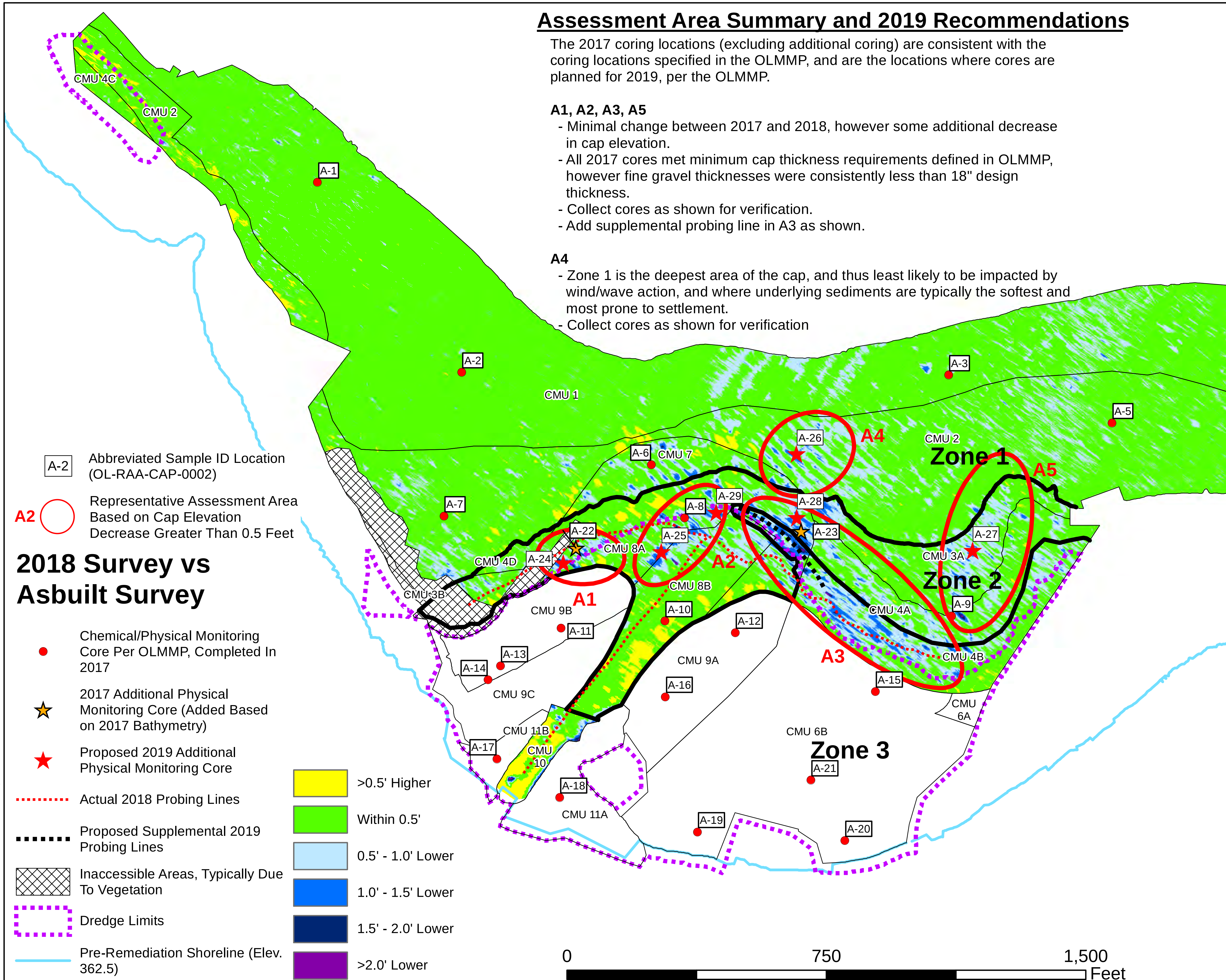
The 2017 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

A1, A2, A3, A5

- Minimal change between 2017 and 2018, however some additional decrease in cap elevation.
- All 2017 cores met minimum cap thickness requirements defined in OLMMP, however fine gravel thicknesses were consistently less than 18" design thickness.
- Collect cores as shown for verification.
- Add supplemental probing line in A3 as shown.

A4

- Zone 1 is the deepest area of the cap, and thus least likely to be impacted by wind/wave action, and where underlying sediments are typically the softest and most prone to settlement.
- Collect cores as shown for verification



2018 Survey vs Asbuilt Survey

- A-2 — Abbreviated Sample ID Location (OL-RAA-CAP-0002)
- A2 — Representative Assessment Area Based on Cap Elevation Decrease Greater Than 0.5 Feet
- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2017
- 2017 Additional Physical Monitoring Core (Added Based on 2017 Bathymetry)
- Proposed 2019 Additional Physical Monitoring Core
- Actual 2018 Probing Lines
- Proposed Supplemental 2019 Probing Lines
- Inaccessible Areas, Typically Due To Vegetation
- Dredge Limits
- Pre-Remediation Shoreline (Elev. 362.5)

- >0.5' Higher
- Within 0.5'
- 0.5' - 1.0' Lower
- 1.0' - 1.5' Lower
- 1.5' - 2.0' Lower
- >2.0' Lower

Plotted By: Joshua Domanski

Plot Date: 5/16/2019

Figure 20.8

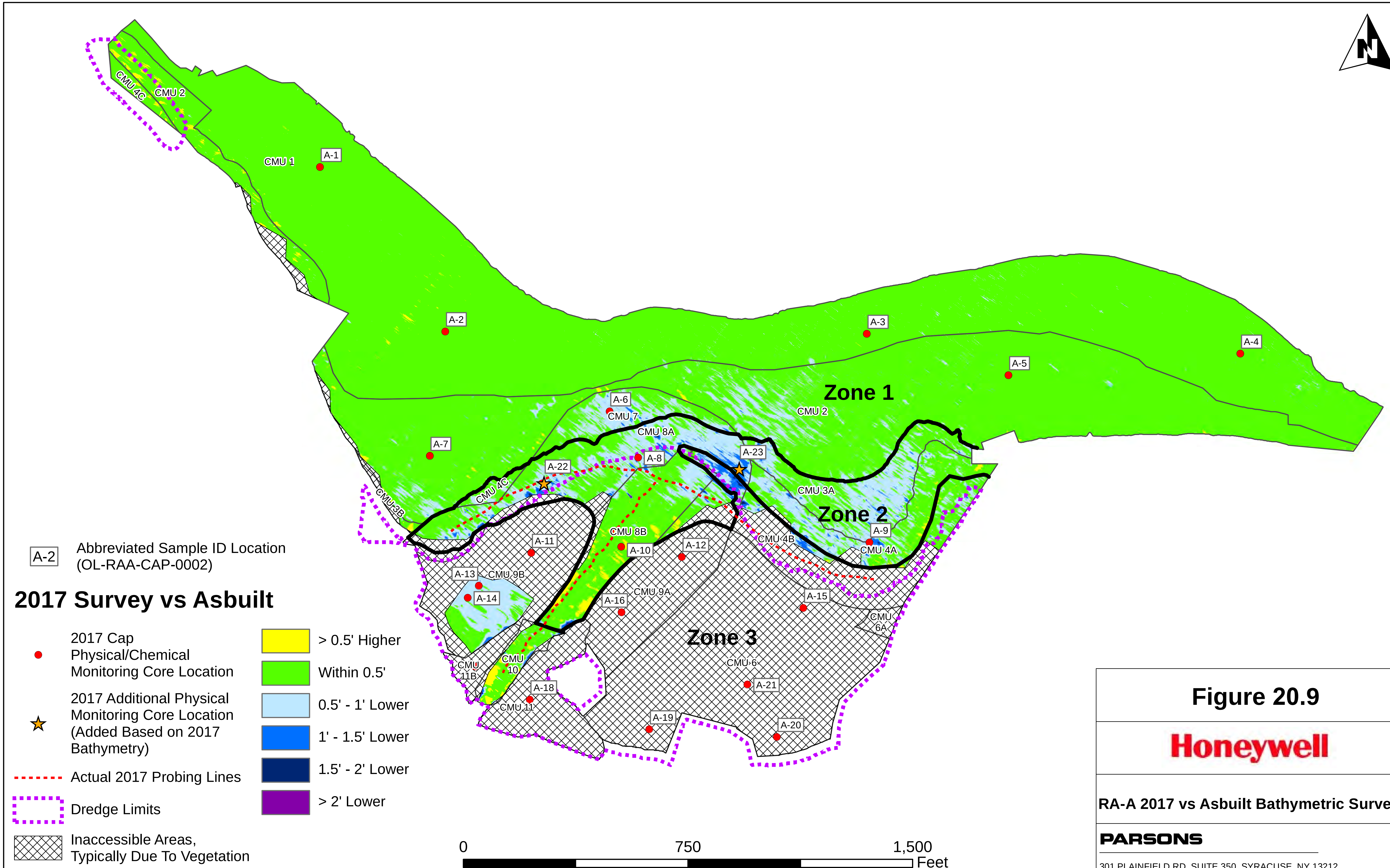
Honeywell

RA-A 2018 vs Asbuilt Bathymetric Survey

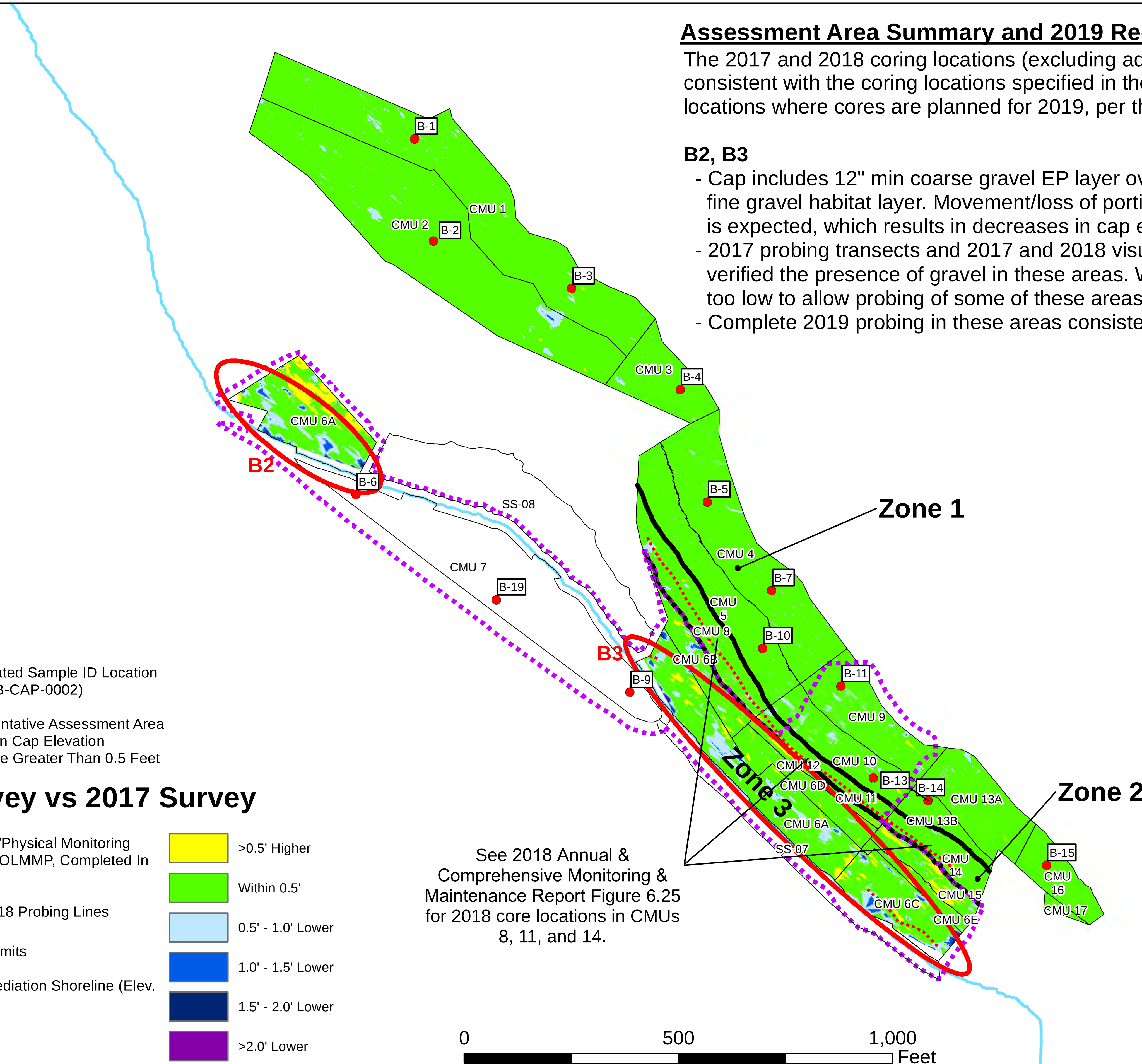
PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAA OMM Survey 2018_Rev1.mxd



Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\2019 Assessment Areas\Figure 6-7 - RAA Bathy_Rev1.mxd Plot Date: 5/8/2019 Plotted By: Joshua Domanski



Assessment Area Summary and 2019 Recommendations

The 2017 and 2018 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

B2, B3

- Cap includes 12" min coarse gravel EP layer overlain by 12" min fine gravel habitat layer. Movement/loss of portions of the habitat layer is expected, which results in decreases in cap elevation.
- 2017 probing transects and 2017 and 2018 visual shoreline inspection verified the presence of gravel in these areas. Water elevations were too low to allow probing of some of these areas in 2018.
- Complete 2019 probing in these areas consistent with OLMMP

A-2 Abbreviated Sample ID Location (OL-RAB-CAP-0002)

B2 Representative Assessment Area Based on Cap Elevation Decrease Greater Than 0.5 Feet

2018 Survey vs 2017 Survey

- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2017
- Actual 2018 Probing Lines
- Dredge Limits
- Pre-Remediation Shoreline (Elev. 362.5)

- >0.5' Higher
- Within 0.5'
- 0.5' - 1.0' Lower
- 1.0' - 1.5' Lower
- 1.5' - 2.0' Lower
- >2.0' Lower

Plotted By: Joshua Domanski

Plot Date: 1/24/2020

Figure 20.10

Honeywell

RA-B 2018 vs 2017 Bathymetric Survey

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

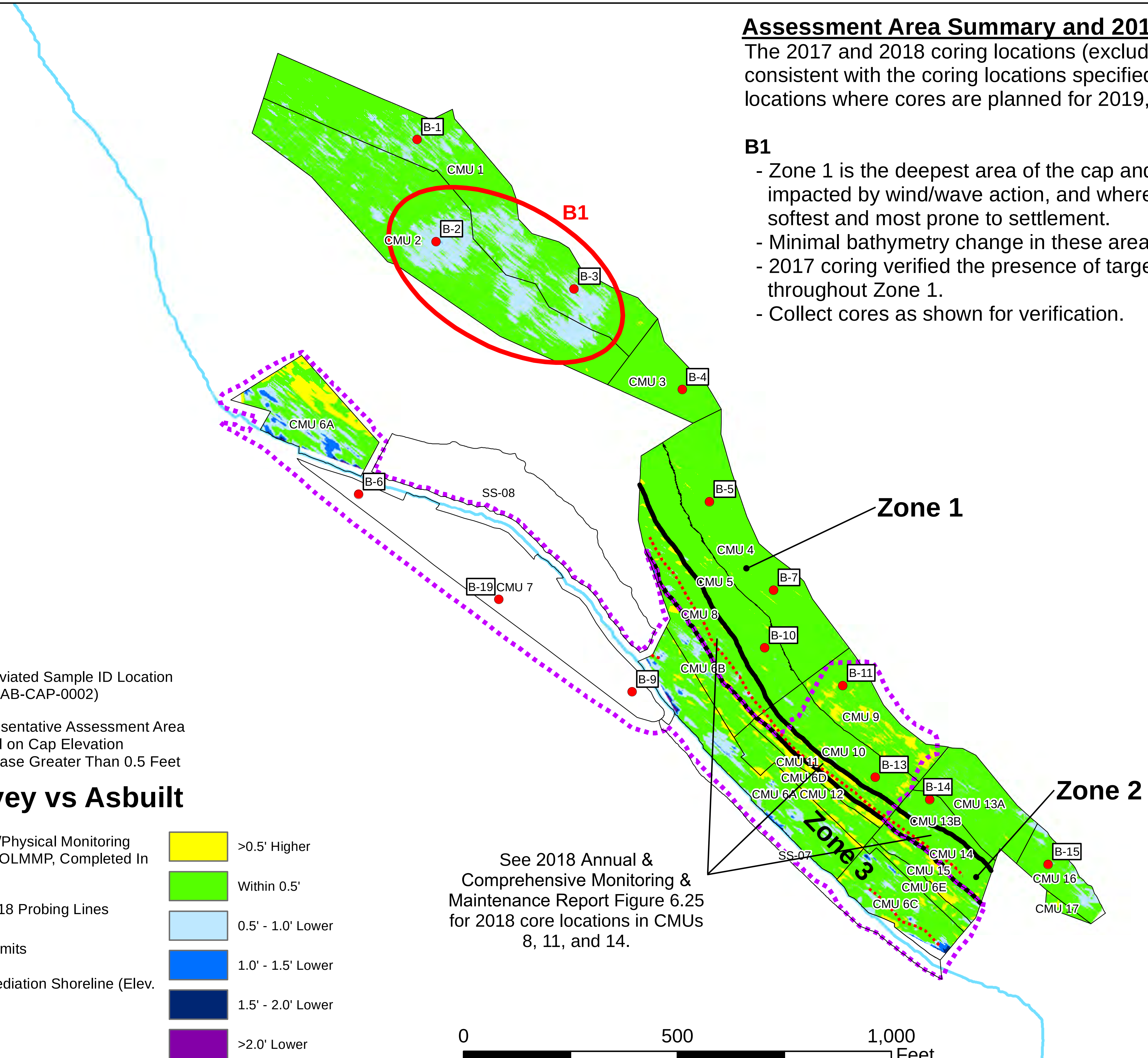
Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAB OMM Survey 2017 v 2018_Rev1.mxd

Assessment Area Summary and 2019 Recommendations

The 2017 and 2018 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

B1

- Zone 1 is the deepest area of the cap and thus least likely to be impacted by wind/wave action, and where underlying sediments are softest and most prone to settlement.
- Minimal bathymetry change in these areas between 2017 and 2018.
- 2017 coring verified the presence of target cap thicknesses throughout Zone 1.
- Collect cores as shown for verification.



B-2 Abbreviated Sample ID Location (OL-RAB-CAP-0002)

B1 Representative Assessment Area Based on Cap Elevation Decrease Greater Than 0.5 Feet

2018 Survey vs Asbuilt

- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2017
- Actual 2018 Probing Lines
- Dredge Limits
- Pre-Remediation Shoreline (Elev. 362.5)

- >0.5' Higher
- Within 0.5'
- 0.5' - 1.0' Lower
- 1.0' - 1.5' Lower
- 1.5' - 2.0' Lower
- >2.0' Lower

Figure 20.11

Honeywell

RA-B 2018 vs Asbuilt Bathymetric Survey

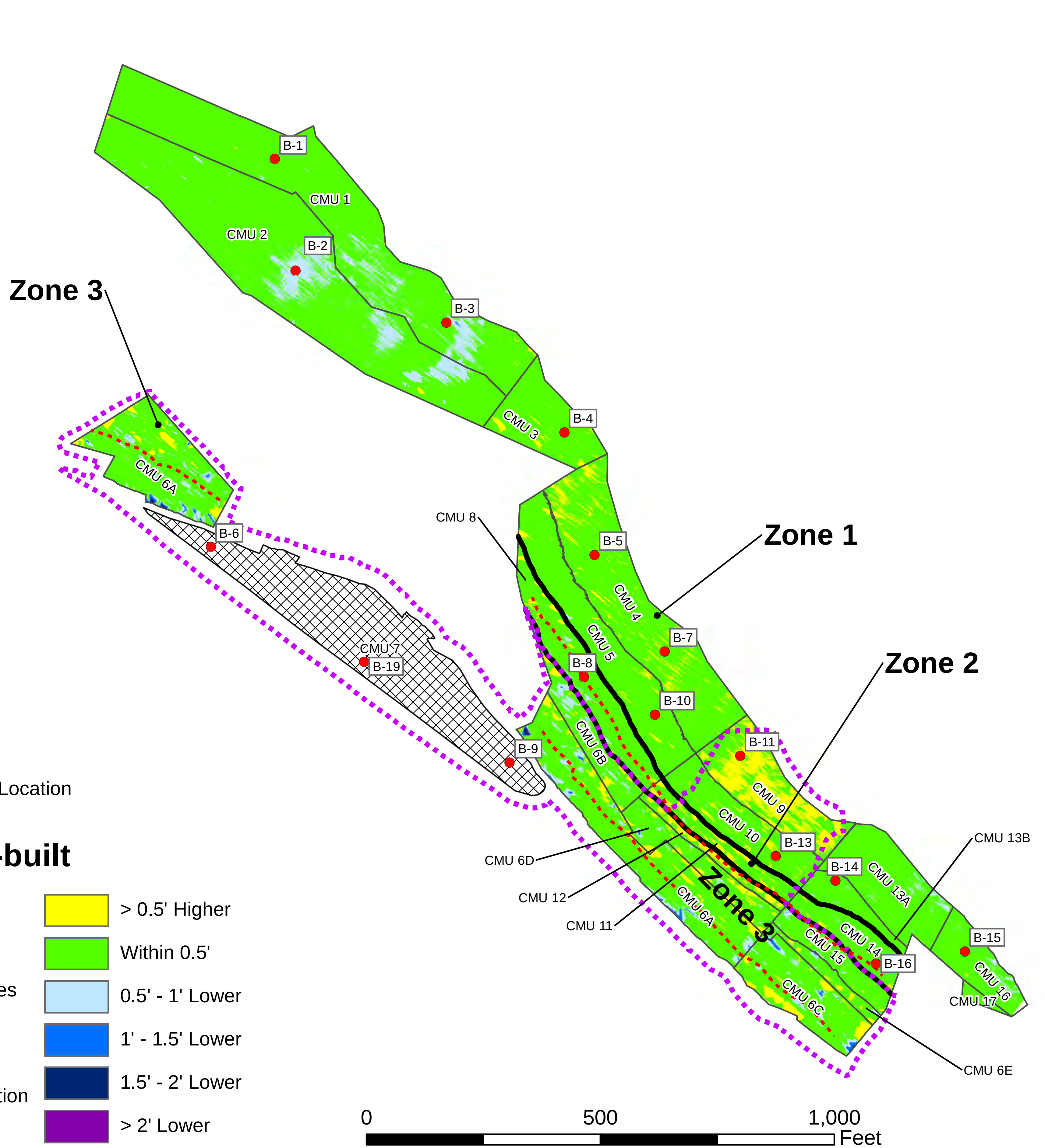
PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Plotted By: Joshua Domanski

Plot Date: 1/24/2020

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAB OMM Survey 2018_Rev1.mxd



B-2 Abbreviated Sample ID Location (OL-RAB-CAP-0002)

2017 Survey vs As-built

- 2017 Physical/Chemical Cap Monitoring Core Location
- Actual 2017 Probing Lines
- Dredge Limits
- Inaccessible Areas, Typically Due To Vegetation

- > 0.5' Higher
- Within 0.5'
- 0.5' - 1' Lower
- 1' - 1.5' Lower
- 1.5' - 2' Lower
- > 2' Lower

Figure 20.12

Honeywell

RA-B 2017 vs Asbuilt Bathymetric Survey

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\2019 Assessment Areas\Figure 6-8 - RAB Bathy_Rev1.mxd

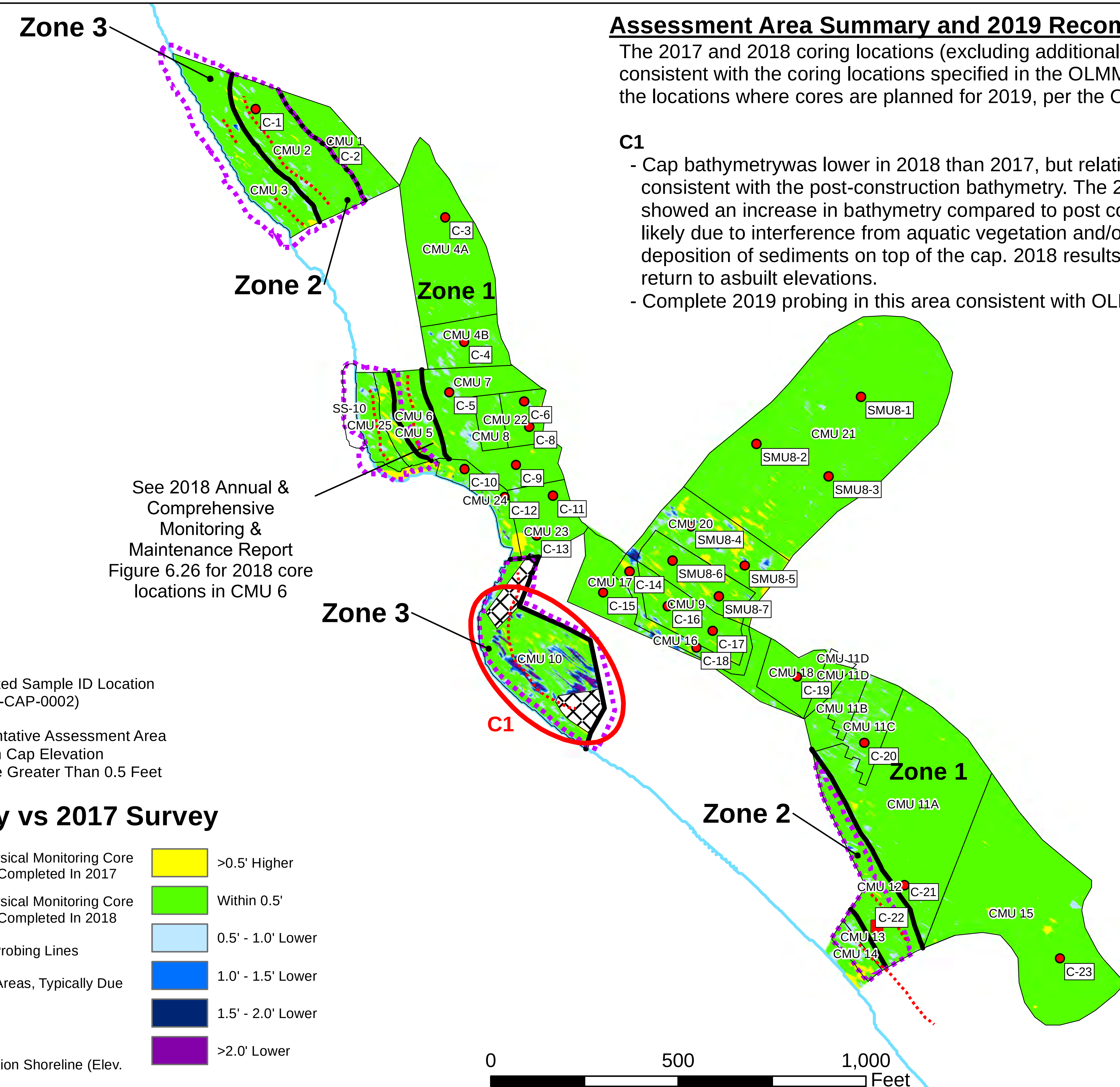
Plot Date: 5/8/2019 Plotted By: Joshua Domanski

Assessment Area Summary and 2019 Recommendations

The 2017 and 2018 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

C1

- Cap bathymetrywas lower in 2018 than 2017, but relatively consistent with the post-construction bathymetry. The 2017 bathymetry showed an increase in bathymetry compared to post construction, likely due to interference from aquatic vegetation and/or temporary deposition of sediments on top of the cap. 2018 results indicate a return to asbuilt elevations.
- Complete 2019 probing in this area consistent with OLMMP



C-2 Abbreviated Sample ID Location (OL-RAC-CAP-0002)

C1 Representative Assessment Area Based on Cap Elevation Decrease Greater Than 0.5 Feet

2018 Survey vs 2017 Survey

- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2017
- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2018
- Actual 2018 Probing Lines
- Inaccessible Areas, Typically Due To Vegetation
- Dredge Limits
- Pre-Remediation Shoreline (Elev. 362.5)

- >0.5' Higher
- Within 0.5'
- 0.5' - 1.0' Lower
- 1.0' - 1.5' Lower
- 1.5' - 2.0' Lower
- >2.0' Lower

Figure 20.13

Honeywell

RA-C 2018 vs 2017 Bathymetric Survey

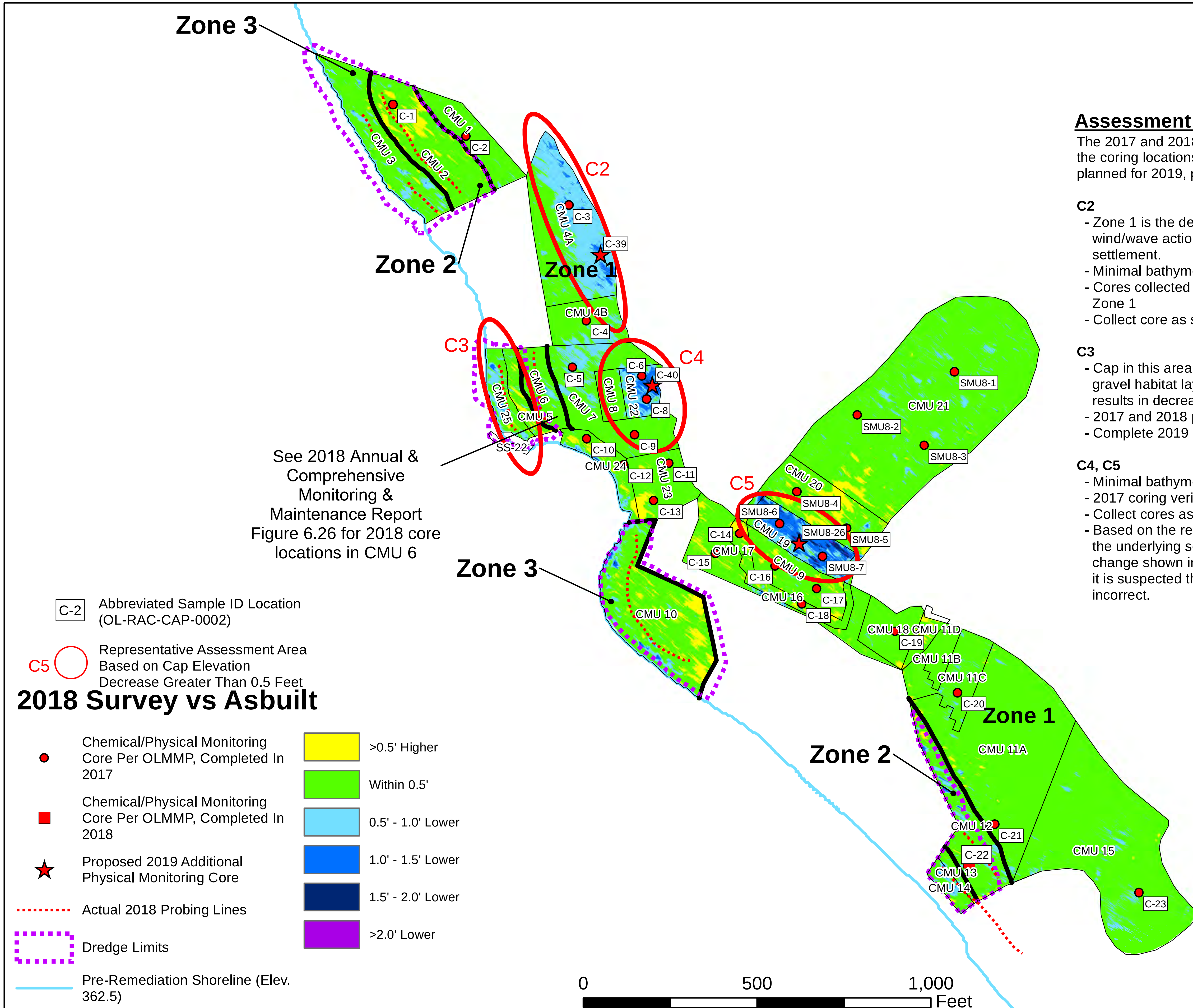
PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Plotted By: Joshua Domanski

Plot Date: 1/24/2020

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAC OMM Survey 2017 v 2018_Rev1.mxd



Assessment Area Summary and 2019 Recommendations

The 2017 and 2018 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

C2

- Zone 1 is the deepest area of the cap and thus least likely to be impacted by wind/wave action, and where underlying sediments are softest and most prone to settlement.
- Minimal bathymetry change in these areas between 2017 and 2018.
- Cores collected in 2017 verified the presence of target cap thickness throughout Zone 1
- Collect core as shown for verification.

C3

- Cap in this area includes 12" min coarse gravel EP layer overlain by 12" min fine gravel habitat layer. Movement/loss of portions of the habitat layer is expected, which results in decreases in cap elevation.
- 2017 and 2018 probing transects verified the presence of gravel in this area.
- Complete 2019 probing in this area consistent with OLMMP.

C4, C5

- Minimal bathymetry change in these areas between 2017 and 2018.
- 2017 coring verified the presence of target cap thickness in these areas.
- Collect cores as shown for verification.
- Based on the relatively thin caps in these areas, significant settlement of the underlying sediment is unlikely. Given the area of significant bathymetry change shown in each area corresponds almost exactly with the CMU boundary, it is suspected that the as-built survey for these two CMUs may have been incorrect.

Figure 20.14

Honeywell

RA-C 2018 vs Asbuilt Bathymetric Survey

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Plotted By: Joshua Domanski

Plot Date: 1/24/2020

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAC OMM Survey 2018_Rev1.mxd

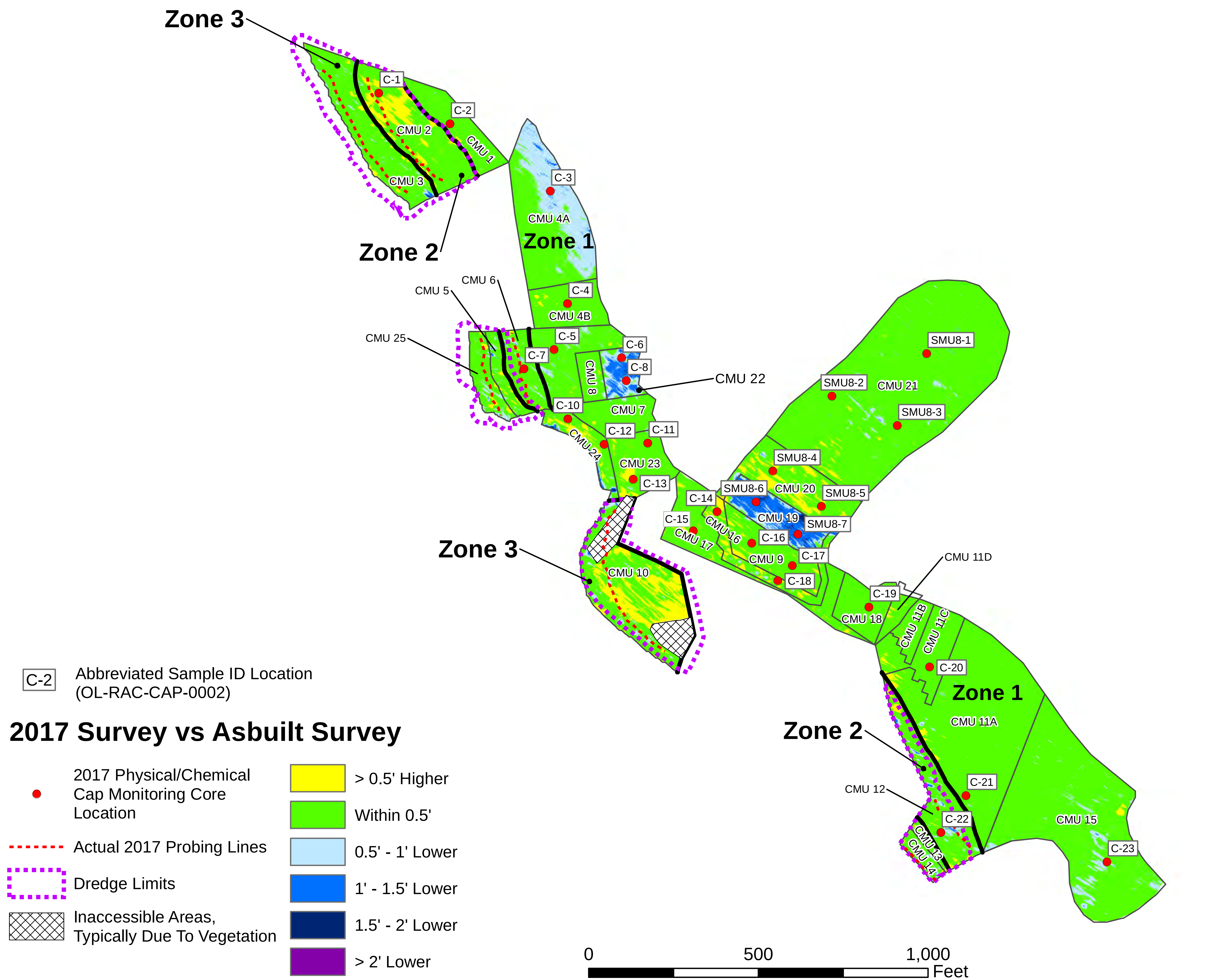


Figure 20.15

Honeywell

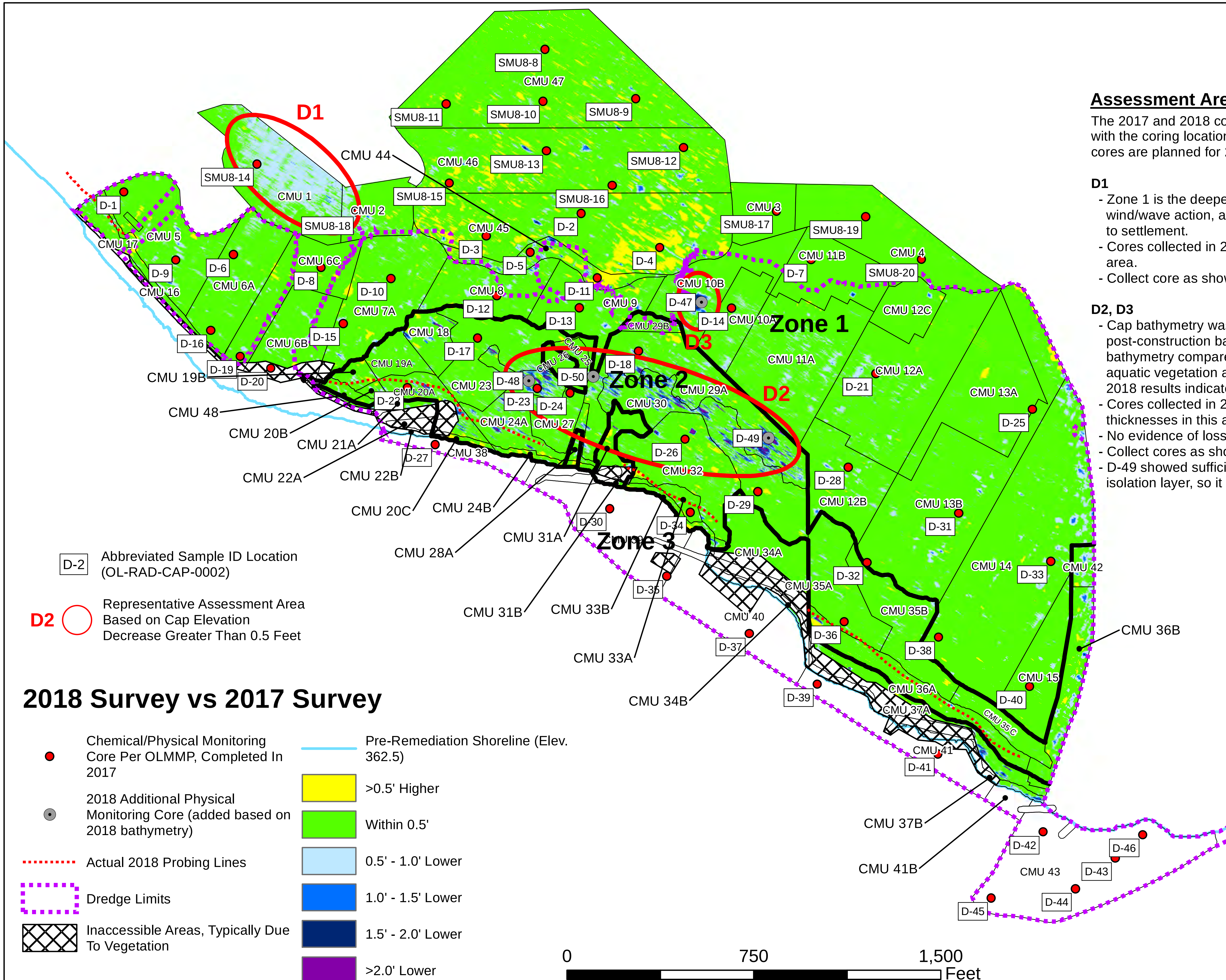
RA-C 2017 vs Asbuilt Bathymetric Survey

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\2019 Assessment Areas\Figure 6-9 - RAC Bathy_Rev1.mxd

Plot Date: 5/16/2019 Plotted By: Joshua Domanski



Assessment Area Summary and 2019 Recommendations

The 2017 and 2018 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

D1

- Zone 1 is the deepest area of the cap and thus least likely to be impacted by wind/wave action, and where underlying sediments are softest and most prone to settlement.
- Cores collected in 2017 verified the presence of target cap thicknesses in this area.
- Collect core as shown for verification.

D2, D3

- Cap bathymetry was lower in 2018 than 2017, but relatively consistent with the post-construction bathymetry. The 2017 bathymetry showed an increase in bathymetry compared to post-construction, likely due to interference from aquatic vegetation and/or temporary deposition of sediments on top of the cap. 2018 results indicate a resturn to asbuilt elevations.
- Cores collected in 2017 and 2018 verified the presence of target cap thicknesses in this area.
- No evidence of loss of cap material
- Collect cores as shown for verification.
- D-49 showed sufficient gravel tickness but did not fully penetrate the chemical isolation layer, so it will be re-cored in 2019.

Figure 20.16

Honeywell

RA-D 2018 vs 2017 Bathymetric Survey

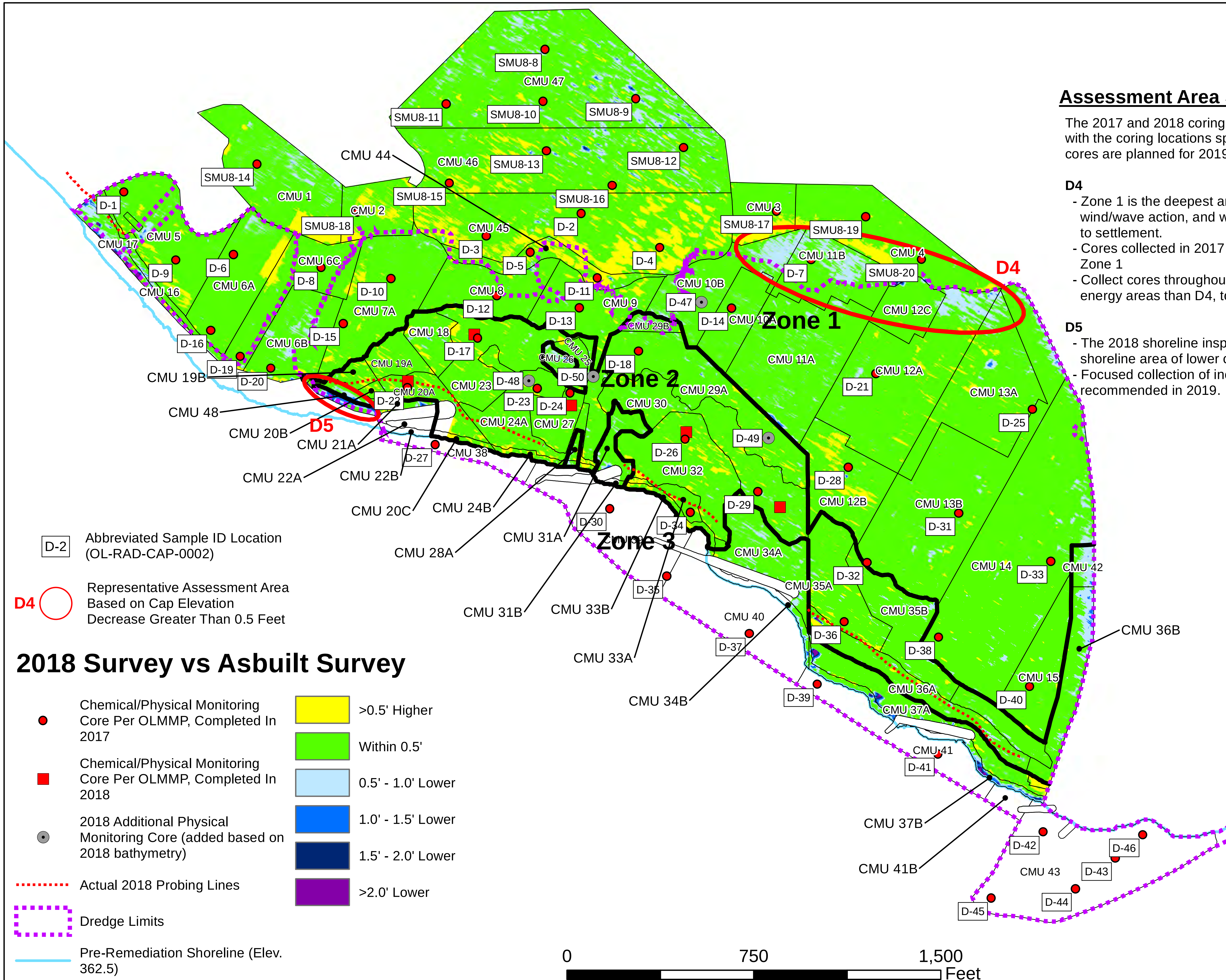
PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Plotted By: Joshua Domanski

Plot Date: 1/24/2020

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAD OMM Survey 2017 v 2018_Rev1.mxd



Assessment Area Summary and 2019 Recommendations

The 2017 and 2018 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

D4

- Zone 1 is the deepest area of the cap and thus least likely to be impacted by wind/wave action, and where underlying settlements are softest and most prone to settlement.
- Cores collected in 2017 verified the presence of target cap thicknesses throughout Zone 1
- Collect cores throughout Zone 1 as shown, including shallower and thus higher energy areas than D4, to verify stability of sand cap.

D5

- The 2018 shoreline inspection and zooming in on this area identified a localized shoreline area of lower cap surface elevation.
- Focused collection of increased bathymetry data and physical inspection recommended in 2019.

Figure 20.17

Honeywell

RA-D 2018 vs Asbuilt Bathymetric Survey

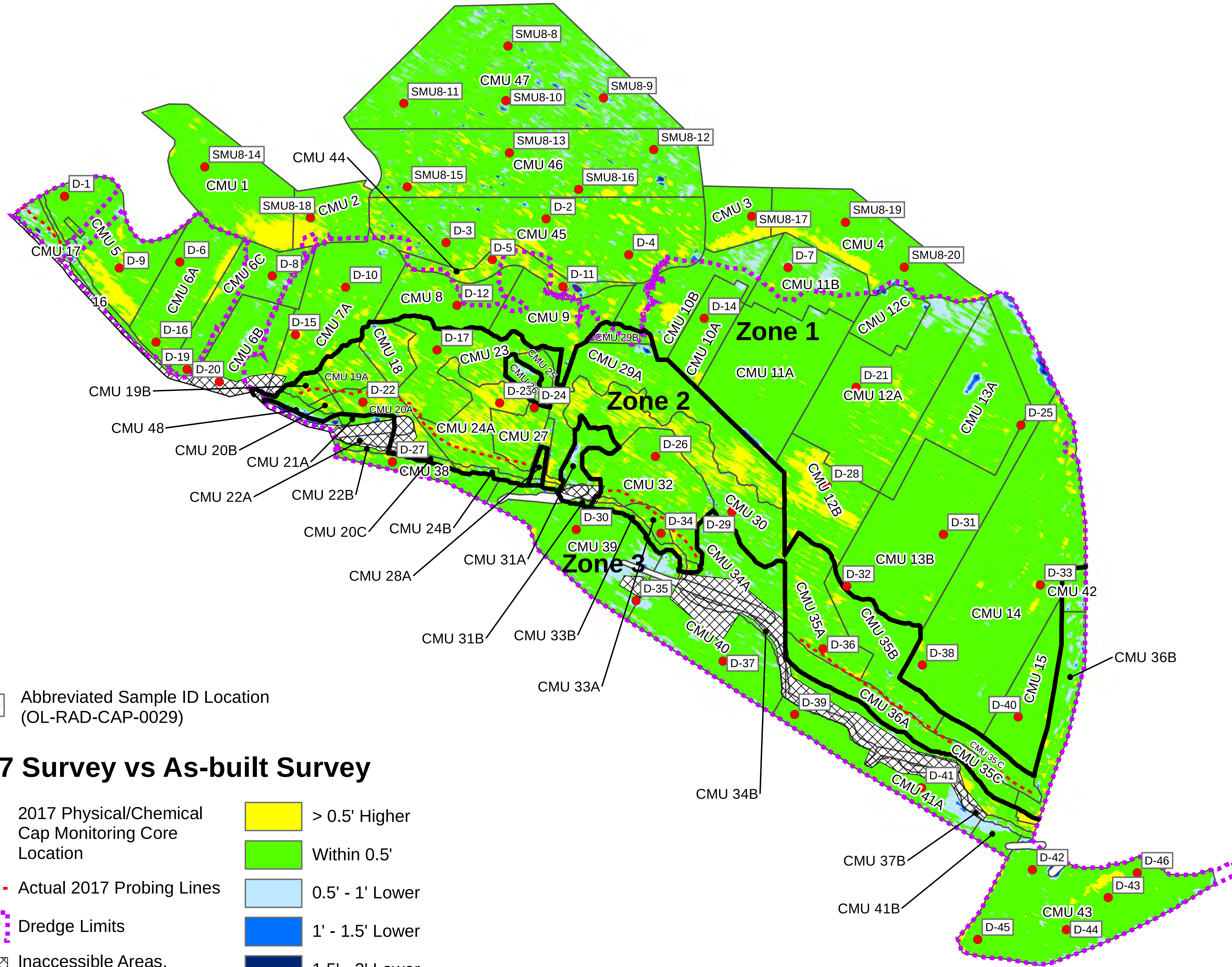
PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Plotted By: Joshua Domanski

Plot Date: 1/24/2020

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAD OMM Survey 2018_Rev1.mxd



D-29 Abbreviated Sample ID Location (OL-RAD-CAP-0029)

2017 Survey vs As-built Survey

- 2017 Physical/Chemical Cap Monitoring Core Location
- Actual 2017 Probing Lines
- Dredge Limits
- Inaccessible Areas, Typically Due To Vegetation
- > 0.5' Higher
- Within 0.5'
- 0.5' - 1' Lower
- 1' - 1.5' Lower
- 1.5' - 2' Lower
- > 2' Lower

Figure 20.18

Honeywell

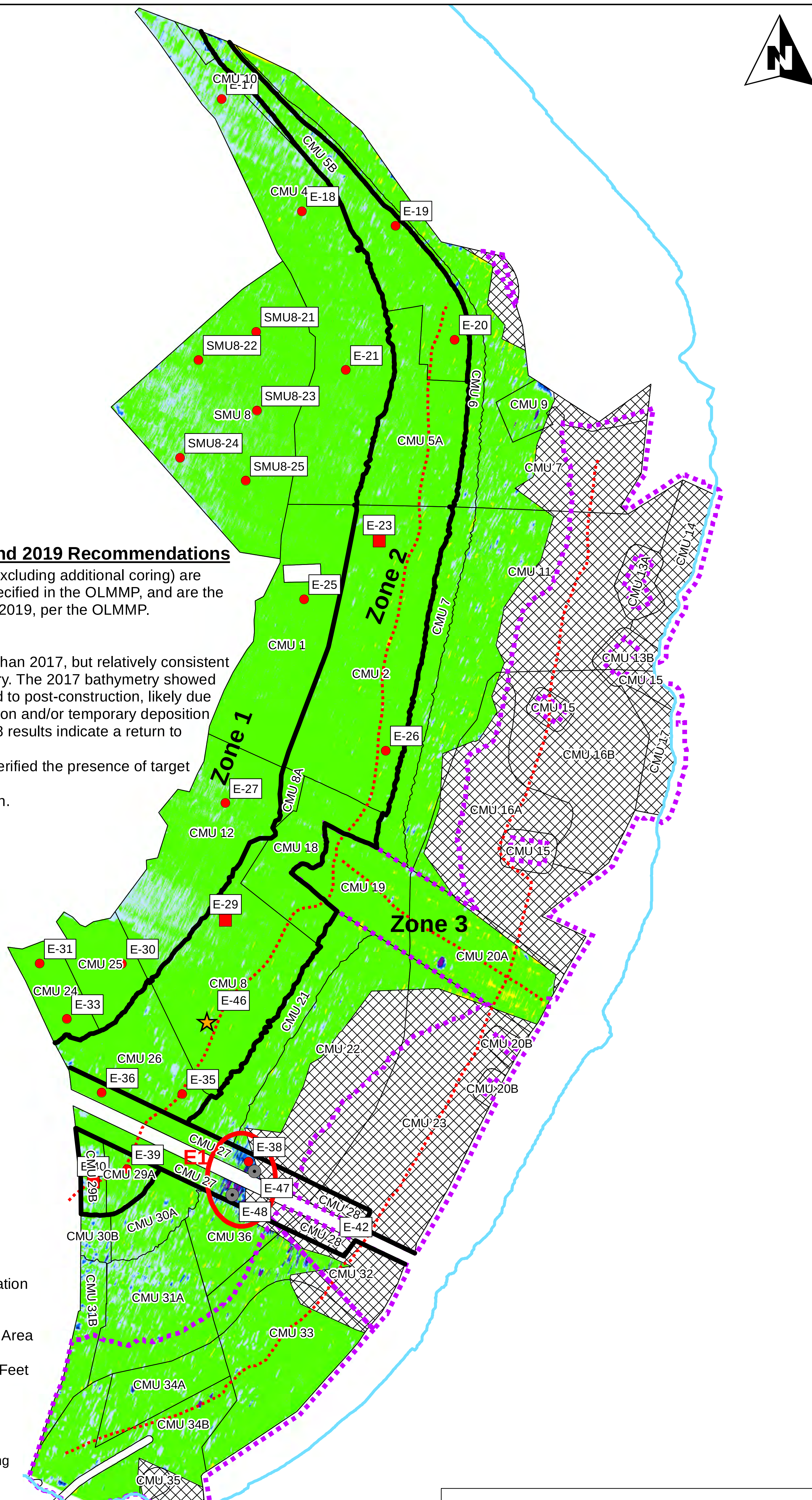
RA-D 2017 vs Asbuilt Bathymetric Survey

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\2019 Assessment Areas\Figure 6-10 - RAD Bathy_Rev1.mxd

Plot Date: 5/17/2019 Plotted By: Joshua Domanski



Assessment Area Summary and 2019 Recommendations

The 2017 and 2018 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

E1

- Cap bathymetry was lower in 2018 than 2017, but relatively consistent with the post-construction bathymetry. The 2017 bathymetry showed an increase in bathymetry compared to post-construction, likely due to interference from aquatic vegetation and/or temporary deposition of sediments on top of the cap. 2018 results indicate a return to asbuilt elevations.
- Cores collected in 2017 and 2018 verified the presence of target cap thickness.
- Collect core as shown for verification.

E-2 Abbreviated Sample ID Location (OL-RAE-CAP-0002)

E1 Representative Assessment Area Based on Cap Elevation Decrease Greater Than 0.5 Feet

2018 Survey vs 2017 Survey

- 2017 Additional Physical Monitoring Core (Added Based On 2017 Bathymetry Results)
- Chemical/Physical monitoring Core Per OLMMP, Completed In 2017
- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2018
- 2018 Additional Physical Monitoring Core (added based on 2018 bathymetry)
- Actual 2018 Probing Lines
- Dredge Outlines
- Inaccessible Areas, Typically Due To Vegetation

- >0.5' Higher
- Within 0.5'
- 0.5' - 1.0' Lower
- 1.0' - 1.5' Lower
- 1.5' - 2.0' Lower
- >2.0' Lower
- Pre-Remediation Shoreline (Elev. 362.5)

0 700 1,400 Feet

Figure 20.19

Honeywell

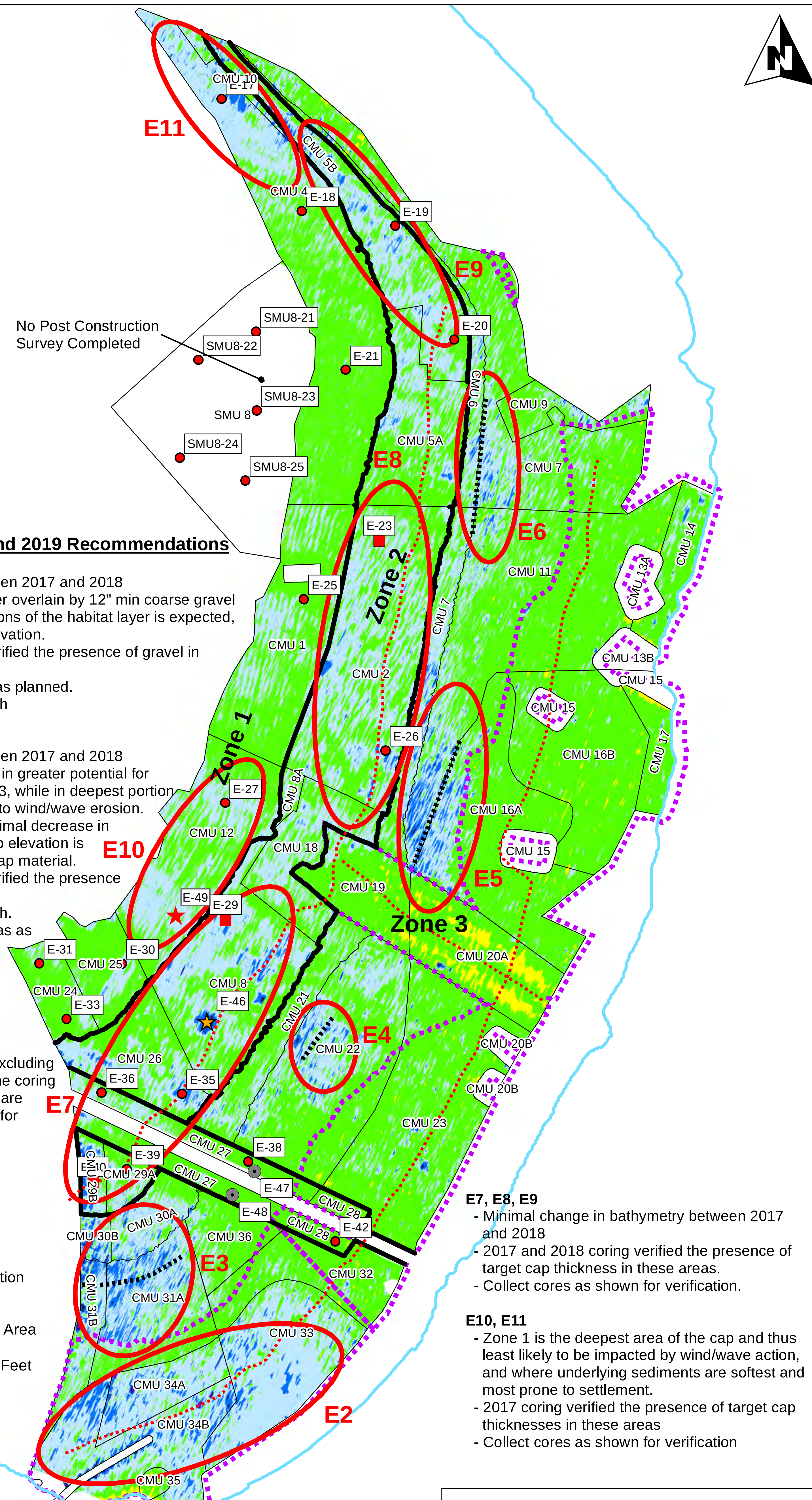
RA-E 2018 vs 2017 Bathymetric Survey

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAE OMM Survey 2017 v 2018_Rev1.mxd

Plot Date: 5/17/2019 Plotted By: Joshua Domanski



Assessment Area Summary and 2019 Recommendations

E2
- Minimal change in bathymetry between 2017 and 2018
- Cap includes 12" min cobble EP layer overlain by 12" min coarse gravel habitat layer. Movement/loss of portions of the habitat layer is expected, which results in decreases in cap elevation.
- 2017 and 2018 probing transects verified the presence of gravel in these areas.
- Complete 2019 probing in this area as planned.
- EP layer is too coarse to core through

E3, E4, E5, E6
- Minimal change in bathymetry between 2017 and 2018
- Beyond extent of dredging, resulting in greater potential for settlement than other areas of Zone 3, while in deepest portion of Zone 3 and thus the least subject to wind/wave erosion. Shallower areas of Zone 3 show minimal decrease in elevation. Therefore, decrease in cap elevation is likely due to settlement, not loss of cap material.
- 2017 and 2018 probing transects verified the presence of gravel in these areas.
- EP layer is too coarse to core through.
- Complete 2019 probing in these areas as planned.
- Add supplemental probing lines as shown.

Note:
The 2017 and 2018 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

E7, E8, E9
- Minimal change in bathymetry between 2017 and 2018
- 2017 and 2018 coring verified the presence of target cap thickness in these areas.
- Collect cores as shown for verification.

E10, E11
- Zone 1 is the deepest area of the cap and thus least likely to be impacted by wind/wave action, and where underlying sediments are softest and most prone to settlement.
- 2017 coring verified the presence of target cap thicknesses in these areas
- Collect cores as shown for verification

E-2 Abbreviated Sample ID Location (OL-RAE-CAP-0002)

E2 Representative Assessment Area Based on Cap Elevation Decrease Greater Than 0.5 Feet

2018 Survey vs Asbuilt Survey

- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2017
- 2017 Additional Physical Monitoring Core (Added Based On 2017 Bathymetry Results)
- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2018
- 2018 Additional Physical Monitoring Core (added based on 2018 bathymetry)
- Proposed 2019 Additional Physical Monitoring Core
- Actual 2018 Probing Lines
- Proposed Supplemental 2019 Probing Lines
- Dredge Outlines

- >0.5' Higher
- Within 0.5'
- 0.5' - 1.0' Lower
- 1.0' - 1.5' Lower
- 1.5' - 2.0' Lower
- >2.0' Lower
- Pre-Remediation Shoreline (Elev. 362.5)

Figure 20.20

Honeywell

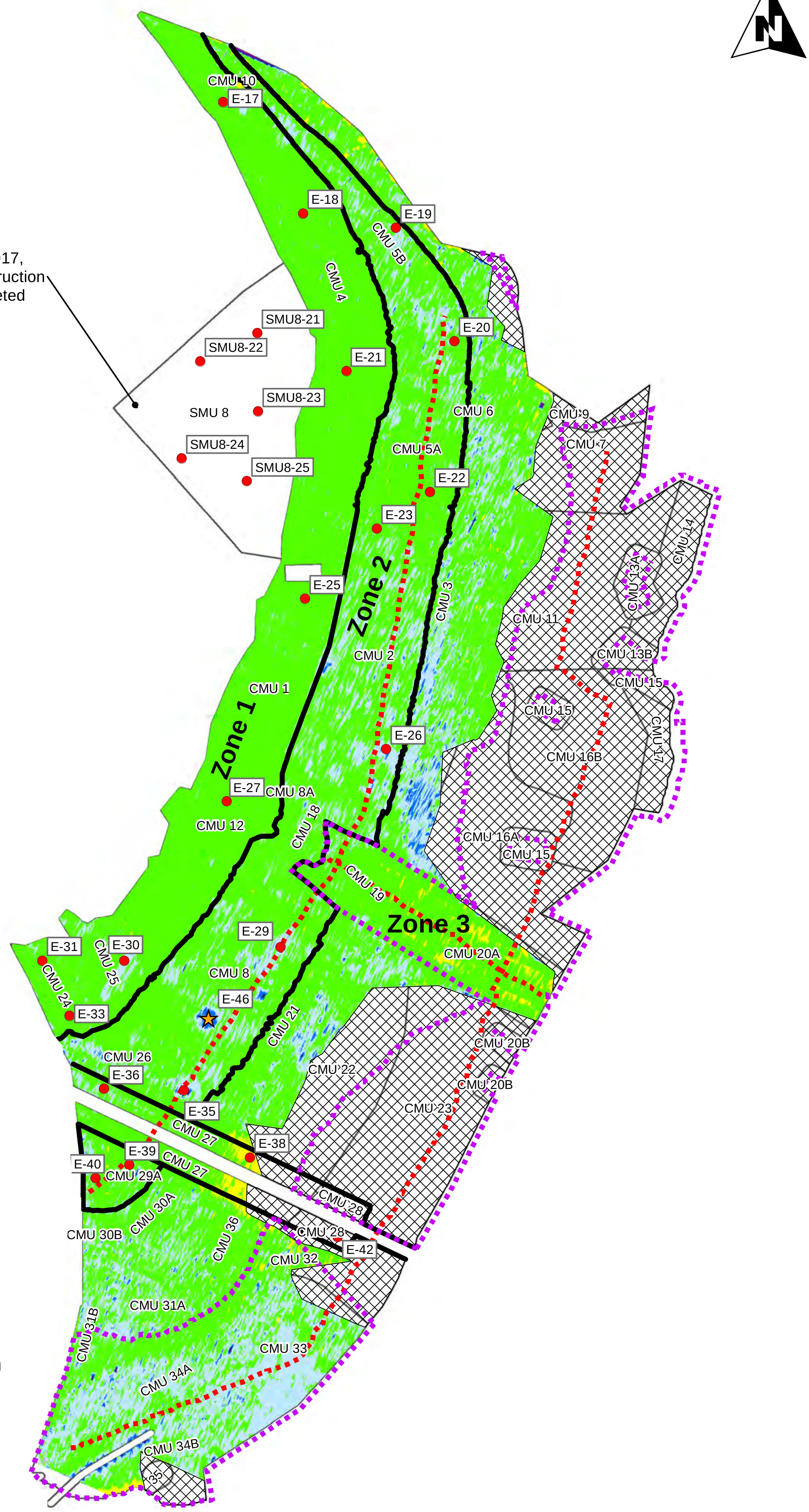
RA-E 2018 vs Asbuilt Bathymetric Survey

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAE OMM Survey 2018_Rev1.mxd

Plot Date: 5/17/2019 Plotted By: Joshua Domanski



E-29 Abbreviated Sample ID Location (OL-RAE-CAP-0029)

2017 Survey vs Asbuilt Survey

- 2017 Chemical/Physical Cap Monitoring CoreLocation
- 2017 Additional Physical Monitoring Core Location (added based on 2017 bathymetry results)
- Dredge Limits
- Actual 2017 Probing Lines
- Inaccessible Areas, Typically Due To Vegitation

- > 0.5' Higher
- Within 0.5'
- 0.5' - 1' Lower
- 1' - 1.5' Lower
- 1.5' - 2' Lower
- > 2' Lower

0 750 1,500 Feet

Figure 20.21

Honeywell

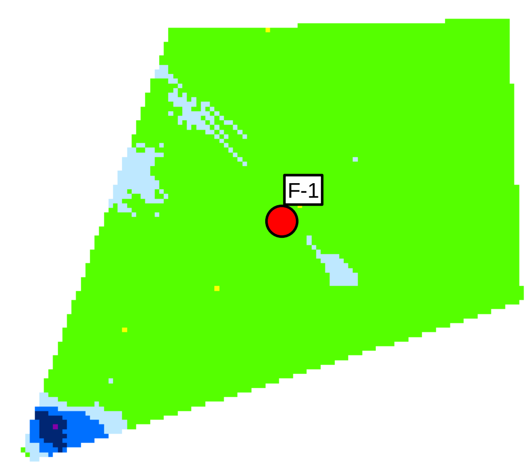
RA-E 2017 vs Asbuilt Bathymetric Survey

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

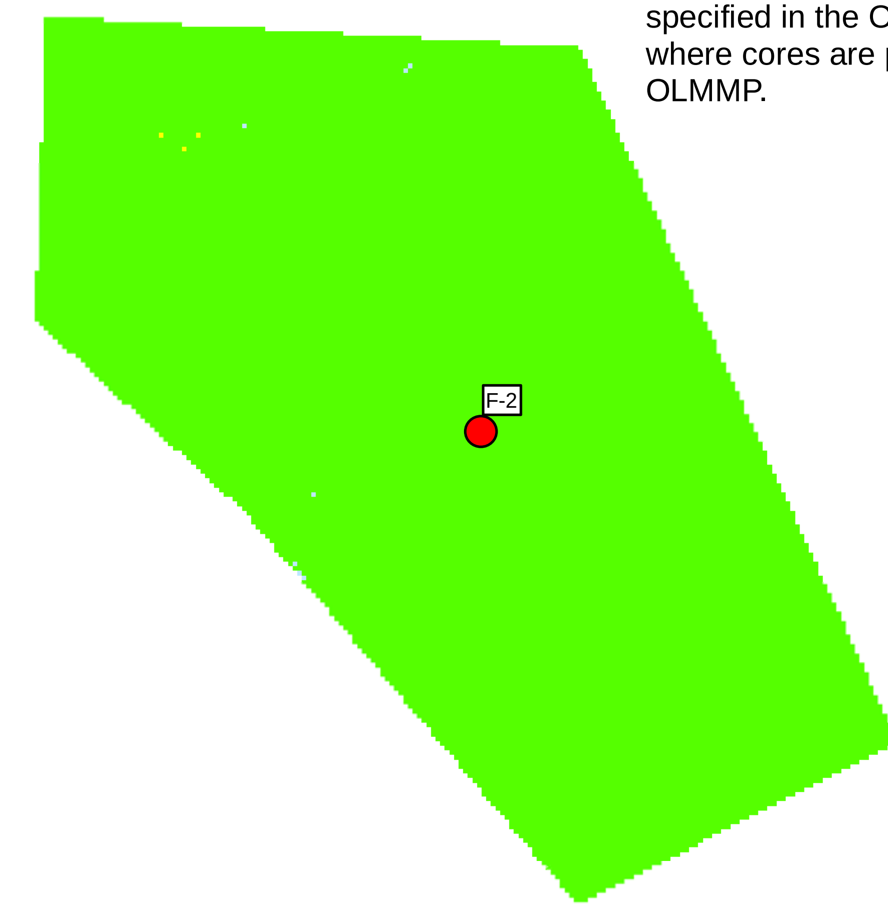
Document Path: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\2019 Assessment Areas\Figure 6-11 - RAE Bathy_Rev1.mxd
Plot Date: 5/17/2019 Plotted By: Joshua Domanski

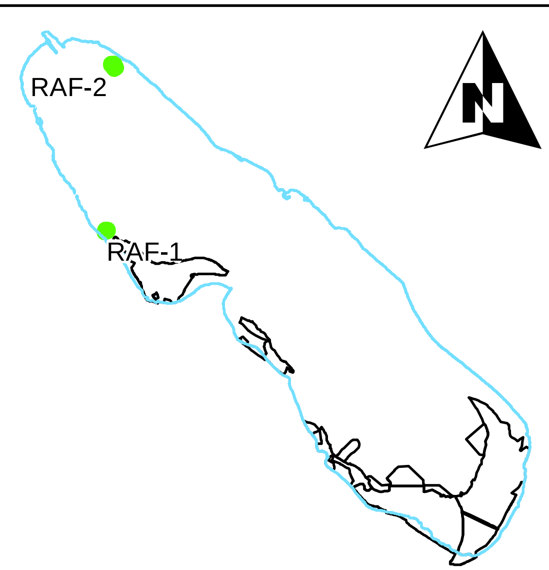
RA-F 1



RA-F 2

Note:
The 2017 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.





2018 Survey vs 2017 Survey

- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2017
- Pre-Remediation Shoreline (Elev. 362.5)
- > 0.5' Higher
- Within 0.5'
- 0.5' - 1' Lower
- 1' - 1.5' Lower
- 1.5' - 2' Lower
- > 2' Lower
- F-2 Abbreviated Sample ID Location (OL-RAF-CAP-0002)

0 50 100 Feet

Figure 20.22

Honeywell

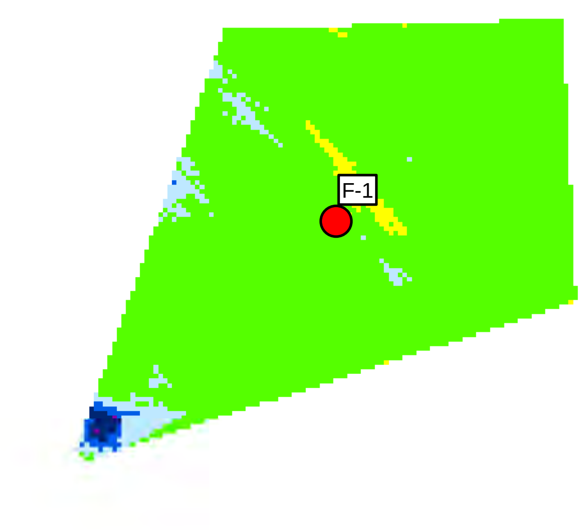
RA-F 2018 vs 2017 Bathymetric Survey

PARSONS

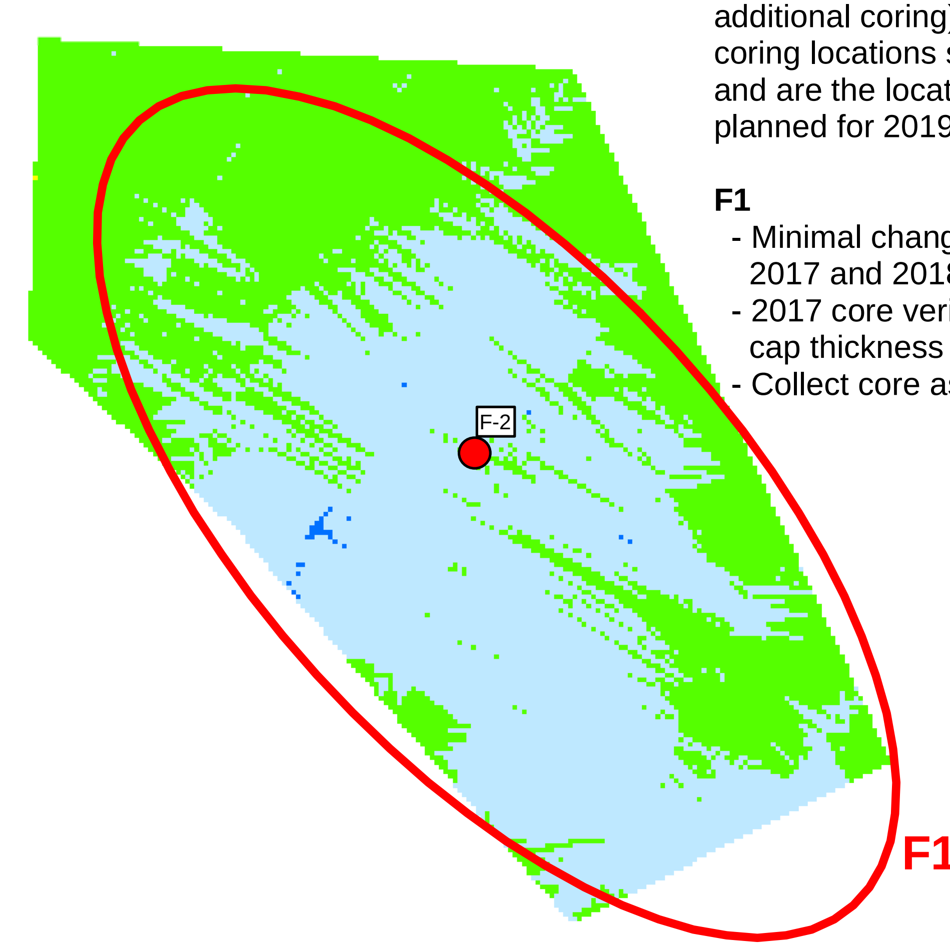
301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

File Name: \\nysyr04fs01\PrjData\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAF OMM Survey 2017 v 2018 Rev2.mxd
Plot Date: 5/7/2019 Plotted By: Joshua Domanski

RA-F 1



RA-F 2

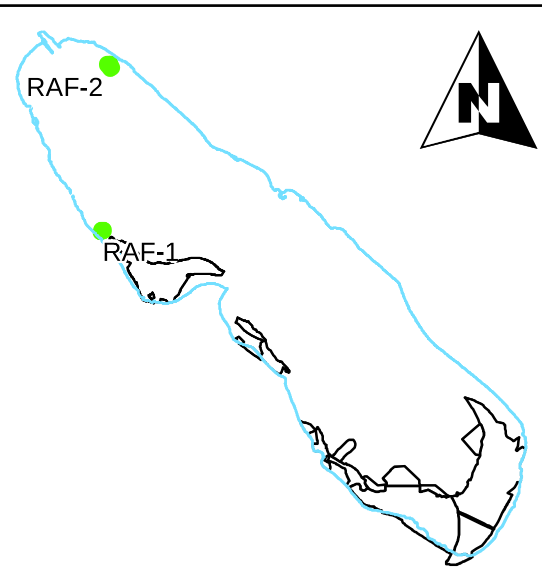


Assessment Area Summary and 2019 Recommendations

The 2017 coring locations (excluding additional coring) are consistent with the coring locations specified in the OLMMP, and are the locations where cores are planned for 2019, per the OLMMP.

F1

- Minimal change in bathymetry between 2017 and 2018.
- 2017 core verified the presence of target cap thickness
- Collect core as shown for verification



2018 Survey vs Asbuilt

- Chemical/Physical Monitoring Core Per OLMMP, Completed In 2017
- Pre-Remediation Shoreline (Elev. 362.5)
- > 0.5' Higher
- Within 0.5'
- F-2 Abbreviated Sample ID Location (OL-RAF-CAP-0002)
- 0.5' - 1' Lower
- 1' - 1.5' Lower
- 1.5' - 2' Lower
- > 2' Lower
- F1 Representative Assessment Area Based on Cap Elevation Decrease Greater Than 0.5 Feet

0 50 100 Feet

Figure 20.23

Honeywell

RA-F 2018 vs Asbuilt Bathymetric Survey

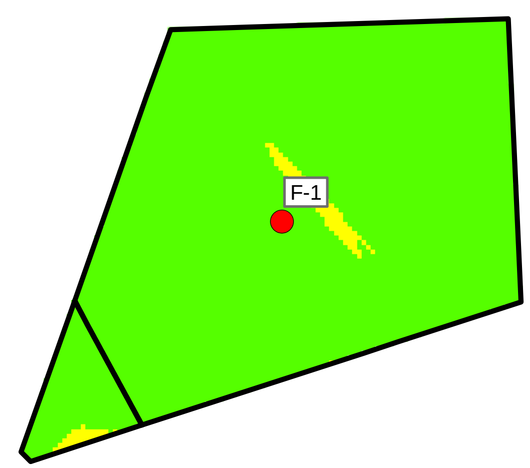
PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212

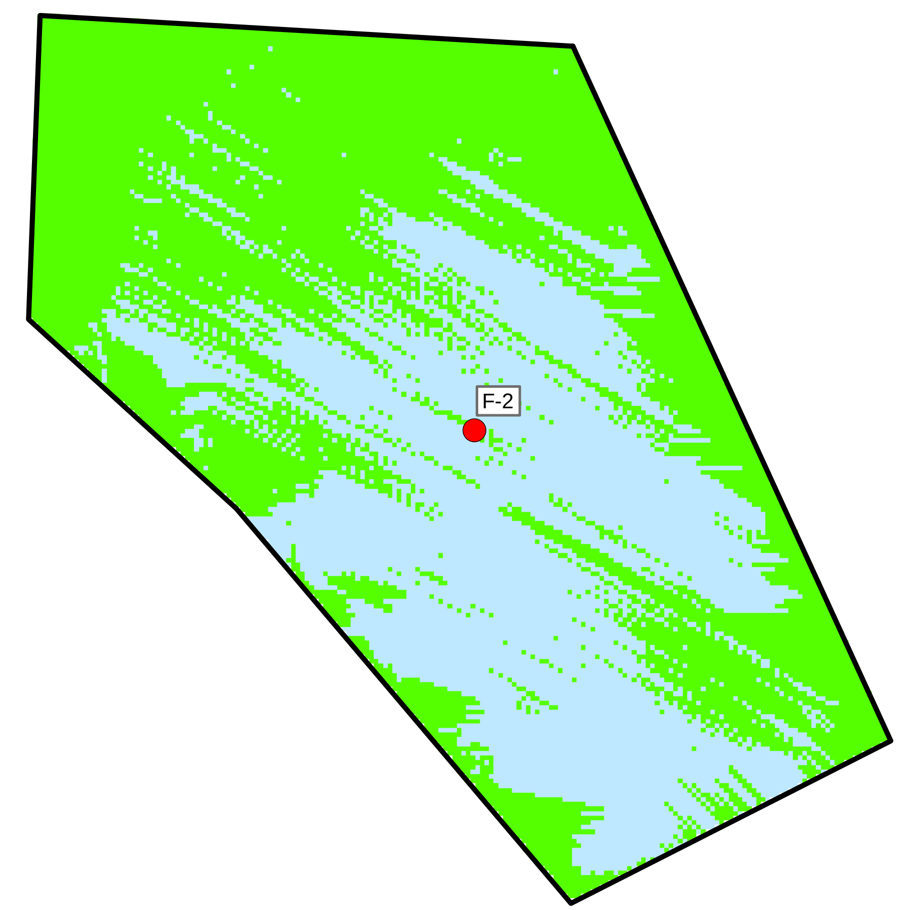
File Name: \\nysyr04fs01\Prj\Data\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\RAF OMM Survey 2018 Rev2.mxd
Plot Date: 5/7/2019 Plotted By: Joshua Domanski

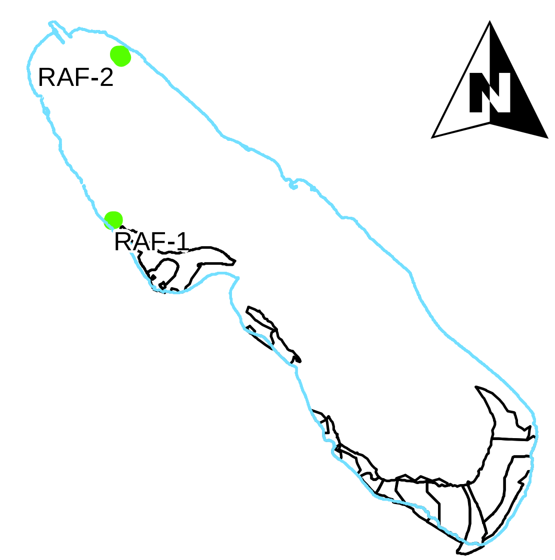
File Name: \\nysyr04fs01\Pr\Data\GIS\Hon_Syracuse\OLMMS\OMM Survey\2018 Survey\MXDs\2019 Assessment Areas\Figure 6-12 - RAF Bathy_Rev1.mxd
Plot Date: 4/16/2019   Plotted By: Joshua Domanski

RA-F 1



RA-F 2





2017 Survey vs As-built Survey

- 2017 Chemical/Physical Cap Monitoring Core Location
- > 0.5' Higher
- Within 0.5'
- 0.5' - 1' Lower
- 1' - 1.5' Lower
- 1.5' - 2' Lower
- > 2' Lower
- F-2 Abbreviated Sample ID Location (OL-RAE-CAP-0029)

0 50 100 Feet

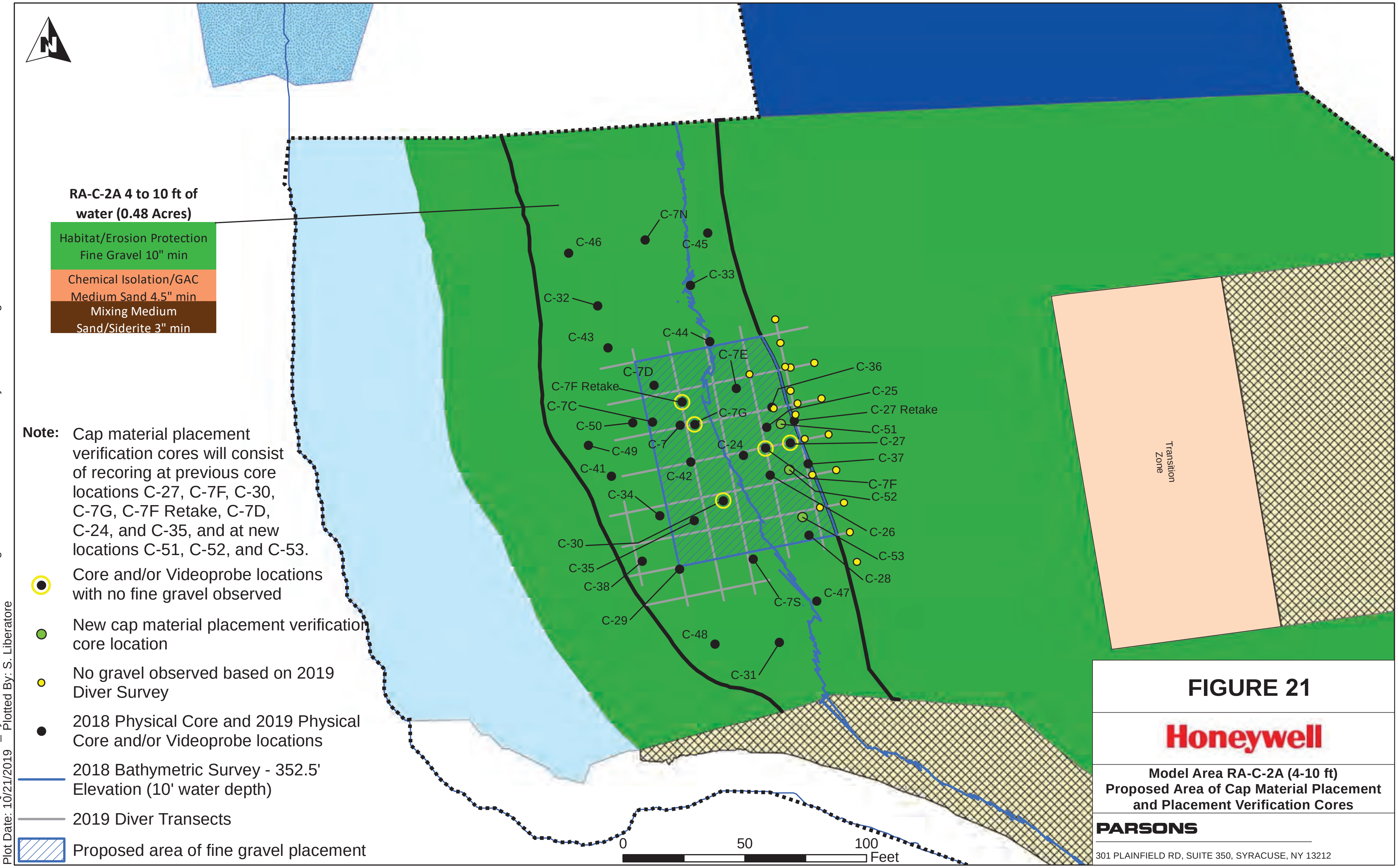
Figure 20.24

Honeywell

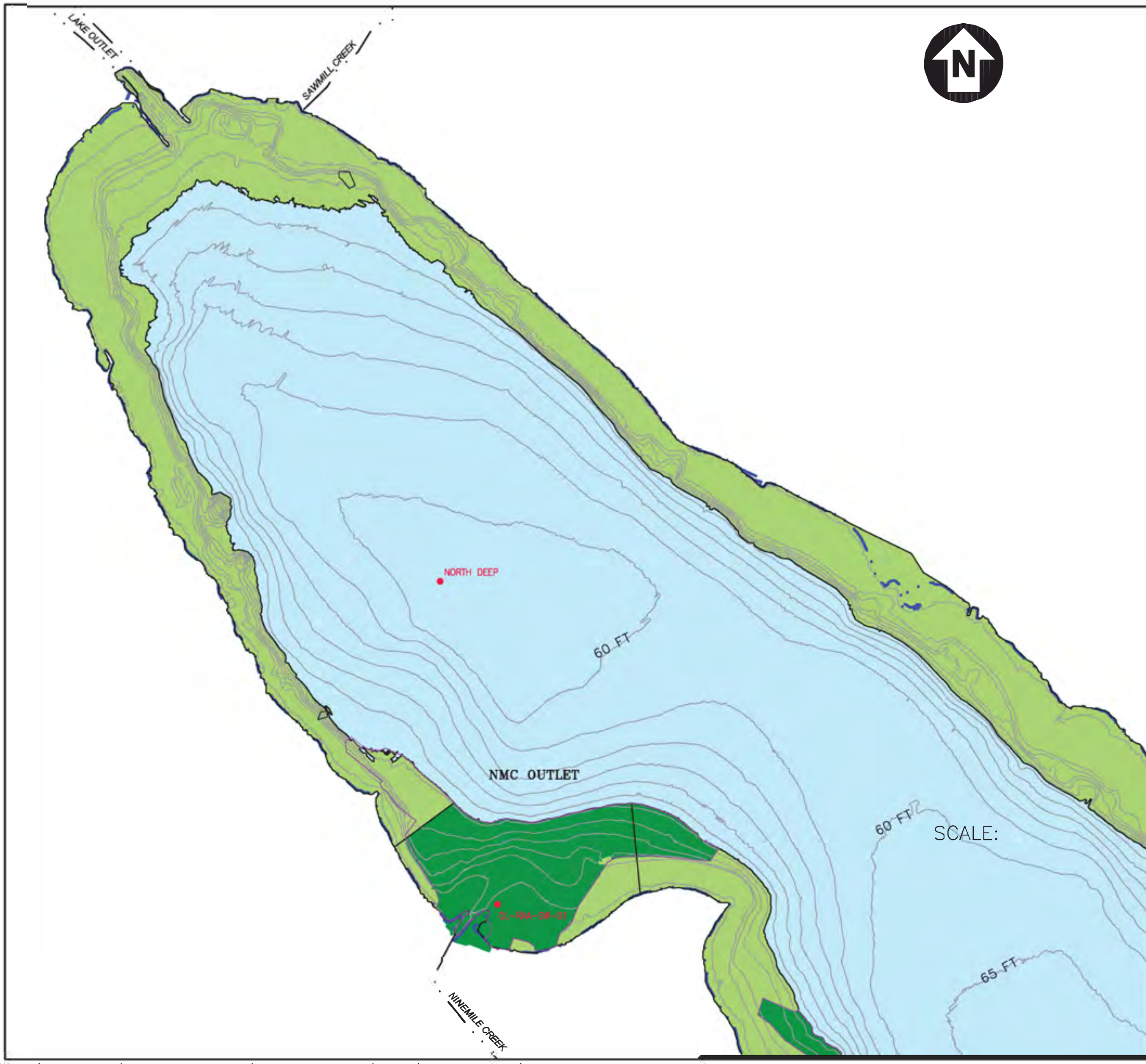
RA-F 2017 vs Asbuilt Bathymetric Survey

PARSONS

301 PLAINFIELD RD, SUITE 350, SYRACUSE, NY 13212



File Name: Q:\GIS\Hon_Syracuse\OLMMS\MXDs\2019\Figure 4 RAC 2018 and 2019 Physical Monitoring.mxd
Plot Date: 10/21/2019 Plotted By: S. Liberatore



LEGEND:

- REMEDIATION AREA BOUNDARY
- SMU BOUNDARY
- CAPPED AREAS (INCLUDES ALL ISOLATION, THIN LAYER, AND MODIFIED PROTECTIVE CAPS)
- SMU 8
- LITTORAL ZONE
- SURFACE WATER SAMPLE LOCATIONS

NOTES:

1. WATER DEPTH CONTOUR INTERVAL IS 5 FT (POST–REMEDIATION).
2. THE 30' WATER DEPTH CONTOUR IS THE BOUNDARY BETWEEN THE LITTORAL ZONE (SMUs 1–7) AND SMU 8.
3. SAMPLING CONDUCTED AT THE SHOWN LOCATIONS FOR BOTH PRE AND POST TURNOVER EVENTS.

1200 600 0 1200 2400

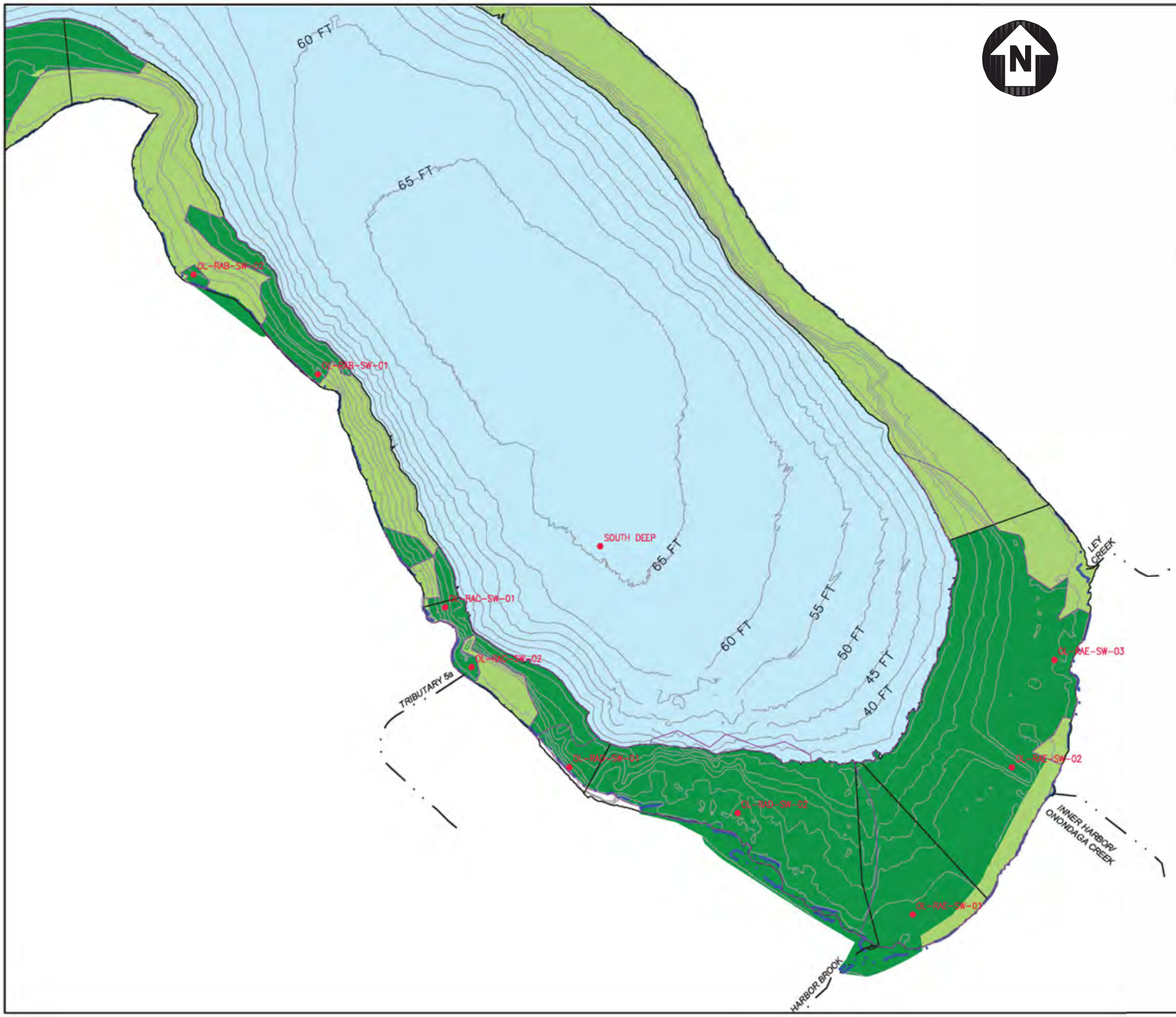
1"=1200'

Figure 22.1

SURFACE WATER COMPLIANCE SAMPLE LOCATIONS IN NORTH HALF OF ONONDAGA LAKE

NFIELD ROAD, SUITE 350, SYRACUSE, N.Y. 13212, PHONE: 315–451–9560

FILE NAME: P:\HONEYWELL -SYR\450704 2017–2018 OL PVM\10 TECHNICAL CATEGORIES\10.1 CAD\2018 ANNUAL REPORT\450704–ANNUALRPT–2018–03.DWG
PLOT DATE: 5/8/2019 9:11 AM PLOTTED BY: RUSSO, JILL



LEGEND:

- REMEDIATION AREA BOUNDARY
- SMU BOUNDARY
- CAPPED AREAS (INCLUDES ALL ISOLATION, THIN LAYER, AND MODIFIED PROTECTIVE CAPS)
- SMU 8
- LITTORAL ZONE
- SURFACE WATER SAMPLE LOCATIONS

NOTES:

1. WATER DEPTH CONTOUR INTERVAL IS 5 FT (POST-REMEDIATION).
2. THE 30' WATER DEPTH CONTOUR IS THE BOUNDARY BETWEEN THE LITTORAL ZONE (SMUs 1–7) AND SMU 8.
3. SAMPLING CONDUCTED AT THE SHOWN LOCATIONS FOR BOTH PRE AND POST TURNOVER EVENTS.

1200 600 0 1200 2400

SCALE: 1"=1200'

FIGURE 22.2

Honeywell | ONONDAGA LAKE SYRACUSE, NEW YORK

SURFACE WATER COMPLIANCE SAMPLE LOCATIONS IN SOUTH HALF OF ONONDAGA LAKE

PARSONS

301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, N.Y. 13212, PHONE: 315-451-9560

FILE NAME: P:\HONEYWELL -SYR\450704 2017-2018 OL PVM\10 TECHNICAL CATEGORIES\10.1 CAD\2018 ANNUAL REPORT\450704-ANNUALRPT-2018-03.DWG
PLOT DATE: 5/8/2019 9:10 AM PLOTTED BY: RUSSO, JILL

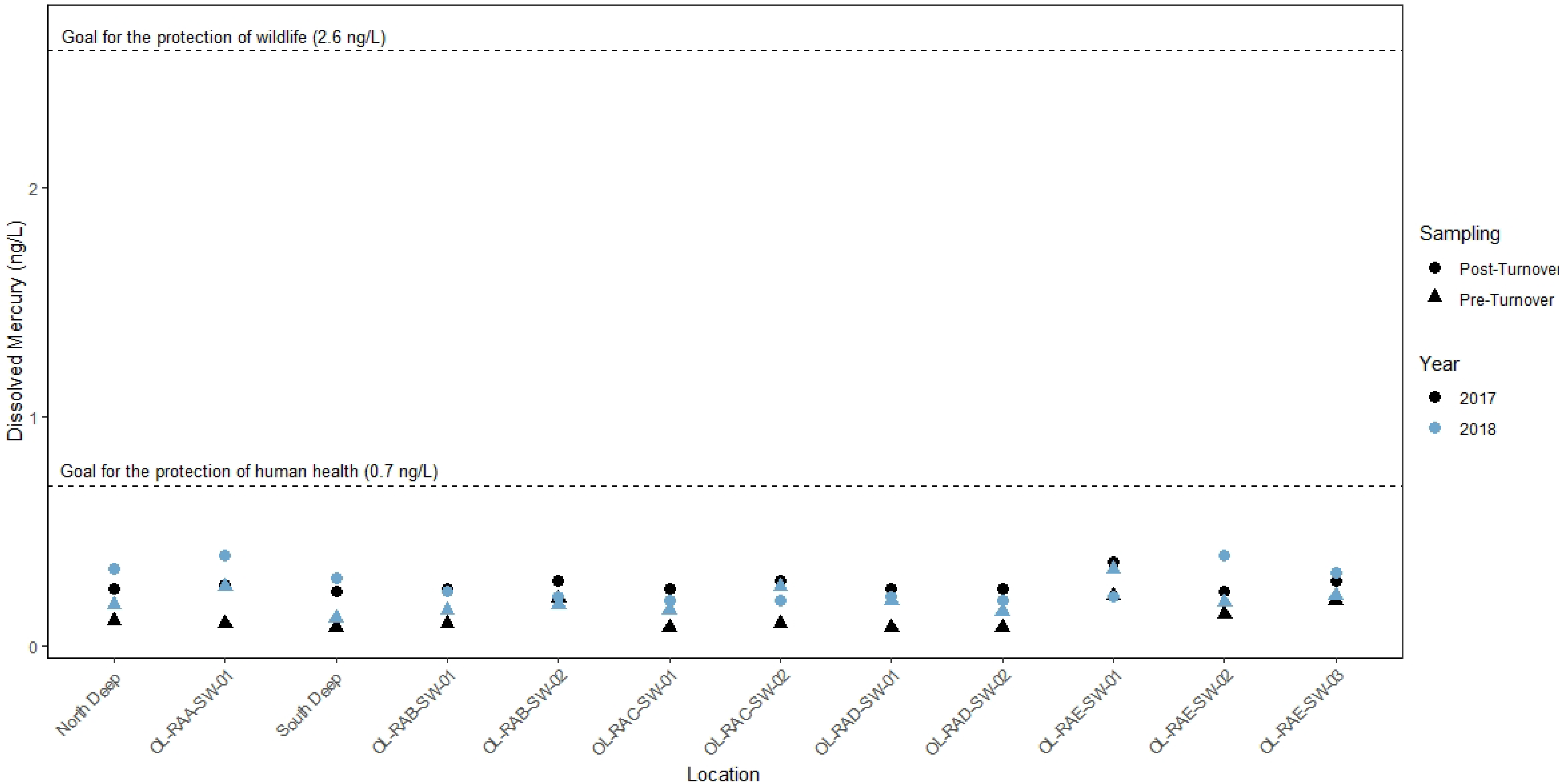


FIGURE 23

Honeywell

Onondaga Lake
Syracuse, New York

Onondaga Lake Dissolved Mercury Concentrations (2017-2018)

PARSONS

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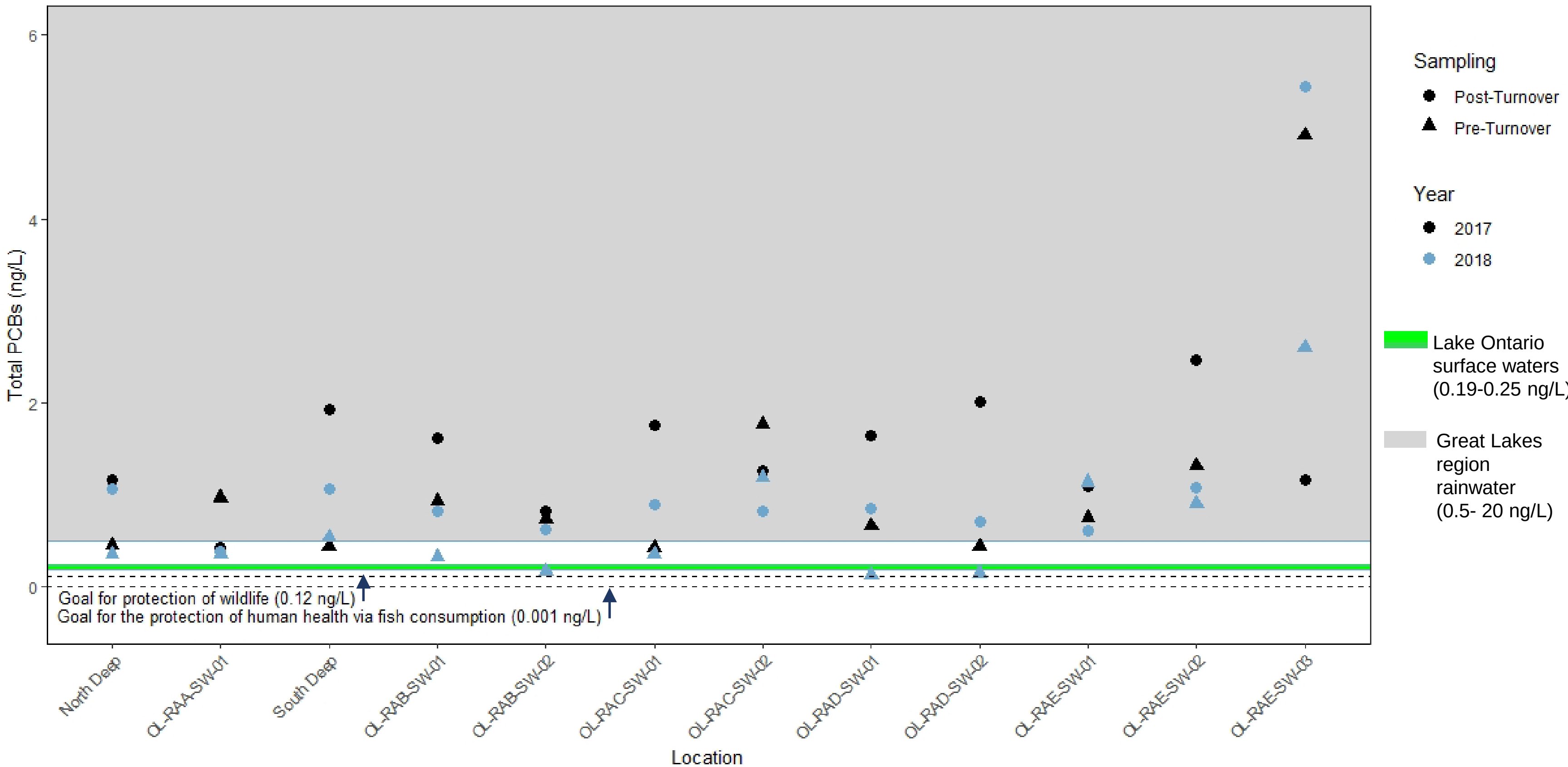


FIGURE 24

Honeywell

Onondaga Lake
Syracuse, New York

Onondaga Lake Total PCB Concentrations (2017-2018)

PARSONS

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

FIGURE 25.1

Honeywell

Evaluation of BSQV Compliance (Method 1)

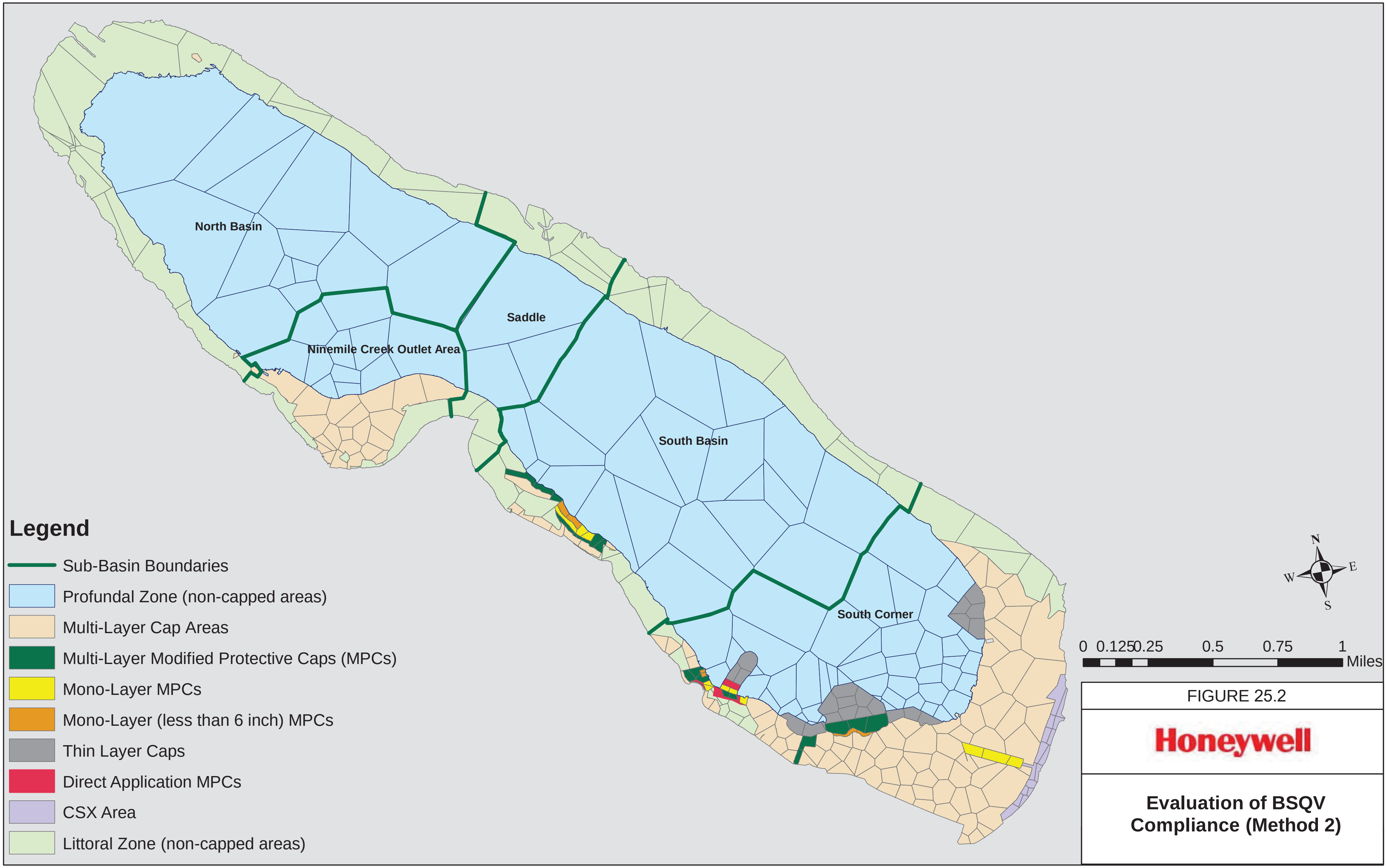
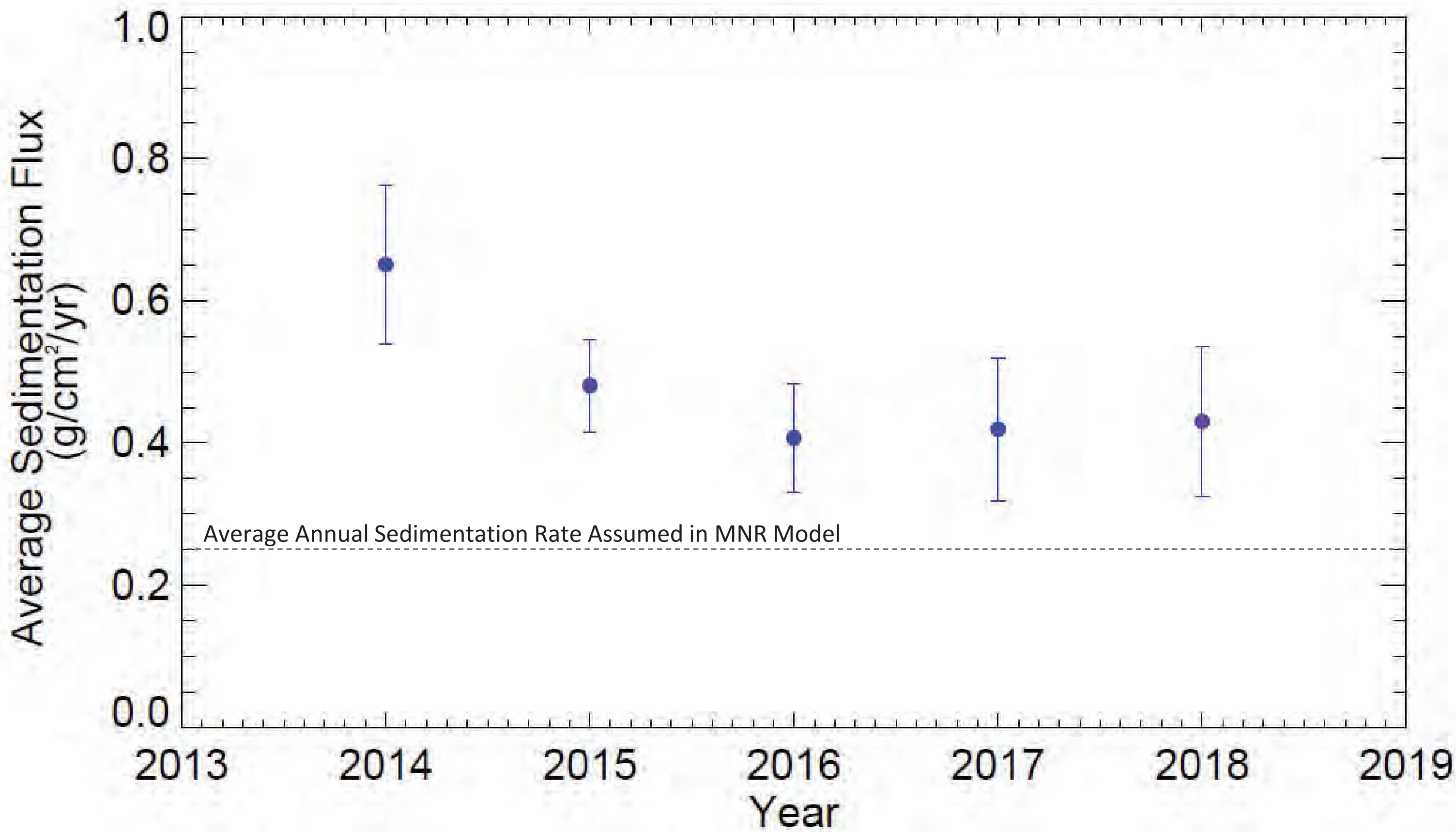


FIGURE 25.2

Honeywell

Evaluation of BSQV Compliance (Method 2)



Note: Plots show the average +/- 2 standard error (SE) of the mean, which is one way of representing the variability in weekly values obtained for the year noted.

FIGURE 26

Honeywell

Onondaga Lake
Syracuse, New York

Onondaga Lake Sediment Trap Flux (2014-2018)

P A R S O N S

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

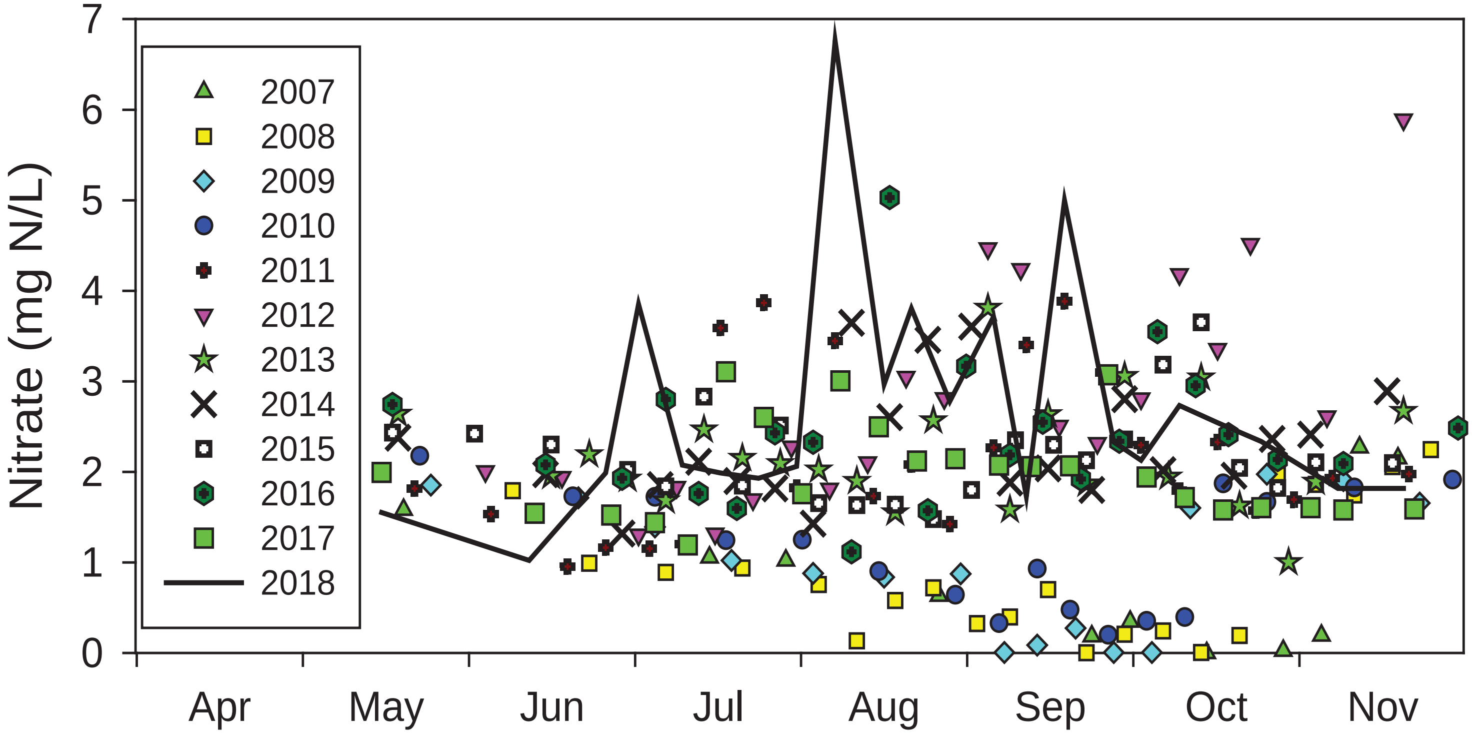


FIGURE 27

Honeywell

Onondaga Lake
Syracuse, New York

Time Series of Weekly Nitrate Concentrations for the 18-meter Water Depth at the South Deep Location, 2007-2018.

PARSONS

301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560

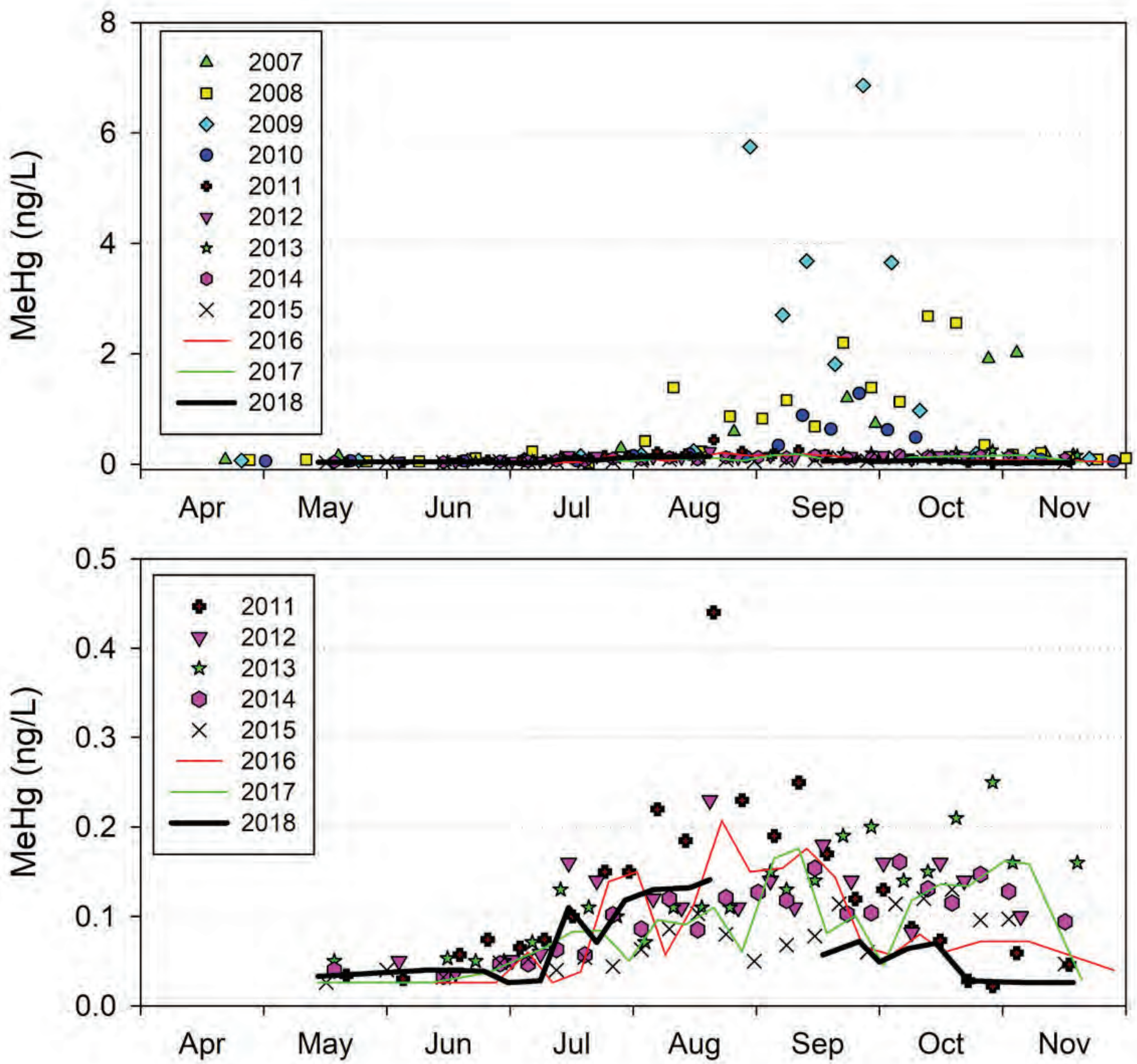


FIGURE 28

Honeywell

Onondaga Lake
Syracuse, New York

Time Series of Methylmercury Concentrations for the 18-meter Water Depth at the South Deep Location, 2007-2018. Bottom panel: 2011-2018 only.

PARSONS

301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560

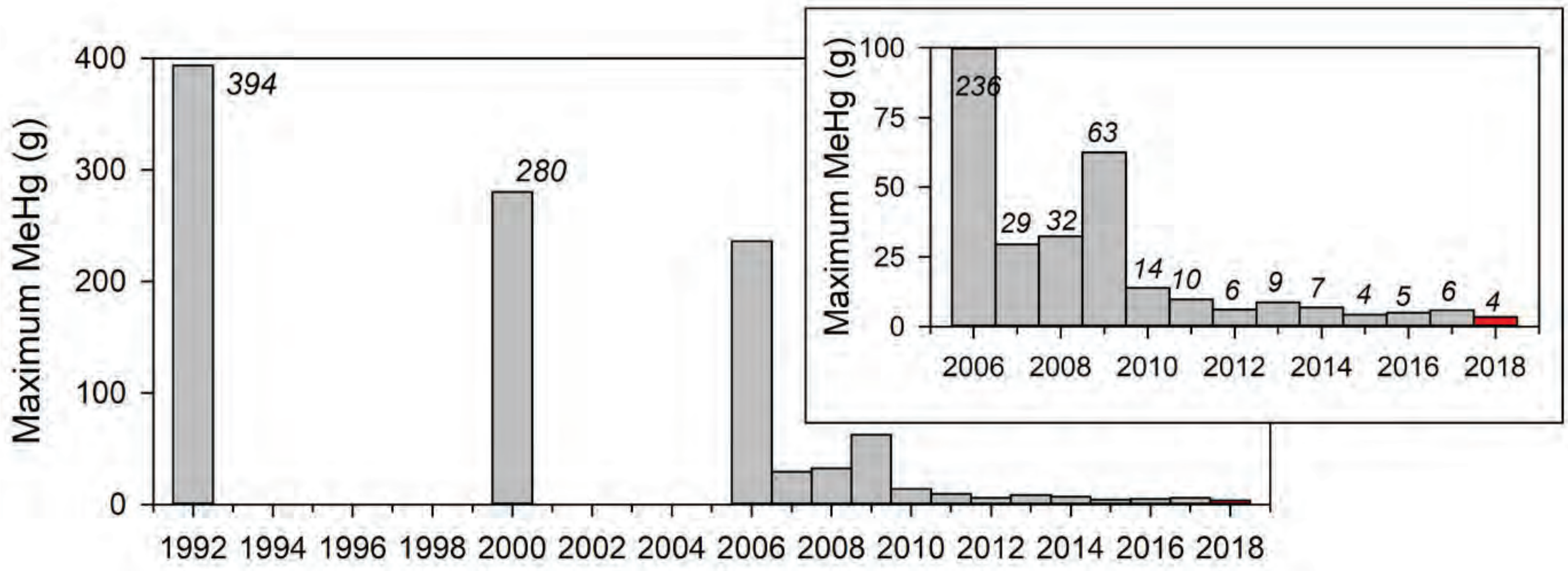


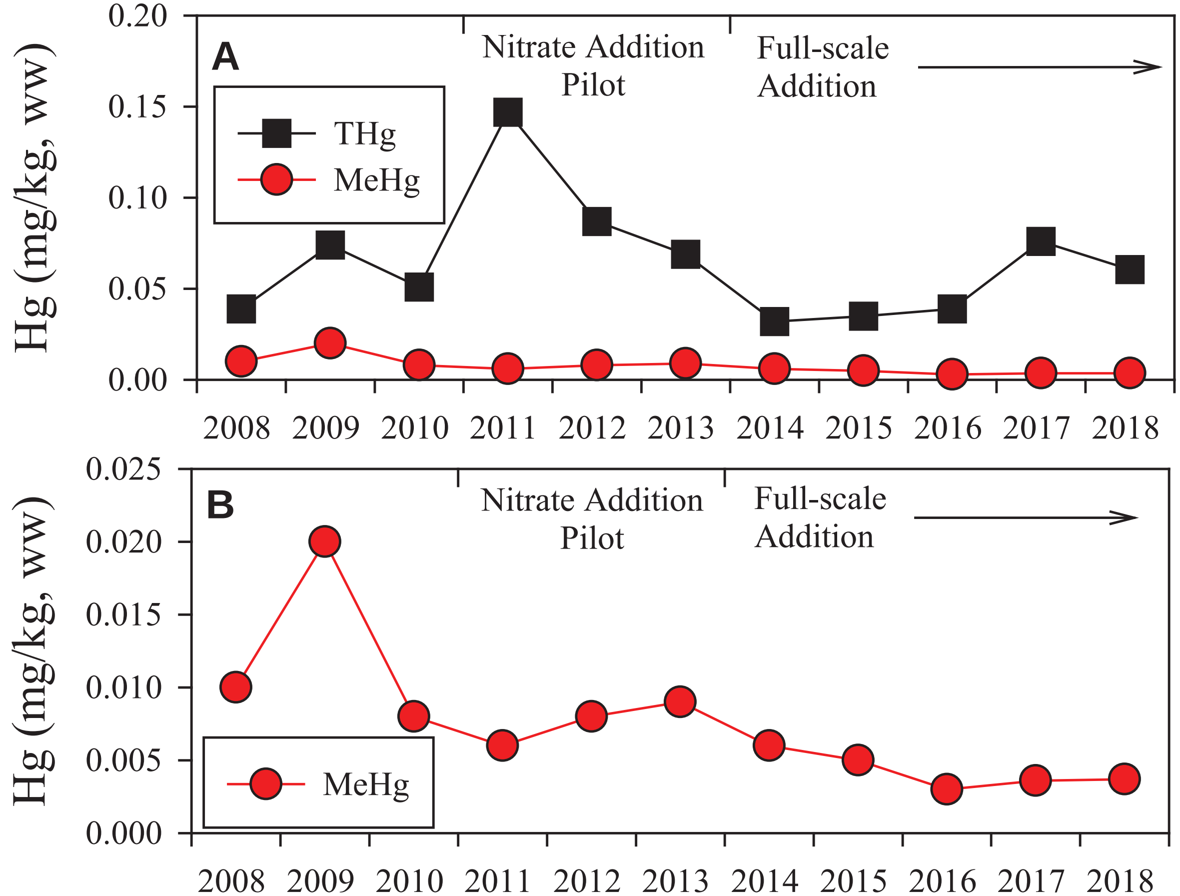
FIGURE 29

Honeywell

Onondaga Lake
Syracuse, New York

Annual Maximum Mass of Methylmercury in the Hypolimnion of Onondaga Lake from 1992 through 2018

PARSONS
301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560



(A) total mercury and methylmercury concentrations and
(B) methylmercury concentrations presented with modified y-axis.

FIGURE 30

Honeywell

Onondaga Lake
Syracuse, New York

Annual Average Wet Weight Mercury Concentrations in Zooplankton (2008-2018)

PARSONS

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

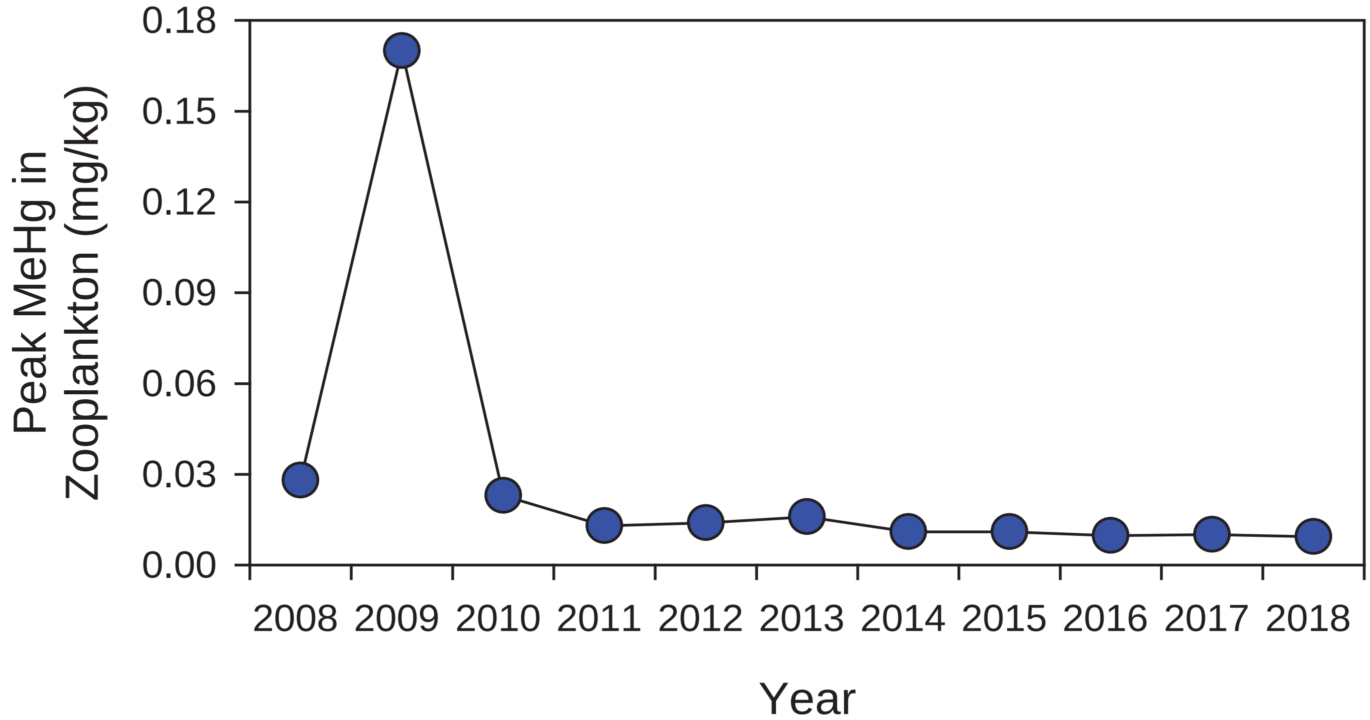


FIGURE 31

Honeywell

Onondaga Lake
Syracuse, New York

Annual Maximum Wet Weight Methylmercury Concentrations in Zooplankton (2008-2018)

PARSONS

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

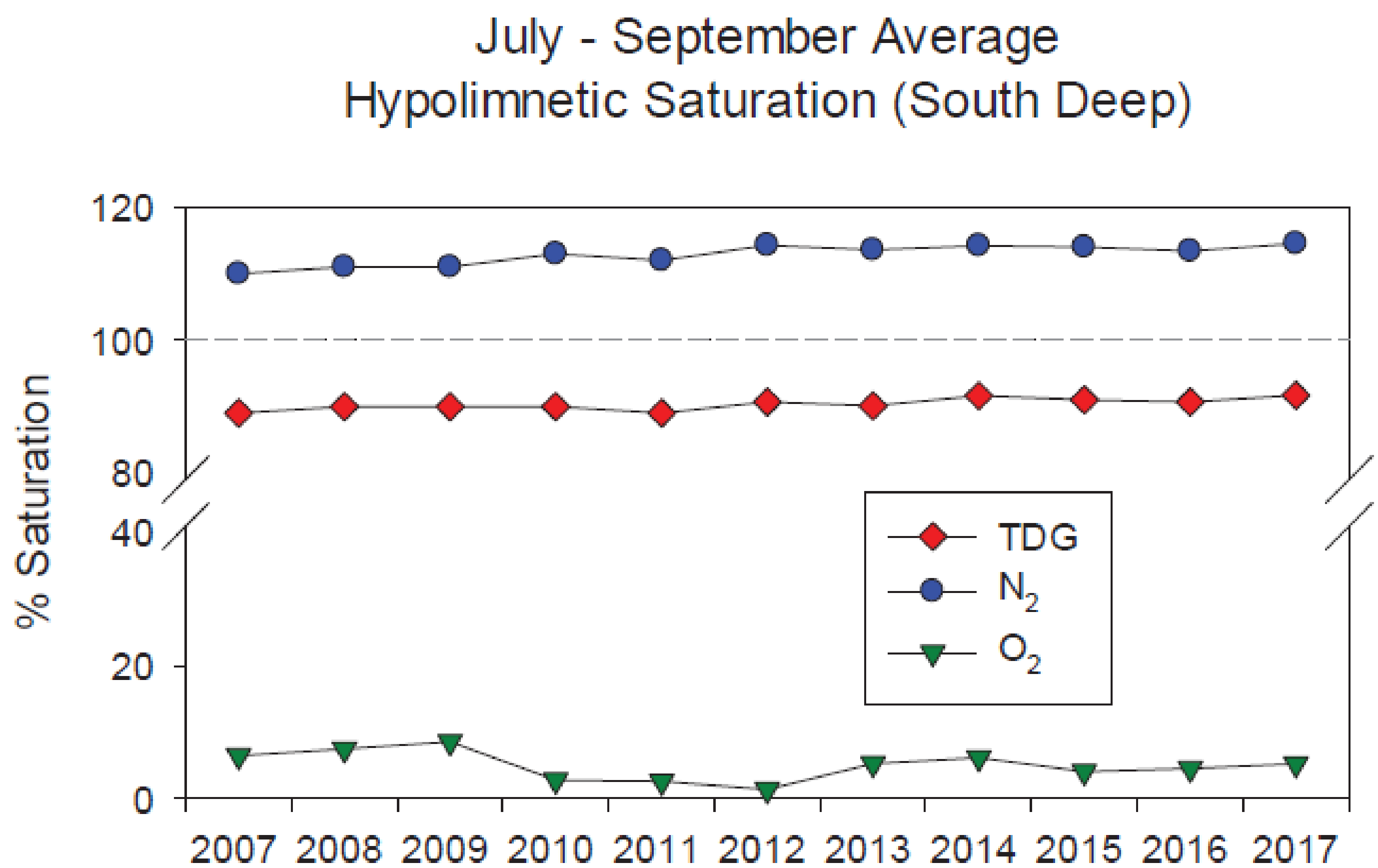
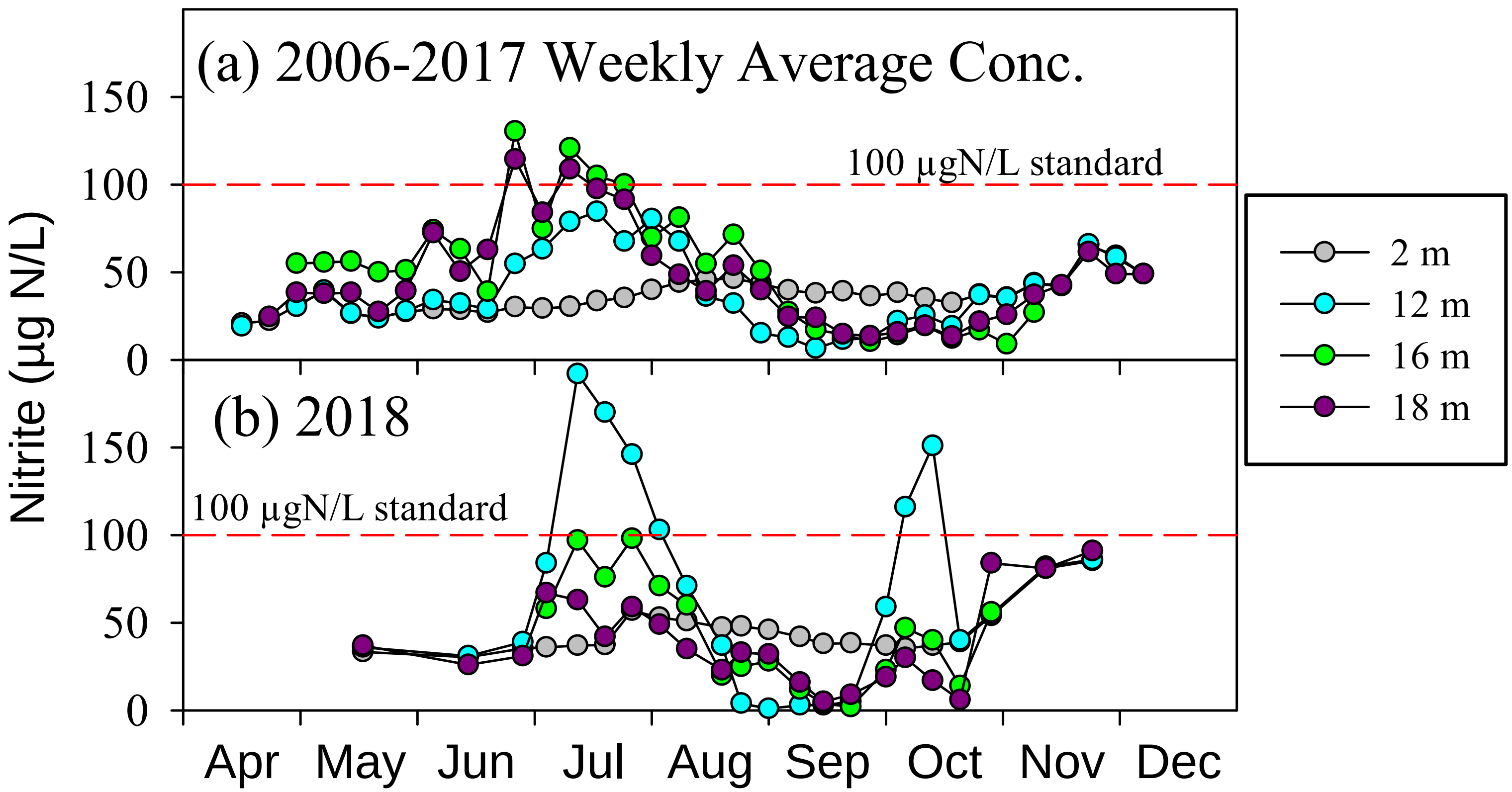


Figure 32 Time series of percent saturation in the hypolimnion for total dissolved gas, dinitrogen (N_2), and oxygen (O_2) for the period 2007-2017. Plotted values are July-September averages from Onondaga Lake, South Deep.



a) weekly average concentration for 2006-2017 and (b) 2018 concentrations. Note: The ambient water quality standard for nitrite applicable to warm-water fisheries is 100 micrograms per liter (µgN/L) as nitrogen (red-dashed line)

FIGURE 33

Honeywell

Onondaga Lake
Syracuse, New York

Time Series of Nitrite-Nitrogen (NO2-N) for Onondaga Lake at South Deep for Four Water Depths

PARSONS

301 Plainfield Rd, Suite 350, Syracuse, NY, 13212, Phone 315-451-9560

FILE NAME: P:\HONEYWELL -SYR\450102 - 2016 OL REMEDIAL GOAL MONITORING\10 TECHNICAL CATEGORIES\CAD\2016\450102-MNR-016.DWG
PLOT DATE: 9/20/2017 3:33 PM PLOTTED BY: RUSSO, JILL

Onondaga Lake Second Five Year Review

Attachment 2

Status Update of Onondaga Lake Upland Operable Units/Subsites

Onondaga Lake Site/Lake Bottom Subsite Second Five-Year Review

Attachment 2

Status Update of Onondaga Lake Upland Operable Units/Subsites

The control of contamination migrating to Onondaga Lake from the various upland sites is an integral part of the overall cleanup of Onondaga Lake. To facilitate coordination of investigation and remedial activities, the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (EPA) have identified eleven subsites, as shown in Figure 1 of this attachment, which comprise the Onondaga Lake National Priorities List (NPL) site. These subsites are also considered to be operable units (OUs) of the NPL site by EPA, and actions at these subsites are being performed consistent with the Comprehensive Environmental Response, Compensation, and Liability Act requirements.

Remedial activities at the upland subsites have been or are being performed via various means (*e.g.*, as part of the remedy selected in a Record of Decision [ROD] for the upland area or as an interim remedial measure [IRM]). The current status of the each of the upland OUs/subsites is discussed below.

<u>LCP Bridge Street Subsite</u>

The 20-acre LCP Bridge Street subsite, which was used for various industrial activities from 1953 to 1988, is located in Solvay, New York (Attachment 2, Figures 1 and 2). The chlor-alkali facility produced caustic soda (sodium hydroxide) and liquid chlorine using the mercury cell process, and, beginning in 1968, both the mercury cell and diaphragm cell processes were used. Between 1955 and 1969, hydrogen gas, generated as a by-product at the facility, was used to manufacture hydrogen peroxide. In 1979, the plant was sold to LCP Chemicals. LCP operated the plant until 1988, when manufacturing ceased. Since 1990, various interim cleanup activities have been performed, including the removal of PCB-contaminated electrical equipment and mercury-contaminated equipment.

A ROD for this subsite was issued in 2000. Remedial construction, which commenced in 2004 and which was substantially completed in 2007, included removal of contaminated sediments from the West Flume, on-site ditches, and wetlands; restoration of wetlands; installation of a low-permeability cutoff wall around this subsite; installation of an interim low-permeability cap; and capture of contaminated groundwater inside the cutoff wall. Some additional excavation work was performed at this subsite in 2011 and 2012. Remediation of the LCP Bridge Street subsite has controlled discharges of contaminants, mainly mercury, to the West Flume, some of which previously migrated to Onondaga Lake through Geddes Brook and Ninemile Creek. Construction of a final cap was completed in 2015. The subsite is undergoing long-term operation and maintenance (O&M).

Geddes Brook/Ninemile Creek Operable Unit of the Onondaga Lake Bottom Subsite

The Geddes Brook/Ninemile Creek system (Attachment 2, Figure 1) was impacted by dissolved and particulate loading from the LCP Bridge Street subsite and episodic loading that occurred when mercury-contaminated sediments in the creeks and floodplains were mobilized during high-flow periods. Analysis of surface water, sediment, and floodplain soils indicated that the West Flume was the main conduit of mercury contamination in the Ninemile Creek watershed.

Pursuant to a 2009 decision document issued by NYSDEC and EPA, and an Administrative Order on Consent (AOC) between NYSDEC and Honeywell, the principal potentially responsible party (PRP) for this and adjacent subsites, an IRM for the Geddes Brook portion of the site began in 2011 and was substantially completed in 2013. The IRM included the removal of approximately 102,400 cubic yards of contaminated sediments and floodplain soils/sediments over approximately 16 acres from Outfall 019, lower Geddes Brook, and the adjacent floodplain (Attachment 2, Figure 3).

NYSDEC/EPA issued two consecutive RODs addressing the Geddes Brook/Ninemile Creek operable unit of the Onondaga Lake Bottom subsite in 2009. The selected remedies included the dredging/excavation and removal of an estimated 120,000 cubic yards of contaminated channel sediments and floodplain soils/sediments in lower Ninemile Creek over approximately 30 acres. Pursuant to the RODs, remedial activities commenced in 2012 and were substantially completed in 2014.

Contaminated sediments and soils removed from Geddes Brook, Ninemile Creek, and the adjacent floodplains were placed at the LCP Bridge Street subsite containment system, which was designed and constructed pursuant to the requirements of the ROD for the LCP Bridge Street subsite. The subsite is undergoing long-term O&M.

Semet Residue Ponds Subsite

The Semet Residue Ponds subsite is located in the Town of Geddes in an industrial area approximately 400 feet from the southern shore of Onondaga Lake (Attachment 2, Figure 1). It included five irregularly-shaped, man-made ponds used between 1917 and 1970 for the disposal of a tarry organic-based residue (Semet residue) generated by the acid washing of coke light oil during the production of benzene, toluene, naphthalene, xylene, and "motor benzol" at the Semet-Solvay Division of Allied Chemical & Dye Company's (a predecessor to Honeywell International, Inc.) BTX [Benzol] Plant) and two small areas bordering the subsite that were built to contain leakage from the ponds.

Consistent with a 2002 ROD for the subsite and pursuant to an IRM stipulated in a 2002 AOC between Honeywell and New York State, construction of a 1,288-foot lakeshore barrier wall and groundwater collection system for the shallow and intermediate groundwater zones occurred between October 2006 and May 2007 (Attachment 2, Figure 4). The Semet Lakeshore barrier wall collection system has been operating since May 2007.

Consistent with the 2002 ROD and a 2004 AOC, potential groundwater impacts to an adjacent tributary, Tributary 5A, were mitigated using a shallow groundwater collection system constructed between 2010 and 2013. The construction of the groundwater collection system also necessitated sediment removal and liner installation along the length of the tributary, which mitigated the potential for contaminated sediment to migrate and re-contaminate the area of the Lake near the tributary. Groundwater collection system performance verification data obtained since its operation demonstrate hydraulic control of groundwater migrating to Tributary 5A. All groundwater collected by the Semet Lakeshore and Tributary 5A systems, and by the groundwater collection systems discussed below for the Willis Avenue, Wastebed B/Harbor Brook, and Wastebeds 1-8 subsites is conveyed to the nearby Willis Avenue Groundwater Treatment Plant (GWTP) where it is pretreated prior to its conveyance to the Onondaga County Metropolitan Wastewater Treatment facility (Metro) for additional treatment for ammonia. The effluent from Metro's wastewater treatment operations is discharged to Onondaga Lake.

In addition to achieving hydraulic control of contaminated groundwater at the subsite, the ROD remedy included excavation and reuse of the Semet residue material present in ponds constructed in the Solvay waste located on the subsite. The remedy specifically called for on-site processing of the Semet residue for use in the production of a soft tar product (RT-12). After the ROD was issued, it became necessary to re-evaluate remedial alternatives for the Semet residues due to a change in market conditions for RT-12. Treatability studies were performed to assess various remedial technologies. In 2017, an Explanation of Significant Difference (ESD) issued by NYSDEC and EPA modified the selected remedy to include the excavation of the Semet residue and off-site transport to a Resource Conservation and Recovery Act-permitted thermal processing facility for beneficial reuse. As part of a pilot demonstration program, which commenced in 2014, and consistent with the ESD, the tar material was excavated and transported off-site to thermal processing facilities (cement kilns) for beneficial reuse. By the end of 2019, all of the Semet residue that could be used at the facilities had been removed from the subsite.

A second ROD for the Semet Residue Ponds subsite was issued by NYSDEC and EPA in 2019 to address the areas beneath the tar ponds and other areas of the subsite. The selected remedy included in-situ treatment of any Semet residue remaining at the site that could not be beneficially reused consistent with the ESD, installation of an enhanced engineered cover system including an impermeable geomembrane cap and 18-inch clean soil cover over the former ponds and other Semet residue areas, and installation of a minimum one-foot soil cover in other areas of the site where soil concentrations were above commercial use soil cleanup objectives (SCOs) (Attachment 2, Figure 5). The targeted in-situ treatment of the residual Semet residue has been implemented and the pond areas are currently being backfilled. The site cover has been completed over portions of the subsite to provide additional parking areas for the New York State Fair.

Willis Avenue Subsite

The Willis Avenue subsite is a former chlor-alkali and chlorinated benzene plant located at the corner of Willis Avenue and State Fair Boulevard in Geddes, New York (Attachment 2, Figure 1). Plant operations, including loading and unloading of material took place near the plant as well as on the lakeshore. The chlor-alkali plant operated from 1918 until 1977, producing chlorine and other chemicals and utilized both diaphragm and mercury cells for chlorine production. Chlorinated benzenes were also produced at this facility between 1918 and 1977. Plant operation resulted in impacts to two smaller areas, the Chlorobenzene Hot-Spot Area and the Petroleum Storage Area, located to the south of the Willis Plant Area. The Willis Avenue subsite was a significant source of mercury and chlorinated compounds to Onondaga Lake through groundwater and surface runoff via the East Flume. The construction of the lakeshore barrier wall/collection system and East Flume IRM activities have mitigated this discharge.

Pursuant to the 2002 AOC noted in the discussion above for the Semet Residue Ponds subsite, construction of 1,612 linear feet of barrier wall and groundwater collection system for the shallow and intermediate groundwater zones occurred between 2008 and 2009 (Attachment 2, Figure 6). Subsequent to this work and the initiation of the construction of the collection system, a tie-back anchorage system to mitigate deflection of the barrier wall in areas with deep water present outboard of the wall was completed in 2012. The hydraulic containment system is meeting the design goals (*i.e.*, groundwater levels are below Onondaga Lake level, indicating that hydraulic capture and an inward hydraulic gradient are being achieved). On occasion, groundwater levels have been recorded above Lake levels, however, these conditions typically occurred during high Lake levels over short periods of time and are not indicative of overall system performance. Also, under this IRM, remediation was implemented to address groundwater influences on the eastern and western storm drain systems related to Interstate Route I-690 (I-690) downgradient of the Willis Avenue and Semet Ponds Subsites. To date, measures implemented in the storm drain systems in four separate phases have mitigated potential impacts to Onondaga Lake.

An IRM was also implemented to address chlorobenzene dense non-aqueous-phase liquid (DNAPL) contamination along the Lakeshore. The system was initiated in 1993 and expanded in 1995 and 2002 to include additional collection wells. In 2012, the system was again expanded, and the system further upgraded and optimized. The DNAPL collection system was shut down between 2017 and 2019 for system optimization, well redevelopment, and implementation of additional modifications. The modifications included relocation of existing DNAPL recovery system facilities and utilities from the DNAPL storage building to the Groundwater Pump Station and Willis Avenue GWTP, demolition of the storage building, repair and maintenance of existing recovery well vault facilities and electrical structures, and decommissioning of eight existing DNAPL wells that demonstrated little or no production. To date, approximately 76,000 gallons of DNAPL from the area have been collected and transported off-site for treatment/disposal.

A ROD for the Willis Avenue subsite was issued by NYSDEC and EPA in 2019. The remedy includes the installation of a one-foot thick cover system, in-situ treatment and/or excavation of mercury hot spots, targeted shallow/intermediate groundwater hydraulic control, evaluation and recovery/treatment of separate phase liquids (if present), continued operation and maintenance related to IRMs that have been implemented at the Subsite, and monitored natural attenuation of shallow/intermediate groundwater at the Waste Management Area point of compliance (POC) for the Willis Avenue subsite and the POC for the adjacent Semet Residue Ponds subsite (Attachment 2, Figure 7). A work plan for remedial design/remedial action is under development and a treatability study relating to in-situ treatment of mercury hot spots is in progress.

Wastebed B/Harbor Brook Subsite

The 90-acres subsite is located to the north and south of I-690 in the City of Syracuse and Town of Geddes, Onondaga County (Attachment 2, Figure 1). The subsite includes three main areas: Lakeshore Area (which includes Wastebed B), Penn-Can Property, and Railroad Area (Attachment 2, Figure 8). Wastebed B is a former Solvay wastebed, which received Solvay waste between 1898 and 1926. Wastebed B covers approximately 54 acres and was engineered to receive waste by construction of a bulkhead into Onondaga Lake. The Penn-Can Property was historically used for the production and storage of asphalt products. The Railroad Area is situated to the south of the Penn-Can Property and is bounded to the north, south and east by railroad tracks. Two additional areas of study (AOS #1 and AOS #2) located east of Harbor Brook were also included in the investigations/studies conducted for the subsite.

Pursuant to an IRM stipulated in a 2003 AOC between Honeywell and New York State, construction associated with a 4,678 ft Lakeshore barrier wall and groundwater collection system along the Onondaga Lake shoreline perimeter of Wastebed B and upstream along the west bank of Harbor Brook, realignment of the lower reach Harbor Brook, and replacement of a culvert for Lower Harbor Brook were conducted from 2009 to 2012 (Attachment 2, Figure 9).

The Wastebed B/Harbor Brook Lakeshore barrier wall collection system has been operating since 2012. The hydraulic containment system is meeting design goals (*i.e.*, groundwater levels are below Lake level, indicating that hydraulic capture and an inward hydraulic gradient are achieved). On occasion, groundwater levels have been above Onondaga Lake levels, however, these conditions typically occurred over short periods of time during high Lake levels and are not indicative of overall system performance.

Potential groundwater impacts to Upper Harbor Brook were mitigated via the operation of a groundwater collection system for shallow groundwater constructed in 2012 and 2013. This work also included sediment removal, isolation layer installation, sealing of leaks in the culverts, and ditch/stream/wetland restoration. Consistent with the design goals, groundwater elevations in Upper Harbor Brook collection trenches have been maintained below the surface water elevation in Harbor Brook since 2014.

Consistent with a 2012 decision document issued by NYSDEC and EPA, and an AOC between Honeywell and New York State, an IRM for a 16-acre strip of land that lies in the outboard area between Wastebed B/Harbor Brook Lakeshore barrier walls and Onondaga Lake (including the mouth of Harbor Brook and areas of wetlands along the shoreline) commenced in 2013 (Attachment 2, Figure 9). The Outboard Area IRM included excavation and/or dredging of approximately 200,000 cubic yards of contaminated soil and sediment located between the Wastebed B/Harbor Brook barrier walls and Onondaga Lake. With the completion of the soil/sediment removal, an isolation cap was installed as part of the Lake remedy to physically isolate the contaminated soil/sediment from the environment. The Outboard Area has been restored and enhanced as a wetland habitat including a pike spawning wetland in a portion of the Outboard Area in the vicinity of the mouth of Harbor Brook.

Discharges of storm water from upstream areas to the East Flume via conveyance and sewer pipes have been addressed under an IRM pursuant to a 2002 AOC between Honeywell and NYSDEC. The Upper East Flume was filled in during the installation of the work platform, Lakeshore barrier wall, and groundwater collection system. The Lower East Flume was addressed under the Wastebed B/Harbor Brook Outboard Area IRM.

A ROD for the Wastebed B/Harbor Brook Subsite was issued by NYSDEC and EPA in 2018. The selected remedy includes the installation of a soil/granular cover (or maintained paved surfaces and buildings), implementation of vegetation enhancements, construction/restoration of an approximately 1-acre wetland (including the installation of a low permeability liner system beyond the wetland footprint within an area of dense non-aqueous phase liquid-impacted soil/fill material), additional actions (*e.g.,* stabilization, removal), if necessary, in the areas where surficial tar material is present, and continued operation and maintenance associated with the IRMs that have been implemented at the subsite (Attachment 2, Figure 10). The remedial design is currently underway.

A wetland area, designated SYW-12 (Attachment 2, Figure 8 for location of SYW-12) is also part of the subsite but is not addressed under the IRMs or the ROD. The SYW-12 area will be addressed as a separate OU. A feasibility study (FS) for the SYW-12 area is currently in progress.

Wastebeds 1-8 Subsite

Wastebeds 1-8 is a 404-acre site that includes eight irregularly shaped wastebeds that extend roughly 1.5 miles along the southwest side of Onondaga Lake (Attachment 2, Figure 1) that were used for Solvay Process waste disposal from 1926 until 1944. The underlying groundwater is contaminated with benzene, toluene, ethylbenzene, and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAHs), phenols, and metals.

Pursuant to a 2011 decision document issued by NYSDEC and EPA and an AOC between Honeywell and NYSDEC, an IRM commenced in 2011 and was completed in 2016. The IRM included the collection and treatment of groundwater and seeps along Ninemile Creek and the shoreline of Onondaga Lake, the placement of a vegetative cover over a 14.4-acre area along the eastern lakeshore, sediment removal from the lower reach of Ditch A, a surface water drainage ditch, rehabilitation of water conveyance pipes at the upper reach of Ditch A, and stabilization of the lakeshore soils. Additional components incorporated into the IRM included mitigation wetlands, a hydraulic groundwater control system along the Wastebeds 1-8 northern shoreline, and restoration, cleaning, and installation of a seep collection trench, geosynthetic lining systems, and seep aprons in the middle and lower reaches of Ditch A (Attachment 2, Figure 11). The IRM was designed to prevent the continued migration of contaminants into Ninemile Creek and Onondaga Lake and reduce groundwater upwelling velocities that may impact the isolation cap placed in Onondaga Lake Sediment Management Unit 4. The eastern shoreline, northern shoreline, and Ditch A control systems are undergoing initial performance verification with oversight by and ongoing coordination with NYSDEC.

A ROD which addresses the OU1 portion of the Wastebeds 1-8 subsite and includes Solvay waste and contaminated soil/fill materials was issued in 2014. The OU1 remedy is being implemented in multiple phases because of cover material availability, material placement productivity rates, planting seasons for the optimal establishment of vegetation enhancements, and site usage by the property owners. Between 2015 and 2019, approximately 52 acres of vegetative enhancement cover, nine acres of one-foot vegetative structural fill cover, and five acres of one-foot vegetative cover were placed on the subsite (Attachment 2, Figure 12). Construction in the area of the New York State Fair Orange Parking Lot entrance area near the eastern end of the Onondaga County West Shore Trail was completed in 2019. The steep bank slopes where exposed Solvay waste was present were cut back and regraded. A soil cover was subsequently placed and vegetated. Design and construction of the Lakeview Amphitheater and related buildings, sidewalks, cover systems, retention basins, and other surface and subsurface features were implemented in 2015 consistent with the OU1 remedy. In addition to the amphitheater construction, several other projects have been undertaken at the subsite that have resulted in the placement of cover, either over previously covered areas or where cover was necessary under the ROD.

An FS for the OU2 portion of the Wastebeds 1-8 subsite, which will consider additional measures to address impacted shallow, intermediate, and deep groundwater, is in progress.

<u>Niagara Mohawk-Hiawatha Boulevard-Syracuse Former Manufactured Gas Plant (MGP) Subsite</u>

The 20-acre Niagara Mohawk–Hiawatha Boulevard manufactured gas plant (MGP) subsite is located south of the Barge Canal on West Hiawatha Boulevard, and borders Onondaga Lake and Onondaga Creek (Attachment 2, Figures 1 and 13). The Barge Canal is part of Onondaga Creek. The MGP operated from 1925 to 1958. In the mid-1970s, a 16-acre parcel of the area of concern was used in the expansion of Metro. The remaining four acres were acquired by Onondaga County for the recent expansion of Metro. The MGP used coal from 1925 to 1947 and partially switched to a carbureted water gas process in 1941. Wastes associated with the MGP include clinker waste containing heavy metals; coal tar, which contains PAHs, BTEX, and phenols; oil sludge; and purifier waste, which contains cyanides.

NYSDEC and National Grid/Niagara Mohawk entered into multi-site consent orders in 1992 and 2003 obligating it to investigate and remediate 21 former MGP sites across the State, including this subsite.

Under an IRM conducted in 2001 and 2002 to support the construction of an ammonia removal/phase 2 phosphorus treatment facility associated with Metro, approximately 73,000 cubic yards of impacted soil in the construction zone were removed and disposed of at permitted solid waste disposal facilities. Soils were excavated to a depth of approximately 15 feet throughout the footprint and to a depth of approximately 20 feet in an area where stained soils and non-aqueous phase liquid lenses and globules were observed in deeper soil samples (Attachment 2, Figure 13).

A ROD for the Niagara Mohawk–Hiawatha Boulevard Former MGP subsite was issued in 2010. The selected remedy called for in-situ solidification (ISS) of contaminated soil in the northeastern portion of the subsite and treatment of groundwater along the northern perimeter of the subsite using enhanced bioremediation. The ISS portion of the remedy was completed in 2014. A pilot study for enhanced bioremediation of groundwater was completed and the remedial design was finalized in 2018. Construction of the groundwater enhanced bioremediation component of the remedy was completed in 2018. Site groundwater was sampled in 2019 with a report to be submitted in 2020.

<u>General Motors–Inland Fisher Guide Subsite</u>

The General Motors (GM)-Inland Fisher Guide subsite includes two OUs. OU1 includes the former GM – Inland Fisher Guide Syracuse plant property that is located south of Ley Creek on Town Line Road in the Town of Salina (Attachment 2, Figures 1 and 14). The facility began operating in 1952, initially as a plating facility and later for the manufacture of plastic automotive components. Some of the wastes from the plant were discharged to Ley Creek. Manufacturing operations at the facility ceased in 1993.

Between 2002 and 2004, three large-scale IRMs were performed on the plant property pursuant to AOCs between GM, the principal PRP for this subsite and some adjacent subsites, and NYSDEC to mitigate contaminant migration from the subsite to Ley Creek; the Former Landfill IRM, the Former Drainage Swale IRM and the State Pollutant Discharge Elimination System (SPDES) Treatment System IRM. Under the Former Landfill IRM, hot spots in an on-site industrial landfill containing chromium- and PCB-contaminated materials were excavated and the landfill was capped to prevent contaminants from leaching into the groundwater. The Former Drainage Swale IRM involved the removal of more than 26,000 tons of PCB-contaminated soil from a former discharge swale that was used in the 1950s and 1960s as a conduit for the discharge of liquid process waste to Ley Creek. The SPDES Treatment System IRM included the construction of a retention pond and associated water treatment system to collect all water that accumulates on the GM-Inland Fisher Guide property in any of the storm sewers or abandoned process sewers. The pond water is then sent through the treatment plant to meet permitted discharge limits prior to discharge to Ley Creek. The IRM was designed to stop the intermittent discharge of PCBs and other contaminants that occurred during storm events. An FS is in progress for OU1.

In 1997, the former site owner GM and NYSDEC entered into an AOC to conduct a Remedial Investigation (RI)/FS for the site. Following GM's filing for bankruptcy in 2009, an RI/FS AOC was executed between Revitalizing Auto Communities Environmental Response (RACER) and NYSDEC in 2015.

Following GM's filing for bankruptcy in 2009, an AOC was executed between RACER and NYSDEC in 2015 to continue the investigatory and remediation work at the subsite.

OU2 of the GM-Inland Fisher Guide subsite (Attachment 2, Figures 1, 14 and 15) includes Ley Creek channel sediments, surface water, and floodplain soils/sediments in the reach between Townline Road and the Route 11 Bridge. OU2 also includes an adjacent wetland and roadway shoulders near the facility and on the northern side of Factory Avenue in the vicinity of LeMoyne Avenue. A remedy for OU2, which includes excavating approximately 25,000 cubic yards of PCB-contaminated sediment and soil from impacted media, was documented in a ROD issued in 2015. Excavation and off-site disposal of PCB-contaminated soil from residential properties (located adjacent to the creek) was conducted in 2016 and remediation of the Factory Avenue and National Grid Wetland soils was conducted in 2018. The design of the remedial action for the creek sediments and floodplain soils is in progress. During the pre-design investigation, floodplain soils exceeding screening criteria were observed on the north side of Ley Creek. Upon determining the extent of the contaminated floodplain soils that need to be addressed and the associated cost, EPA will reassess the remedy selected in the 2015 ROD. Based upon the results of this reassessment, EPA will prepare an appropriate decision document with updated volume and cost estimates for remedial action.

<u>Ley Creek PCB Dredgings Subsite</u>

The Ley Creek PCB Dredgings_subsite includes areas along the banks of Ley Creek where PCB-contaminated dredge spoils removed from the creek were placed (Attachment 2, Figures 1, 14, and 16).

GM and NYSDEC entered into an AOC in 1991 to perform investigatory and remediation work at the subsite.

A ROD for this subsite was issued in 1997 and remedial construction activities were completed in 2001. The selected remedy included the consolidation and covering of PCB-contaminated dredge spoils along a portion of Ley Creek. Approximately 8,400 cubic yards of PCB-contaminated material above 50 milligrams per kilogram were excavated and disposed of off-site. RACER is currently performing long-term O&M at this subsite.

Groundwater at this subsite will be addressed under the forthcoming GM-Inland Fisher Guide OU1 remedy.

Lower Ley Creek Subsite

The Lower Ley Creek subsite consists of sediments and floodplain soils located along the lower two-miles of Ley Creek beginning at and including the Route 11 bridge and ending downstream at Onondaga Lake, as well as the sediments and floodplain soils associated with the "Old Ley Creek Channel" (Attachment 2, Figures 1 and 17).

A ROD for this subsite was issued in 2014. The selected remedy includes excavation and capping of contaminated soil and excavation of contaminated sediment in Lower Ley Creek and disposal of the excavated soil and sediment. In 2016, EPA entered into an AOC with a number of PRPs to conduct the remedial design; the remedial design is in progress.

Town of Salina Landfill Subsite

The 55-acre Town of Salina Landfill is located in the Town of Salina, New York (Attachment 2, Figures 1 and 18). Because of flooding events, in 1970, the adjacent Ley Creek was widened, deepened, and rerouted through the Town of Salina Landfill, splitting the landfill into a 50-acre main landfill north of Ley Creek and a five-acre landfill south of Ley Creek.

In 1997, the Town of Salina entered into an AOC with NYSDEC to perform investigatory and remediation work at the subsite.

The Town of Salina Landfill subsite ROD was issued in 2007. The selected remedy included capping the landfills north and south of Ley Creek, with leachate collection and treatment. In 2010, NYSDEC and EPA executed a ROD amendment calling for the excavation and consolidation of municipal waste from the five-acre landfill onto the main landfill. Construction of all components of the remedy was completed in 2015. The subsite is undergoing long-term O&M.

Onondaga Lake Second Five Year Review

Attachment 2

Figures

Figure 1: Onondaga Lake Subsites

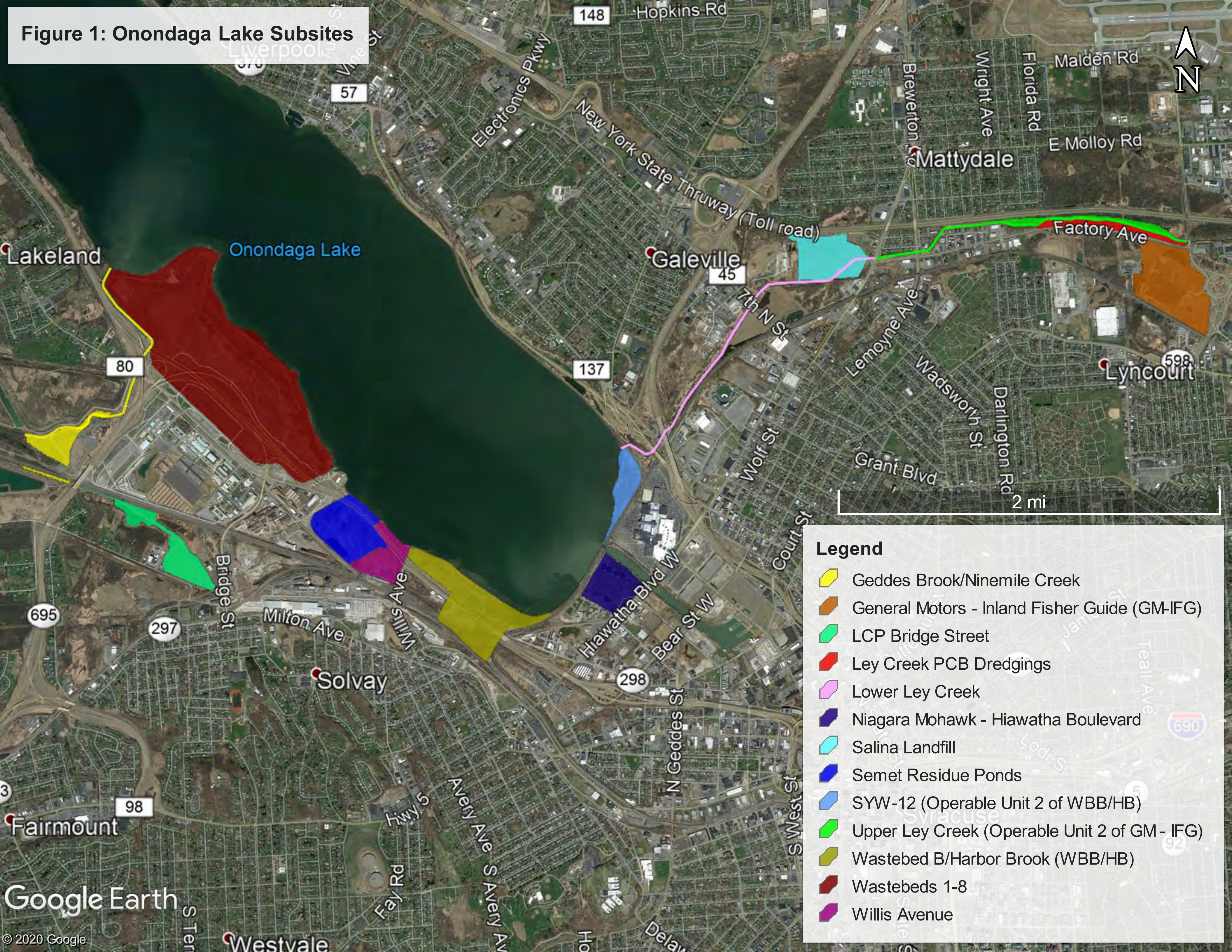


FIGURE 2

Honeywell

2014–2018 OPERATION, MAINTENANCE, AND MONITORING REPORT

LCP Bridge Street Subsite Location

NEW YORK QUADRANGLE

LATITUDE: N43° 04' 30"
LONGITUDE: W76° 13' 56"

SOURCE ARCVIEW GIS– WORLD STREET MAP

PARSONS
301 PLAINFIELD ROAD, SUITE 350, SYRACUSE, N.Y. 13212, PHONE: 315-451-9560

FILE NAME: P:\HONEYWELL -SYR\449919 LCP OU1 OMM 2016\10.0 TECHNICAL CATEGORIES\10.2 CAD\FIGURES\2018\449919-SLM-OMM.DWG
PLOT DATE: 8/2/2010 1:51 PM PLOTTED BY: RUSSO, JILL

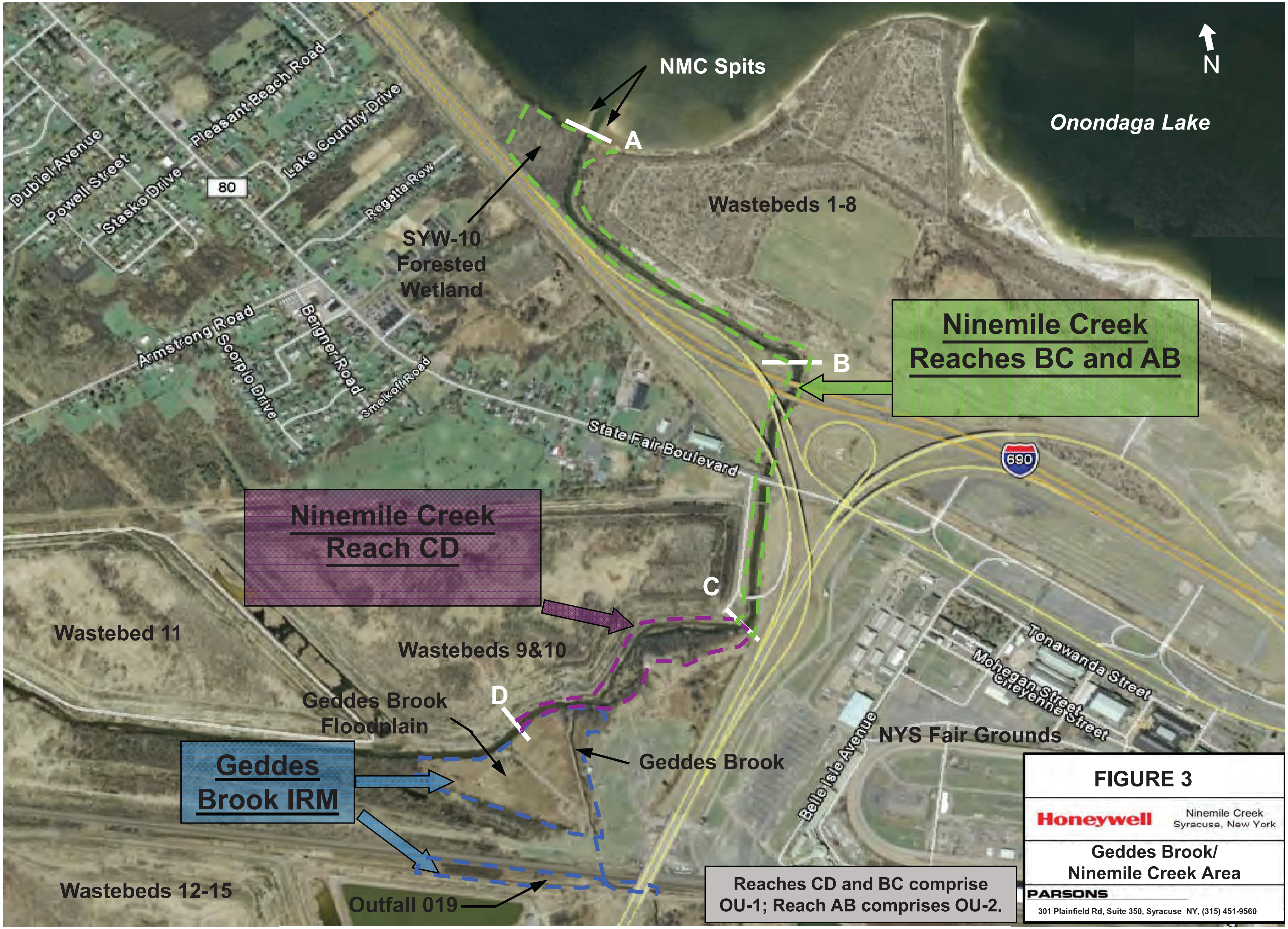
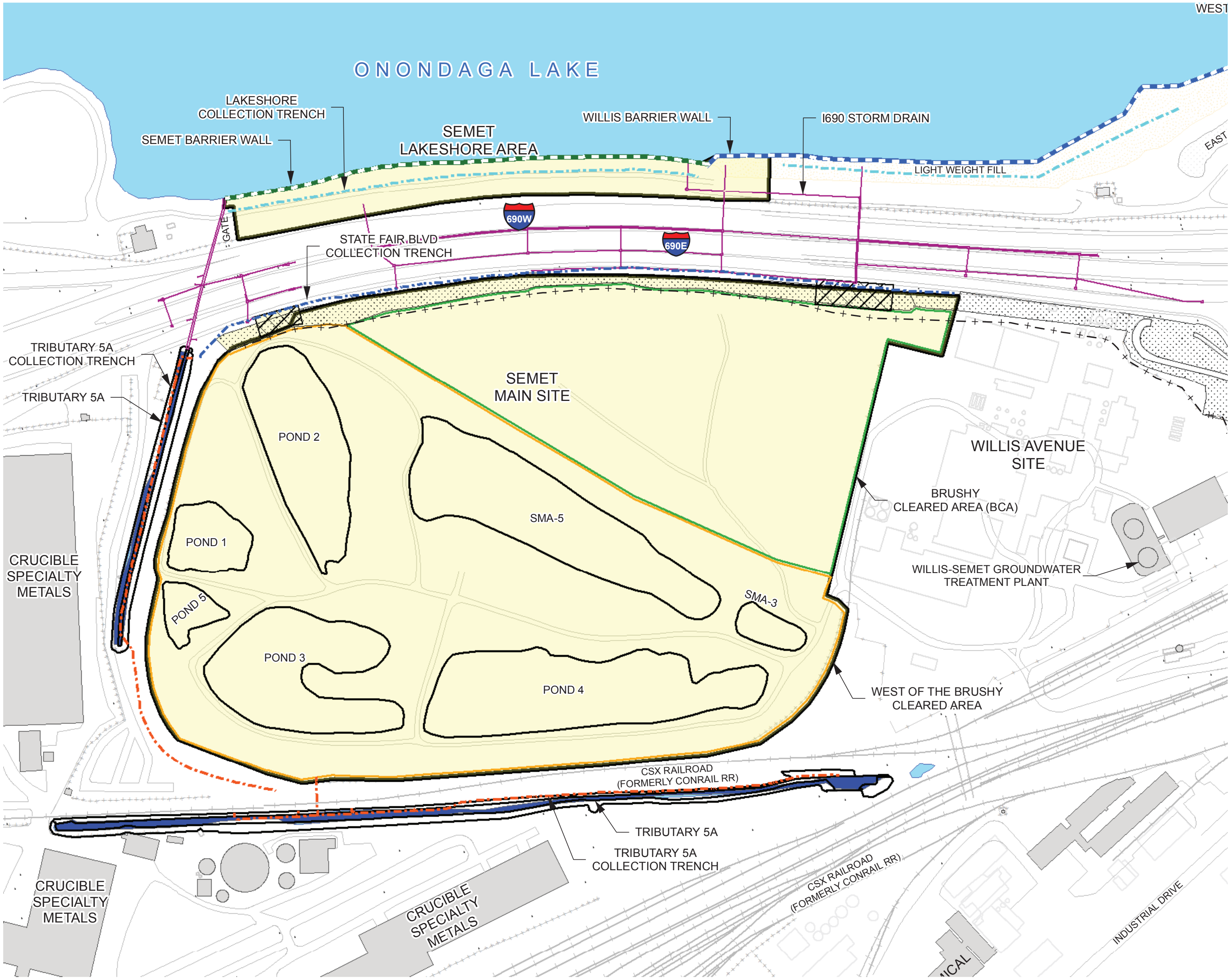

N
Onondaga Lake
NMC Spits
A
SYW-10
Forested
Wetland
Wastebeds 1-8
Ninemile Creek
Reaches BC and AB
B
Pleasant Beach Road
Lake Country Drive
Dubiel Avenue
Powell Street
Stasko Drive
80
Regatta Row
Armstrong Road
Scorpio Drive
Bergner Road
Smelkoff Road
State Fair Boulevard
690
Ninemile Creek
Reach CD
C
Wastebed 11
Wastebeds 9&10
Geddes Brook
Floodplain
D
Geddes Brook
Geddes
Brook IRM
Tonawanda Street
Mohegan Street
Cheyenne Street
NYS Fair Grounds
Belle Isle Avenue
Wastebeds 12-15
Outfall 019
Reaches CD and BC comprise
OU-1; Reach AB comprises OU-2.
FIGURE 3
Honeywell
Ninemile Creek
Syracuse, New York
Geddes Brook/
Ninemile Creek Area
PARSONS
301 Plainfield Rd, Suite 350, Syracuse NY, (315) 451-9560

FIGURE 4



N

LEGEND

SEMET RESIDUE PONDS SITE

INTERIM REMEDIAL MEASURES

WILLIS - SEMET HYDRAULIC CONTAINMENT SYSTEM

LAKESHORE COLLECTION TRENCH

SEMET BARRIER WALL

WILLIS BARRIER WALL

I-690 STORM DRAINAGE SYSTEM INVESTIGATION AND REHABILITATION IRM

I-690 STORM DRAIN

STATE FAIR COLLECTION TRENCH

WILLIS - SEMET BERM SITE IMPROVEMENTS PROJECT

BALLFIELD / WILLIS / SEMET BERM AREA

SOIL REMOVAL AREA

OU1 REMEDY

SEMET RESIDUE REMOVAL

FORMER POND AREAS - OU1

SEMET PONDS SHALLOW GROUNDWATER REMEDIAL ACTION (TRIBUTARY 5A)

TRIBUTARY 5A SEDIMENT REMOVAL

TRIBUTARY 5A COLLECTION TRENCH

SEMET RESIDUE PONDS

GEDDES, NEW YORK

SEMET RESIDUE PONDS INTERIM REMEDIAL MEASURES AND REMEDIAL ACTIONS

0 125 250 500
Feet

OCTOBER 2018
1163.63447

O'BRIEN & GERE ENGINEERS, INC.

PLOTDATE: 06/14/18 2:04:36 PM stantosa

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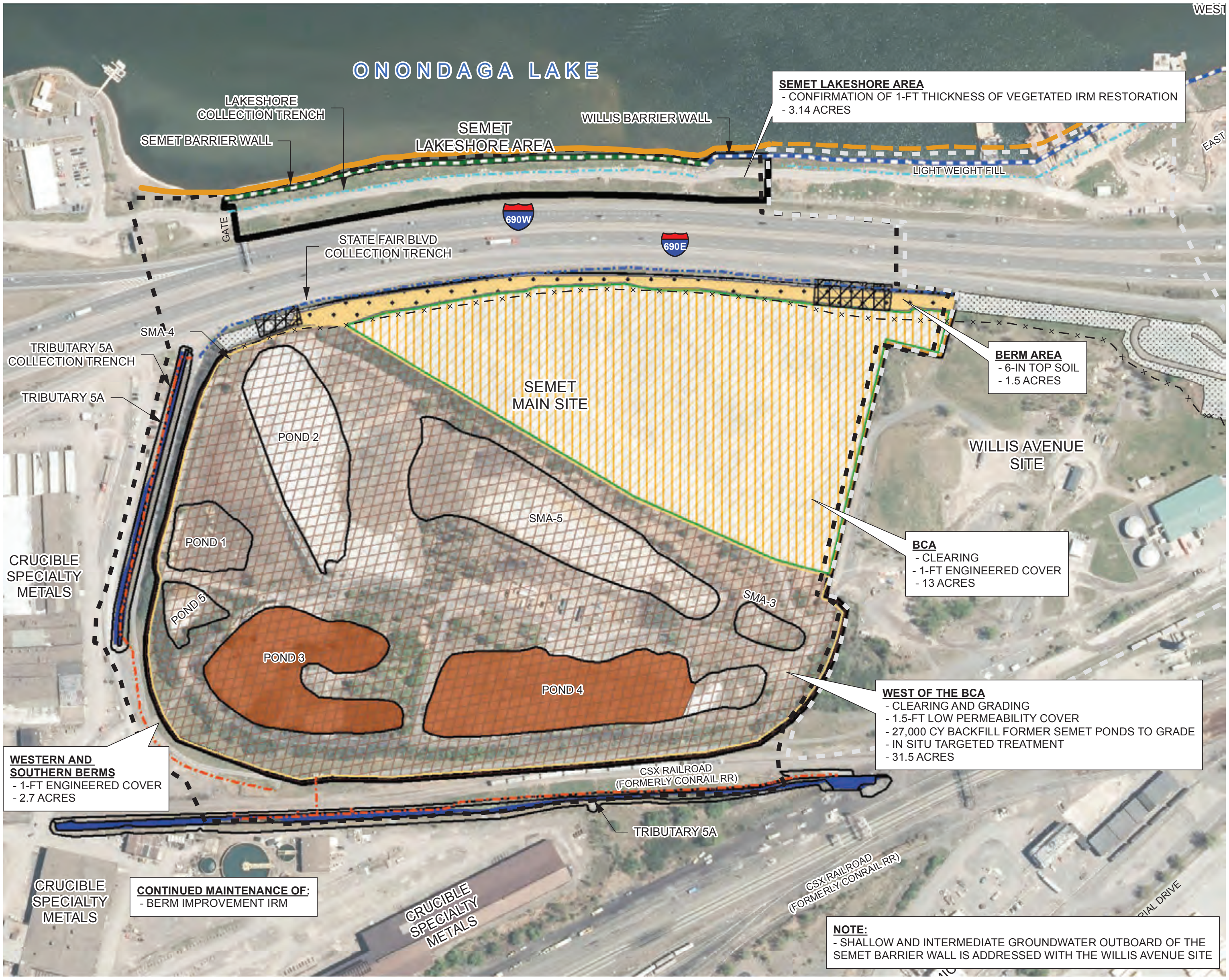
FIGURE 5



LEGEND

- SEMET PONDS SITE BOUNDARY
- BRUSHY CLEARED AREA (BCA)
- WEST OF THE BCA
- TRIBUTARY 5A
- 6-INCH TOP SOIL
- 1-FOOT ENGINEERED COVER
- 1.5-FOOT LOW-PERMEABILITY COVER
- IN-SITU TARGETED TREATMENT
- STATE FAIR BOULEVARD COLLECTION TRENCH (IRM)
- SEMET POINT OF COMPLIANCE
- WILLIS POINT OF COMPLIANCE
- SEMET WASTE MANAGEMENT
- WILLIS WASTE MANAGEMENT
- SOIL REMOVAL AREA (IRM)
- BALLFIELD / WILLIS / SEMET BERM SITE IMPROVEMENTS AREA (IRM)

OU1 REMEDY

- LAKESHORE COLLECTION TRENCH
- SEMET BARRIER WALL
- WILLIS BARRIER WALL
- TRIB 5A COLLECTION TRENCH
- TRIB 5A SEDIMENT REMOVAL

SEMET RESIDUE PONDS SITE
OU2 REMEDY
GEDDES, NEW YORK

0 125 250 500
Feet

DECEMBER 2018
1163.63447

O'BRIEN & GERE ENGINEERS, INC.

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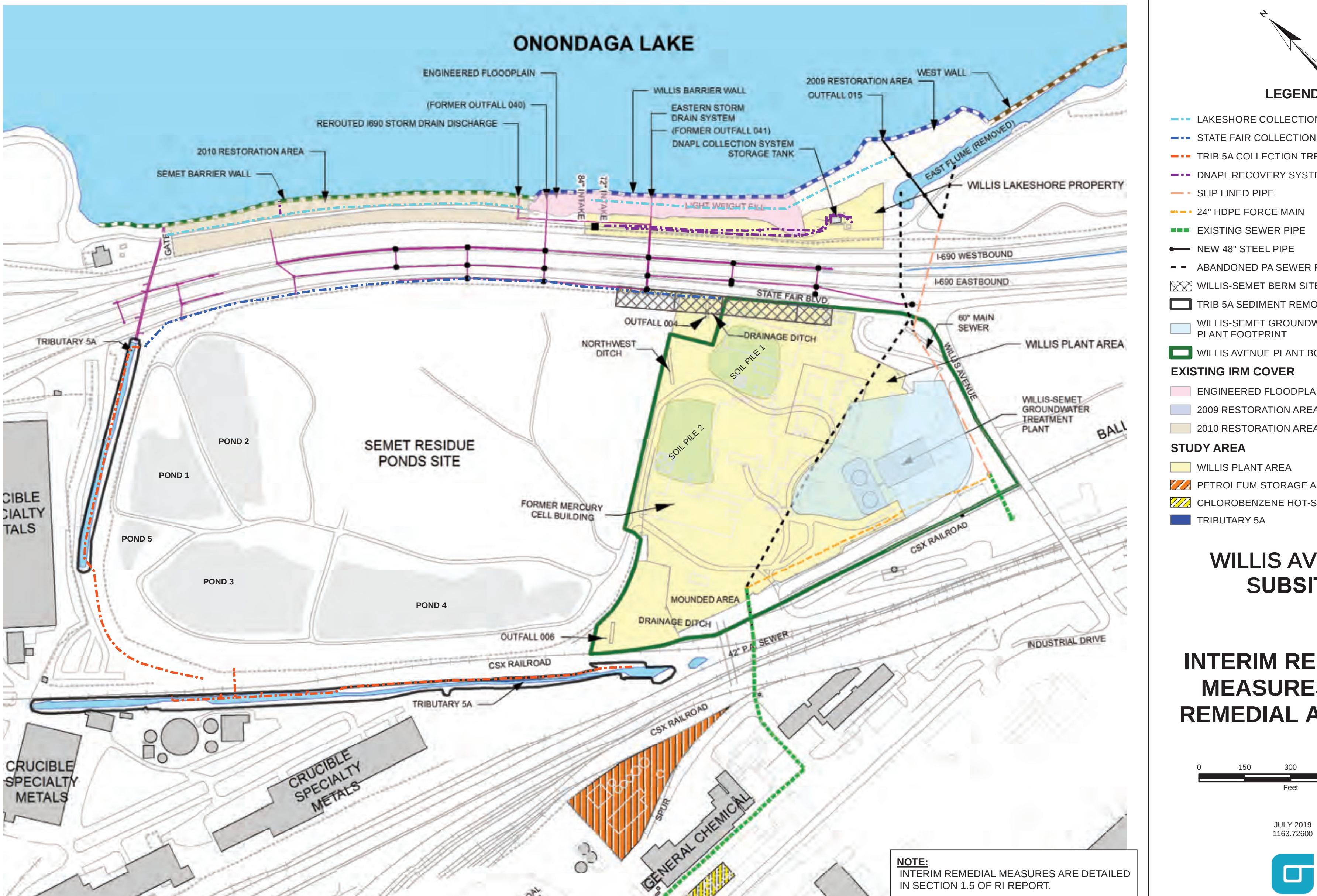


WILLIS AVENUE SUBSITE

INTERIM REMEDIAL MEASURES AND REMEDIAL ACTIONS

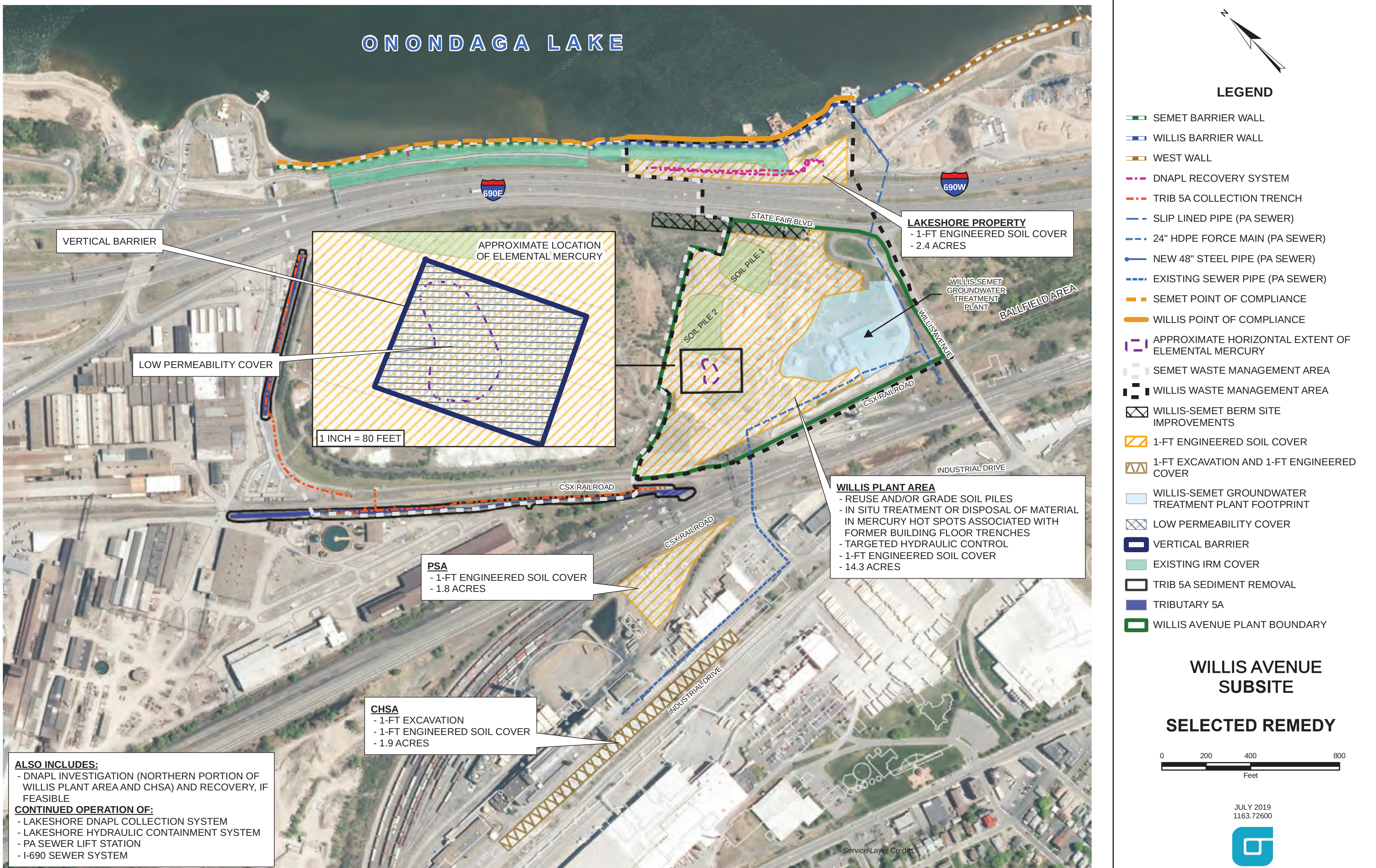
JULY 2019
1163.72600

O'BRIEN & GERE ENGINEERS, INC.

PLOTDATE: 06/14/18 12:00:38 PM ROZWODBJ

I:\Honeywell.1163\70277.Semet-2018-Ou-2\Docs\DWG\MXD\PRAP\FIGURE 4.mxd

FIGURE 7



WILLIS AVENUE SUBSITE

SELECTED REMEDY

JULY 2019
1163.72600

O'BRIEN & GERE ENGINEERS, INC.

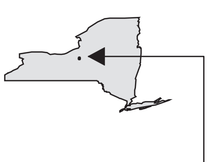
PLOTDATE: 09/22/17 10:44:29 AM ROZWODBJ

I:\Honeywell.1163\70277.Semet-2018-Ou-2\Docs\DWG\MXD\PRAP\FIGURE 9.mxd

FIGURE 8

WASTEBED B / HARBOR BROOK SUBSITE

SITE PLAN



MAP LOCATION

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Feet

1:24,000

SEPTEMBER 2018
1163.61858

O'BRIEN & GERE ENGINEERS, INC.

PLOTDATE: 06/13/18 12:52:23 PM RozwodBJ

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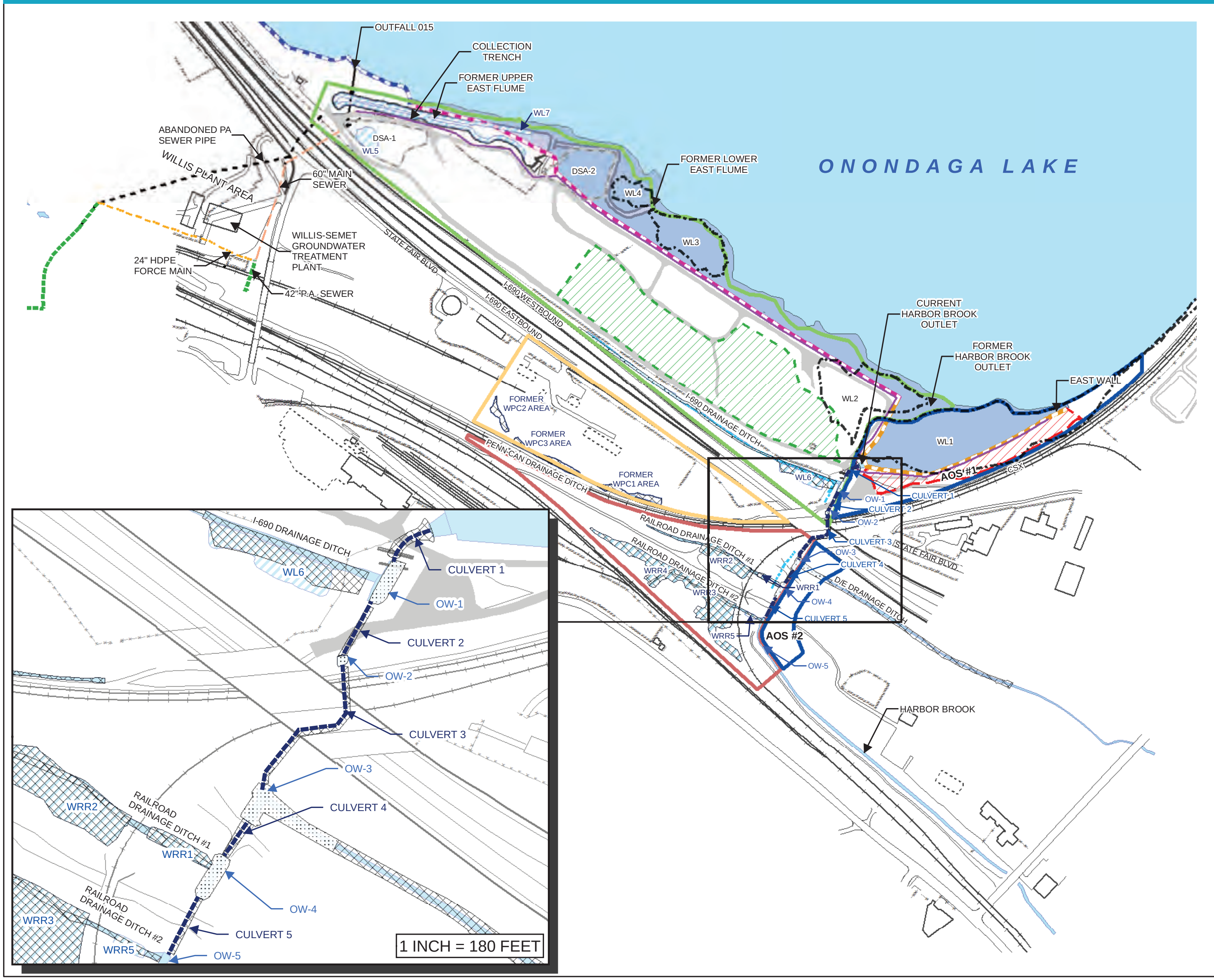

N

LEGEND

IRM FEATURES

- COVER AREA
- STAGED MATERIAL
- SEDIMENT REMOVAL
- SEDIMENT REMOVAL WITH LINER
- OUTBOARD WETLAND TRANSITIONAL ZONE
- EAST WALL
- WEST WALL
- WILLIS BARRIER WALL
- COLLECTION TRENCH
- UPPER HARBOR BROOK COLLECTION TRENCH
- CULVERT

SITE FEATURES

- ACCESS PATHWAYS
- DELINEATED WETLAND
- BUILDING

HISTORIC FEATURES

- HISTORIC/FORMER BUILDING
- DREDGE SPOIL AREA BOUNDARY
- FORMER WETLANDS

SITE BOUNDARIES

- RAILROAD AREA BOUNDARY
- LAKESHORE AREA BOUNDARY
- PENN-CAN PROPERTY BOUNDARY
- ADDITIONAL AREA OF STUDY BOUNDARY

WASTEBED B / HARBOR BROOK SUBSITE INTERIM REMEDIAL MEASURES

0 250 500 1,000
Feet

SEPTEMBER 2018
1163.61858

O'BRIEN & GERE ENGINEERS, INC.

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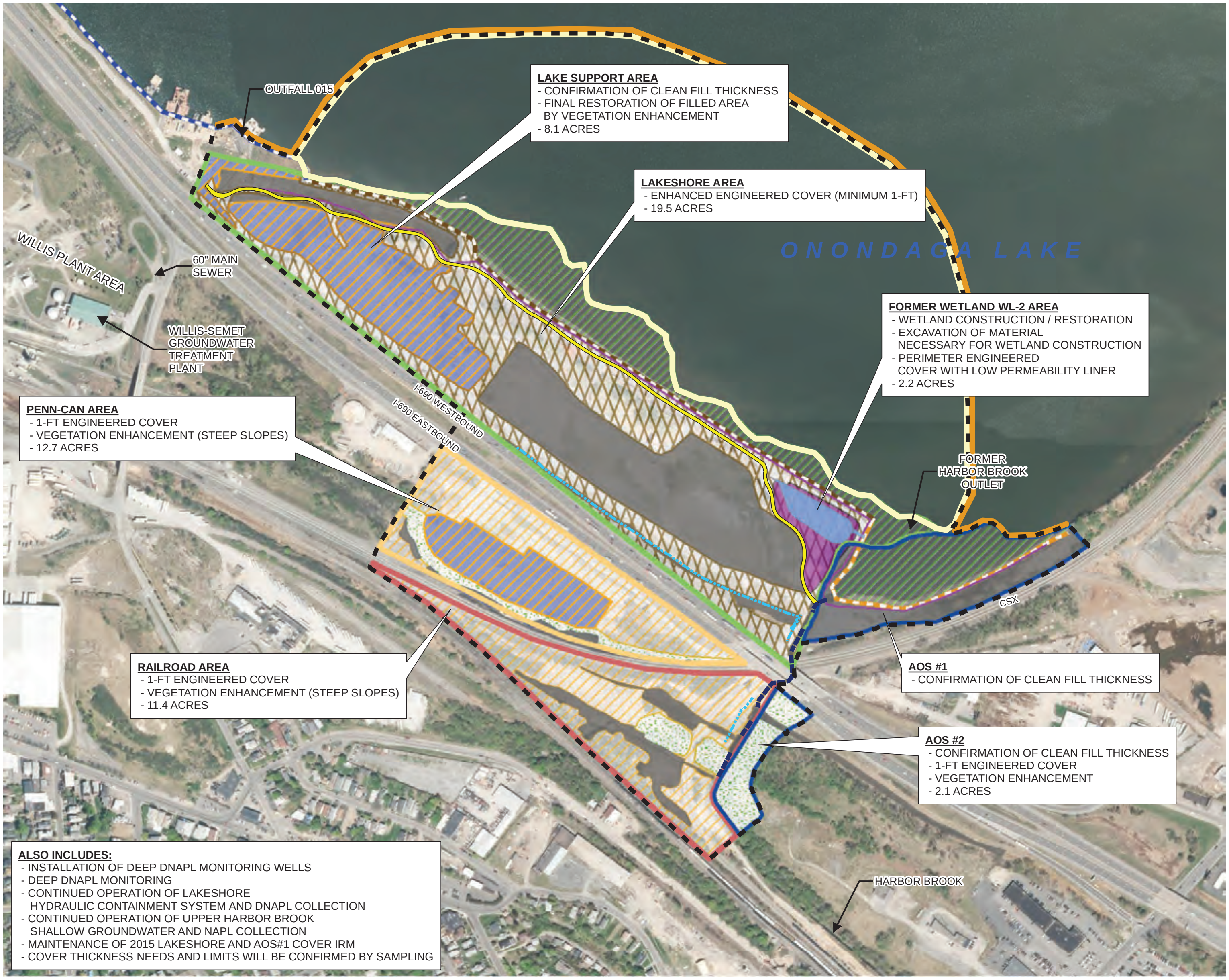
FIGURE 10



N

LEGEND

- EAST WALL
- WEST WALL
- WILLIS BARRIER WALL
- CULVERT
- UPPER HARBOR BROOK COLLECTION TRENCH
- COLLECTION TRENCH
- POINT OF COMPLIANCE (IN-LAKE POINT OF COMPLIANCE WOULD BE EXISTING LAKE BOTTOM)
- IN-LAKE WASTE DEPOSIT
- WASTE MANAGEMENT AREA
- IRM AREA
- CONCEPTUAL ONONDAGA COUNTY WEST SHORE TRAIL (PROPOSED BY OTHERS)
- ENHANCED ENGINEERED COVER
- 1-FT ENGINEERED COVER
- AREA ADDRESSED BY EXISTING FILL
- VEGETATION ENHANCEMENTS
- AREA ADDRESSED BY LAKE REMEDY / IRM
- LOW PERMEABILITY LINER BELOW COVER
- WETLAND CONSTRUCTION / RESTORATION

SITE BOUNDARIES

- RAILROAD AREA BOUNDARY
- LAKESHORE AREA BOUNDARY
- PENN-CAN PROPERTY BOUNDARY
- ADDITIONAL AREA OF STUDY BOUNDARY

WASTEBED B/HARBOR BROOK SUBSITE OU1 REMEDY

0 225 450 900
Feet

SEPTEMBER 2018
1163.61858

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 11

LEGEND

- DITCH A IRM
- SEEP COLLECTION TRENCH
- GROUNDWATER COLLECTION TRENCH
- ACCESS PATHWAYS
- REVETMENT
- SEEP APRON
- VEGETATIVE COVER / RESTORED AREA / SHORELINE STABILIZATION / WET SWALE
- MITIGATION WETLAND
- BIOSOLIDS AREA
- WASTEBEDS 1-8 SITE

WASTEBEDS 1- 8
GEDDES, NEW YORK

WASTEBEDs 1-8 IRM COMPONENTS

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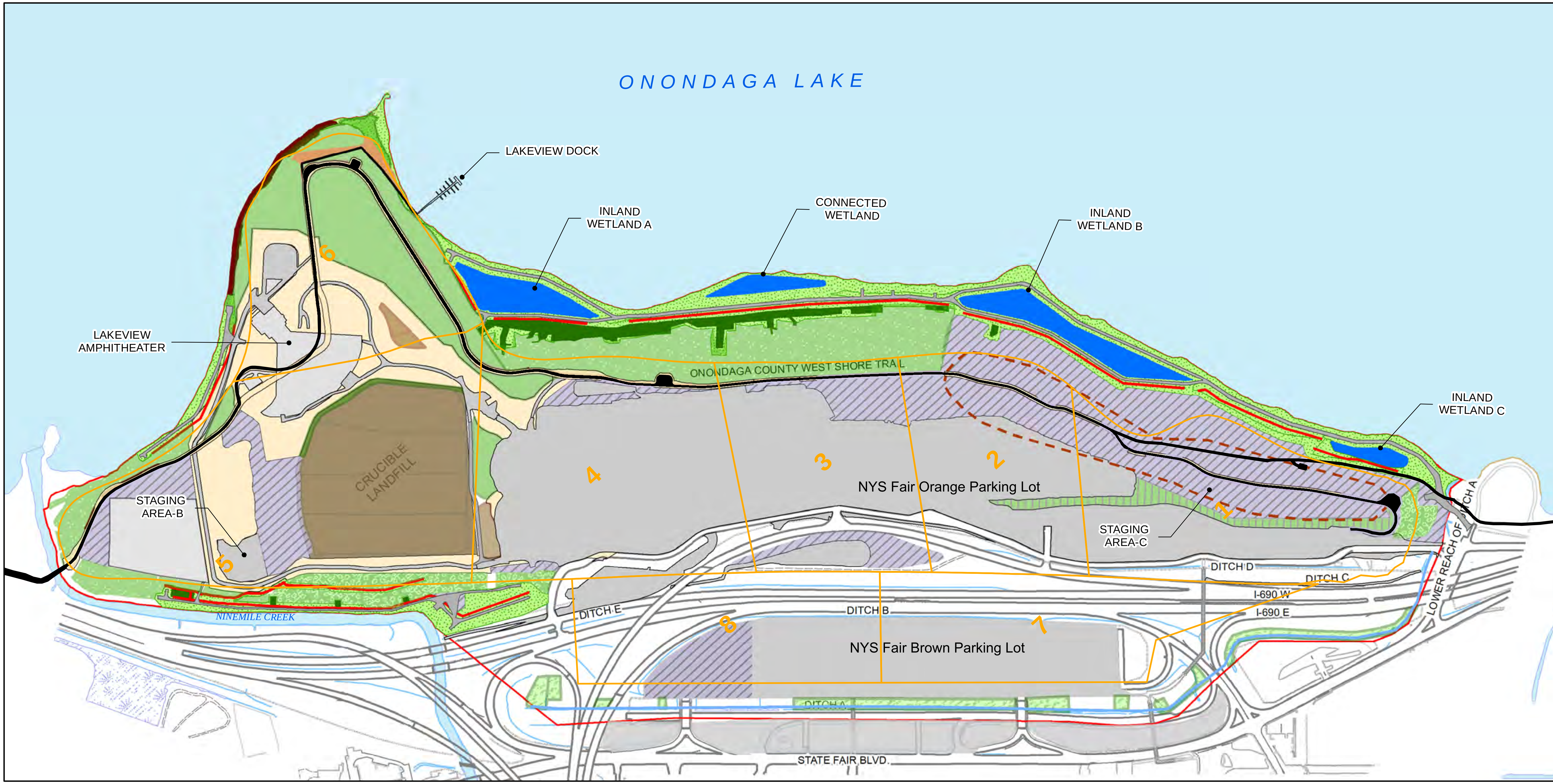
Feet

DECEMBER 2016
1163.45176

O'BRIEN & GERE ENGINEERS, INC.



LEGEND

- ACCESS PATHWAYS
- ONONDAGA COUNTY AMPHITHEATER FOORPRINT
- CRUCIBLE LANDFILL
- ONONDAGA COUNTY WEST SHORE TRAIL
- BIOSOLIDS AREA FOOTPRINT
- LAKEVIEW DOCK ACCESS CONSTRUCTION BOUNDARY

PV PROJECT AREAS

- MITIGATION WETLANDS
- VEGETATIVE COVER / SHORELINE ENHANCEMENT AREAS/ VEGETATED WET SWALE
- REVETMENT
- SEEP APRON
- APPROXIMATE LOCATION OF VEGETATED WET SWALE
- PHASE 1 VEGETATED SOIL COVER
- PHASE 1VEGETATION ENHANCEMENT COVER
- PHASE 2 STRUCTURAL FILL PARKING AREA
- PHASE 2 VEGETATION ENHANCEMENT COVER
- PHASE 3 VEGETATION ENHANCEMENT COVER (2018)
- PHASE 3 VEGETATION ENHANCEMENT COVER (2017)
- PHASE 3 STABILIZED VEGETATED SOIL COVER (2018)
- PHASE 3 1-FT VEGETATED SOIL COVER (2017)
- Addendum DP#4 Cover
- COVER REMAINING[1]

NOTES:
1. COVER REMAINING EXTENTS ARE FROM THE SELECTED REMEDY IN THE DECEMBER 2014 RECORD OF DECISION AND MAY BE MODIFIED AS PART OF FUTURE REMEDIAL DESIGNS.

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

N

HONEYWELL INTERNATIONAL
WASTEBEDS 1-8
SYRACUSE, NEW YORK

SITE PLAN WITH COVER TYPES AND EXTENT

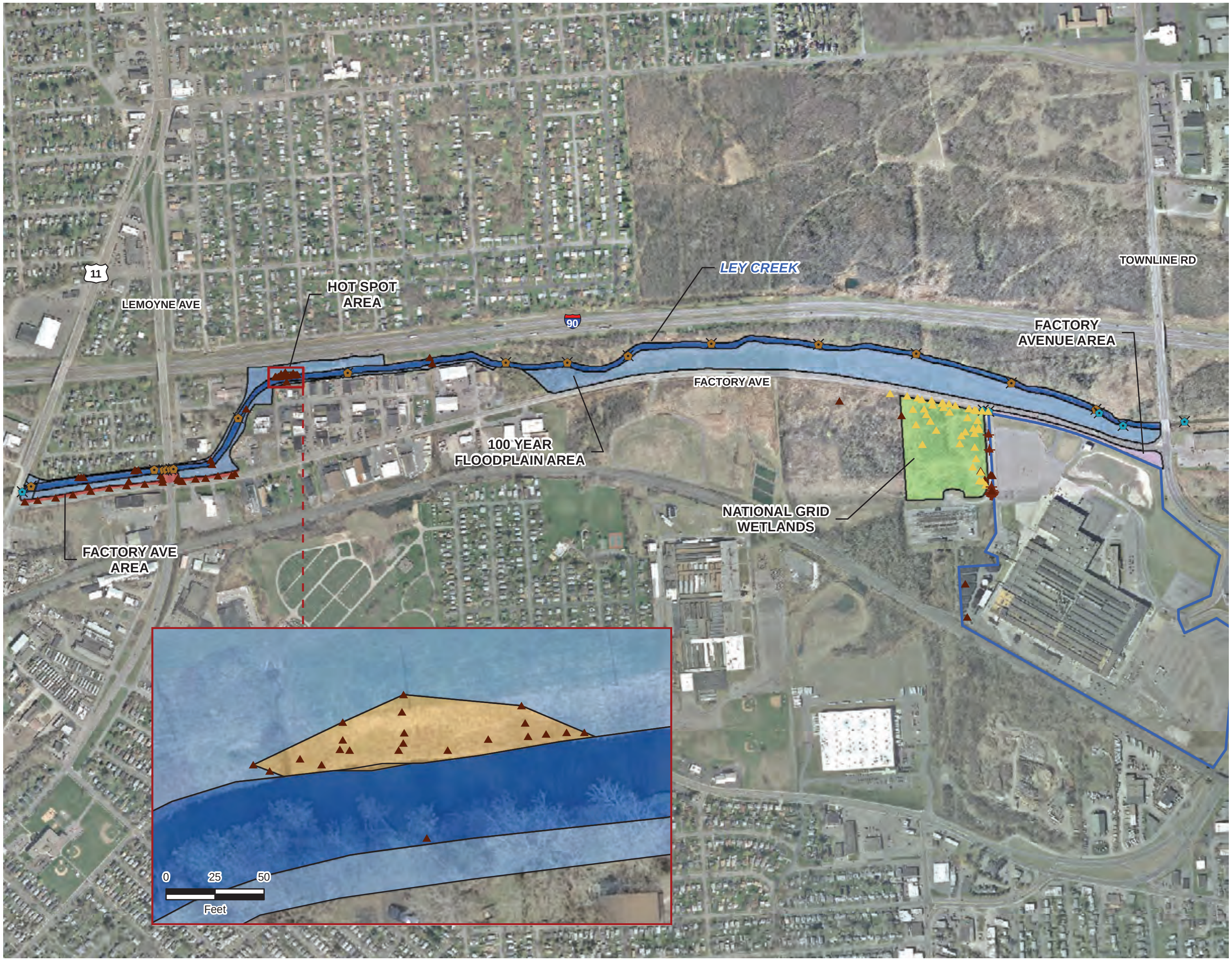
1163.71536
MARCH 2020

O'BRIEN & GERE ENGINEERS, INC.

Figure 13: Niagara Mohawk Hiawatha Blvd Former MGP Subsite

Figure 14 - GM Inland Fisher Guide and Ley Creek PCB Dredgings Subsites

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation



LEGEND

- SOIL BORING
- SURFACE SOIL
- SOIL SAMPLE
- SEDIMENT SAMPLE
- SURFACE WATER
- FORMER IFG FACILITY PROPERTY BOUNDARY (OU 1)
- FACTORY AVENUE AREA
- LEY CREEK 100-YEAR FLOODPLAIN AREA
- LEY CREEK 100-YEAR FLOODPLAIN HOT SPOT AREA
- LEY CREEK
- NATIONAL GRID WETLANDS
- FACTORY AVENUE / LEMOYNE AVENUE INTERSECTION

GENERAL MOTORS
IFG SUBSITE
OPERABLE UNIT 2
SYRACUSE, NEW YORK

OU 2 SELECTED REMEDY AREAS

0 375 750 1,500
Feet

APRIL 2014
15388.51418

O'BRIEN & GERE

This document was developed in color. Reproduction in B/W may not represent the data as intended.

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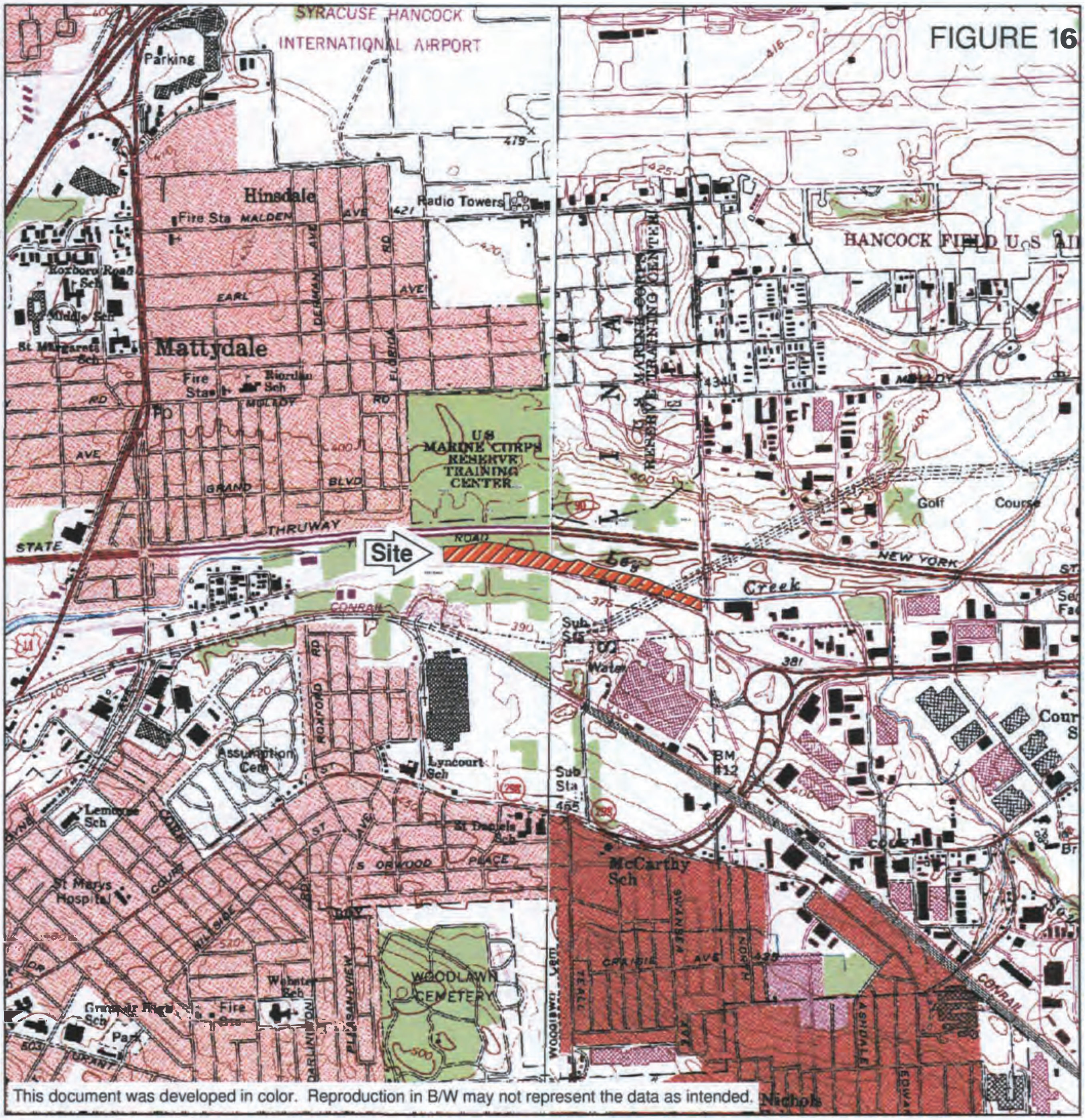
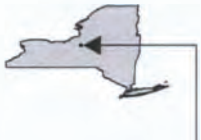
PLOT DATE: 12/19/06 DIV. 732 JPS



ADAPTED FROM: SYRACUSE EAST AND SYRACUSE WEST, NEW YORK USGS QUADRANGLES



QUADRANGLE LOCATION

LEY CREEK PCB
DREDGINGS SUBSITE
SYRACUSE, NEW YORK

SITE LOCATION

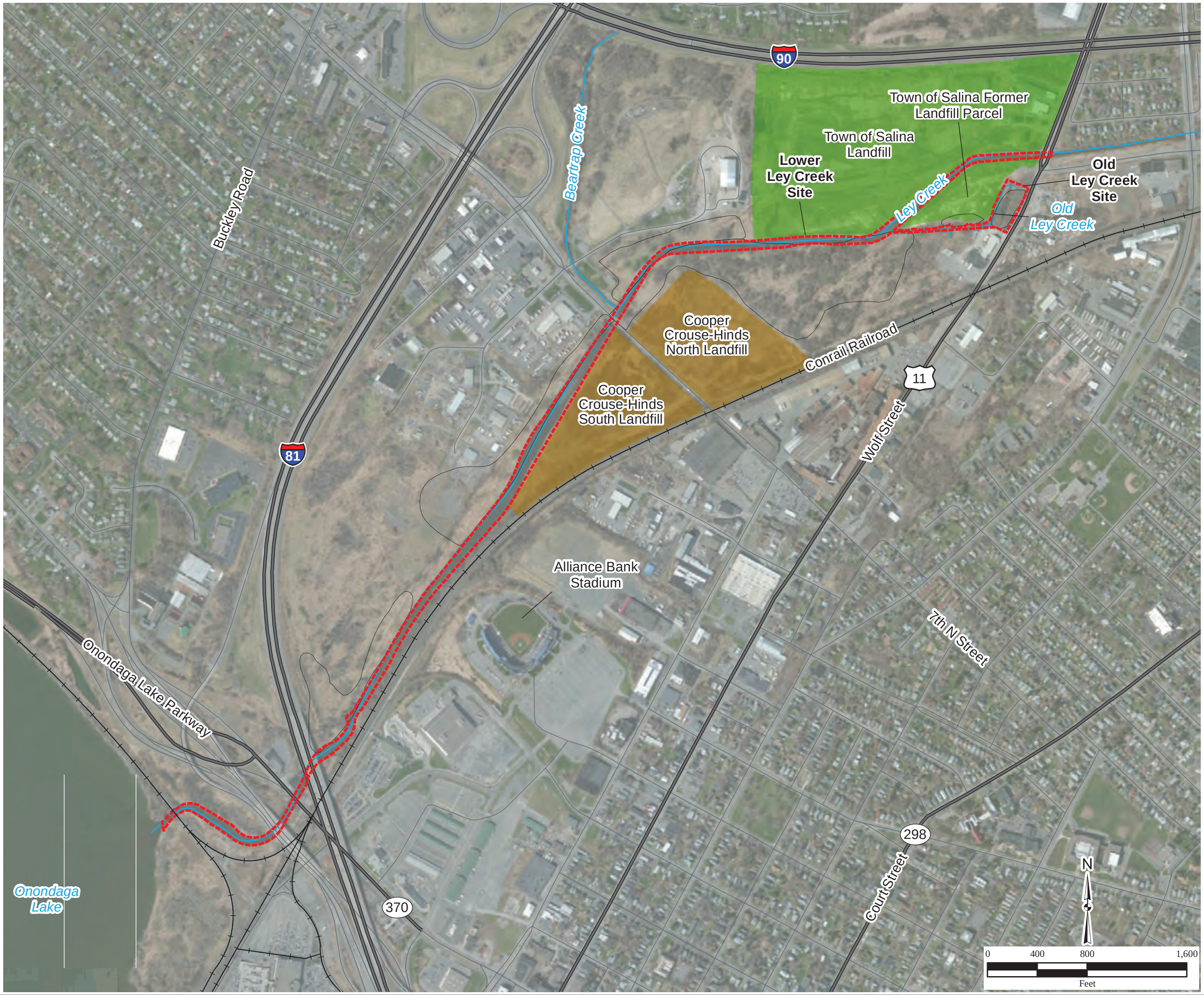
0 1,000 2,000 4,000 6,000 8,000

Feet

4966.34124
JANUARY 2017

1:24,000

O'BRIEN & GERE



Lower Ley Creek Subsite of Onondaga Lake, Syracuse, NY

Figure 17
Site Layout

Legend

- Surface Water Course
- Road
- Highway
- Railroad
- Lower Ley Creek and Old Ley Creek Site Boundary
- Soil Site Boundary
- Cooper Crouse-Hinds Landfill
- Town of Salina Landfill and Former Landfill Parcel

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1/13/2014 CNL
Source: HGL, AE Engineering, ESRI, ArcGIS Online Imagery

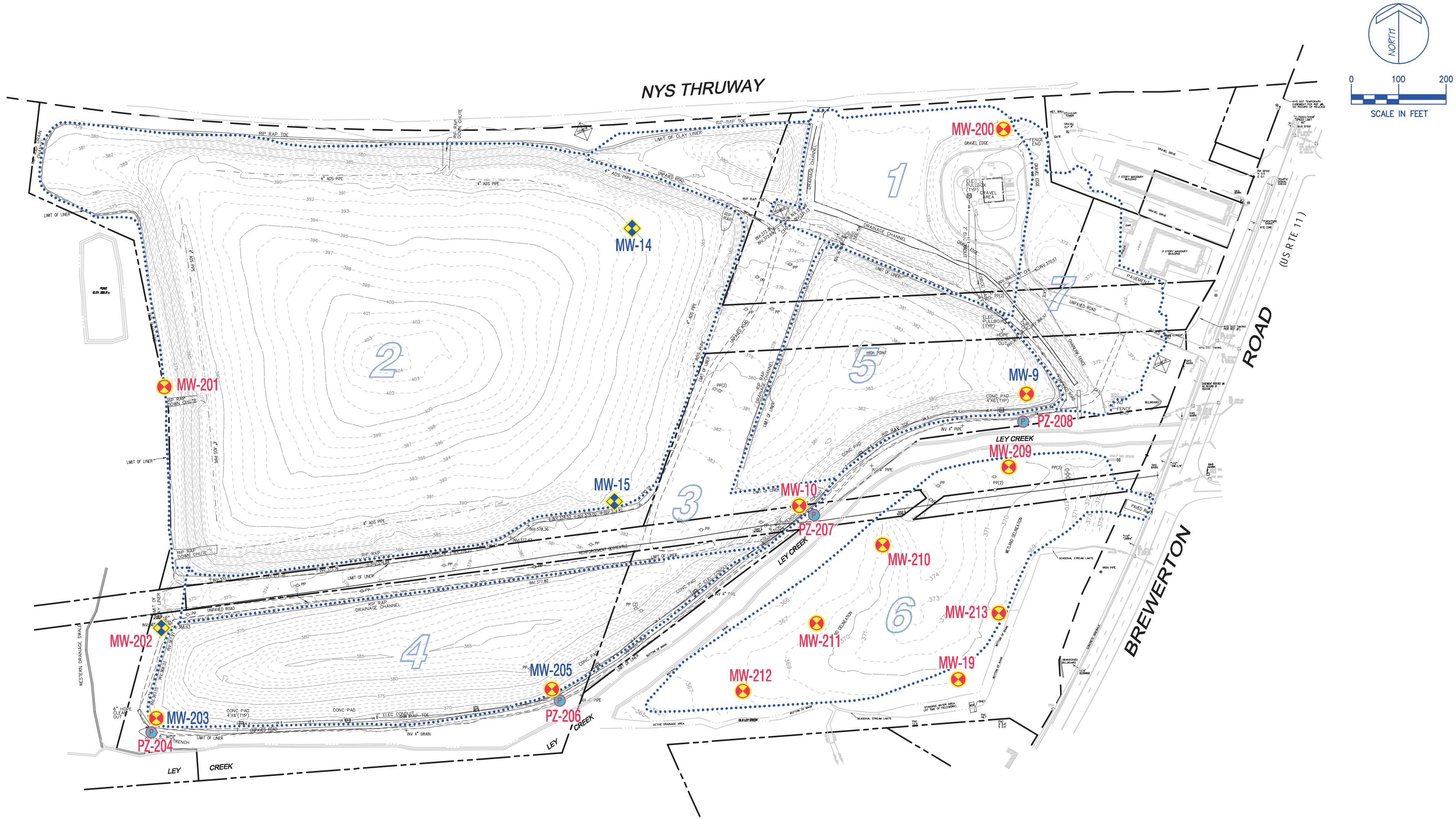

Figure 18 - Town of Salina Landfill, Site Layout

Onondaga Lake Second Five Year Review

Attachment 3

Fish Tissue Data Summary Tables and Figures

Onondaga Lake Site/Lake Bottom Subsite
Second Five-Year Review Report
Attachment 3
Fish Tissue Data Tables and Figures

Introduction

The following includes a summary of the fish tissue data tables and figures presented in this Five-Year Review (FYR) Report and a general description of the fish tissue monitoring program since 2008. As noted in the Onondaga Lake Monitoring and Maintenance Plan (OLMMP) (Parsons, 2018), fish tissue concentrations by species, with statistical evaluation (e.g., 95 percent upper confidence limit [UCL] on the mean) are compared to the Onondaga Lake fish tissue goals and target concentrations, as presented below and in Table 13 of the main section of this FYR report. The information presented here and the assessments in the main portion of the FYR Report reflect the general distribution of the bulk of the data (i.e., a large percentage of the data is reflected in the assessment rather than a specific metric, and the full range of concentrations can be seen in the box-and-whisker plots, as defined below).

The Onondaga Lake Record of Decision (ROD) (NYSDEC and USEPA, 2005) indicated that mercury is a primary concern in the lake and is a part of all five remedial action objectives (RAOs), and therefore the ROD specified the following remedial goals for mercury in fish tissue for protection of human health and ecological exposure:

- 0.2 mg/kg (fish tissue fillet) for protection of human health based on the reasonable maximum exposure scenario assumptions from the Onondaga Lake Human Health Risk Assessment (HHRA) (TAMS, 2002a).
- 0.3 mg/kg (fish tissue fillet) based on EPA's methylmercury National Recommended Water Quality criterion for the protection of human health for the consumption of organisms.
- 0.14 mg/kg (whole fish) for protection of ecological receptors (wildlife) based on the exposure assumptions from the Onondaga Lake Baseline Ecological Risk Assessment (BERA) (TAMS, 2002b). This ecological goal was based on the lowest-observed-adverse-effect level (LOAEL) for the river otter.

In addition to the remedial goals for mercury in fish tissue, cited above, ecological target tissue concentrations for mercury based on the no-observed-adverse-effect levels (NOAELs) as well as target tissue concentrations for bioaccumulative organic contaminants, corresponding to various risk levels (including both the 10^{-4} and 10^{-5} cancer risk levels for human health exposure and both the LOAELs and NOAELs for ecological exposure), were developed in the Onondaga Lake Feasibility Study (Parsons, 2004) based on exposure parameters from the Onondaga Lake HHRA and BERA and were included in the ROD (ROD Table 7).[1] These targets are not remedial goals,

[1] Non-carcinogenic targets were not developed for PCDD/PCDFs prior to the issuance of the ROD. Subsequent to its issuance, a RME noncancer endpoint target of 1.3E-06 mg/kg (1.3 ng/kg) was developed using the parameters presented in Appendix G of the FS for a target concentration for the non-cancer endpoint, and using the EPA 2012 reference dose of 7E-10 mg/kg-day.

as presented in the ROD, but are points of reference for evaluations of reduction of risk for human and wildlife consumers of fish.

As indicated in the ROD, other contaminants, including PCBs, hexachlorobenzene, and PCDD/PCDFs, are not as widespread in sediments in the lake (as compared to mercury) and are found primarily in a few specific areas of the lake (e.g., sediment management units [SMUs] 1, 2, 6, and 7), which underwent aggressive active remediation (dredging and/or capping). The ecological and human health remedial goals for mercury and targets for other bioaccumulative contaminants in fish tissue are summarized in Table 13 in the main section of this FYR Report.

As the areas of the lake with elevated concentrations of these bioaccumulative organic contaminants for which target tissue concentrations were developed are generally within the remedial areas based on exceedance of the cleanup criteria of the mean PECQ of 1 (which addresses multiple contaminants) plus the mercury PEC, the exposures to these compounds would be reduced to the same or greater extent as that of mercury. It was therefore expected that if the remedial goals for mercury in fish tissue are met in the future (e.g., during the 10-year monitored natural recovery [MNR] period after completion of the dredging and capping), that the future fish tissue concentrations for the contaminants listed in ROD Table 7 would fall within the concentration ranges shown in that table for each contaminant and receptor. If the expectation is proven not to be the case, based on ongoing fish tissue monitoring, then an evaluation will take place to determine why this expectation may no longer be valid.

The Onondaga Lake ROD envisioned a long-term monitoring program to assess the effectiveness of the remedy, since changes in the contaminant concentrations in biota typically take at least several years to fully manifest. This concept is reflected in the ten-year MNR period discussed in the ROD and is consistent with the results seen following remediation at other sediment sites (e.g., Cumberland Bay in New York State). Future Five-Year Reviews will continue to assess the data trends as they are established as well as attainment of the fish tissue goals.

Although fish have been collected on an annual basis during the post-ROD baseline monitoring period (2008 to 2011) prior to commencement of remedial actions in the lake and during the remedial action period (2012 to 2016), only two years of data (2017 and 2018) have been collected and are currently available since remediation activities were completed in 2016. To statistically assess the direction and rate of change in fish concentrations post-remedy (i.e., after 2016), additional years of data collection are needed and will be undertaken in future years as defined in the OLMMP. Therefore, the discussion in the "Data Review" section in the main portion of this FYR Report focuses on a qualitative comparison of pre-remedy and post-remedy concentrations and comparisons to the fish tissue goals for mercury and the fish tissue target concentrations for the organics.

Fish Data Reporting

For the fish tissue data reporting, both the Honeywell data sets from 2008 to 2018 (fillets of smallmouth bass, walleye, pumpkinseed, and carp [2014-2018]), whole-body small prey fish, and whole-body large prey fish (2014-2018) and NYSDEC data sets from 2008 to 2018 (largemouth bass and yellow perch) are used. The Honeywell fish data presented herein are as provided by

Honeywell's consultants. The NYSDEC fish data from 2008 through 2016 were obtained from the August 2019 version of the NYSDEC Onondaga Lake Database (AECOM, consultant to NYSDEC) and data from 2017 and 2018 were obtained from source files provided by NYSDEC in December 2019. Honeywell data from 2008 through 2011 were collected under the Baseline Monitoring Program, data from 2012 through 2016 were collected under the Monitoring and Maintenance Program during remedial action (dredging and capping)[2], and data from 2017 and 2018 were collected under the Post-Construction Monitoring Program.

For the Honeywell Baseline Monitoring Program, the selected adult sport fish species covered a range of trophic levels including top level piscivores (smallmouth bass, walleye), benthic invertivores (brown bullhead), and invertivores (pumpkinseed). In 2014, a benthic herbivore (common carp), was also collected at the request of NYSDEC. In 2015, brown bullhead was dropped from the program and replaced by common carp. Fish tissue sampling and analysis conducted by Honeywell in 2015 and 2016 were implemented consistent with NYSDEC approved submittals, including the 2015 and 2016 work scopes for tissue monitoring submitted as work plan addenda to the Onondaga Lake Tissue Monitoring Work Plan for 2012 (Parsons and Anchor QEA, 2015; Parsons and Anchor QEA, 2016). Fish tissue sampling conducted by Honeywell in 2017 and 2018 was implemented consistent with draft and final versions of the Onondaga Lake Monitoring and Maintenance Plan (Parsons and Anchor QEA, 2018; Parsons, 2018).

The NYSDEC monitoring program is independent of the Honeywell program. NYSDEC instituted a long-term sampling program in 1970, initially concentrating on smallmouth bass and later largemouth bass. Other species were analyzed by NYSDEC if collected in certain years to provide information on other trophic levels such as carp, yellow and white perch (invertivores), and channel catfish (benthic omnivore). Under the NYSDEC monitoring program carp have not been collected since 2013, and white perch and channel catfish have not been collected since 2012.

Based on prior discussions with Honeywell related to data usability, the Honeywell organics data from 2010 are not used and the mercury data from 2010 are qualified as estimated due to incorrect filleting procedures and potential problems with extractions resulting in very low concentrations of organic contaminants in sport fish and prey fish in 2010. In addition, four of the revised lipids results from 2011 were rejected and the lipids results for these samples are not used. In addition, as discussed in NYSDEC's January 17, 2020 comments on Honeywell's draft Onondaga Lake 2018 Annual and Comprehensive Monitoring and Maintenance Report (Parsons, 2020), the PCBs and lipids data sets for 2017 and 2018 are under NYSDEC review. As noted by NYSDEC during review of the 2017 data, due to a potential misinterpretation of the lipids analysis standard operating procedure (SOP) by the laboratory, the lipid analysis of many of the fish samples may not have confirmed that the hexane solvent used in the extraction had been properly evaporated, and it is likely that many of those samples were not properly dried. This potentially caused the laboratory to report artificially high weights of residuals, resulting in lipid results biased high. A limited set of the samples using archived material were reanalyzed although many of the samples did not have sufficient mass for reanalysis. It is believed that similar issues existed with the 2018 data. Based on this, as well as other modifications to the analytical program to incorporate

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[2] Adult sport fish and alewife prey fish were collected by Honeywell in June 2012 just prior to the commencement of dredging in late July 2012. Minnow prey fish were collected in August 2012.

improvements in the QA/QC procedures (e.g., inclusion of additional fish tissue certified reference materials that will be analyzed and evaluated with each analytical batch), some of the analytical SOPs have been revised for the analysis of fish samples collected in the 2019 and 2020 seasons and the revised SOPs are being included in a revised Onondaga Lake Media Monitoring Quality Assurance Project Plan (in progress).

Calculations of total PCBs, sum of DDT and metabolites, and dioxin/furan toxic equivalence (TEQs) (based on the World Health Organization human health and mammalian-based toxicity equivalence factors [TEFs] from van den Berg et al., 2006) were performed for those data sets where totals were not included in the source files.

For ecological exposure, the fish were grouped into two size classes: small (30 to 180 mm) and large (180 to 600 mm) consistent with the Onondaga Lake BERA (TAMS, 2002b). Data for small whole-body prey fish are available in the Honeywell data set since 2008. Between 2014 and 2018, Honeywell collected large (180 to 600 mm) prey fish for whole-body analysis, consisting exclusively of white suckers. As large whole-body prey fish were not collected from 2008 to 2013 and to supplement the large prey fish data collected since 2014, whole-body concentrations were estimated based on the fillet samples from that size class and the fillet to whole-body conversion factors (0.7 for mercury, 2.5 for PCBs, and 2.3 for DDTs and HCB) from the Onondaga Lake BERA (Section 8.2.6.4). These conversion factors will be reassessed with new data in the future, if appropriate.

In this attachment, Tables 1 and 2 provide a summary of the number of samples used in the analyses for each species and analyte for the Honeywell and NYSDEC data sets, respectively. Tables 3a, 3b, and 3c include annual fish tissue arithmetic mean and 95% UCL contaminant concentrations, as defined below, for each species for the 2015-2018 period for the Honeywell data for sport fish fillet data, prey fish whole-body data, and calculated whole-body concentrations based on the fillet data, respectively. Tables 4a and 4b include annual fish tissue mean and 95% UCL contaminant concentrations for the NYSDEC sport fish fillet data for Largemouth Bass and Yellow Perch, and calculated whole-body concentrations based on the NYSDEC fillet data, respectively. USEPA's ProUCL Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations was used by both Honeywell/Parsons and NYSDEC/AECOM for calculation of the 95% UCL and mean values for their respective fish data sets, unless three or fewer results were detects (USEPA, 2015). If three or fewer results were detects, then means and 95% UCLs were not calculated for the tables and the 95% UCLs are not shown on the figures. However, for the figures, the mean was calculated arithmetically when one to three results were detects, substituting one-half the detection limit (mercury) or reporting limit (organic analytes) for non-detects. For data sets where all the results were non-detects, "ND" is shown on the figure.

The data are presented in the Sets 1 through 3 figures as box-and-whisker plots with 95% UCL values, and as means plus and minus two standard errors in the Set 4 Honeywell figures, which provides an estimate of 95 percent upper and lower confidence limits. (See Figure 1 in this attachment.) Refinements to these methods may be incorporated in future Five-Year Reviews.

Honeywell Labs for Fish Analyses (2008 to 2018):

- 2008. Test America, Vermont (all analytes)
- 2009. Accutest, New Jersey (mercury in prey fish); Test America, Pittsburgh, PA (other analytes, mercury in sport fish)
- 2010. SGS, North Carolina (dioxins/furans); Accutest, NJ (other analytes)
- 2011, 2012, 2013. Test America, Pittsburgh PA and Knoxville TN
- 2014, 2015, 2016. Pace Analytical (all analytes)
- 2017, 2018. Eurofins – Lancaster, PA and Eurofins – Frontier, WA

NYSDEC Lab for Fish Analyses (2008 to 2018):

- Hale Creek Field Station, Analytical Services Unit

Note, largemouth bass was the predominant species analyzed by NYSDEC during the 2015-2018 period and yellow perch was also analyzed in 2016 and 2018. As samples of the other species (*i.e.,* white perch, carp, channel catfish) were not analyzed after 2013 as shown in Table 2, figures for fillet data for white perch, carp, and channel catfish are not included in the Set 1 figures and calculated whole-body concentrations based on the fillet data for these species are not included in the Set 3 figures.

LIST OF FISH MONITORING SUMMARY TABLES

LIST OF FISH MONITORING SUMMARY FIGURES

Set 2: Small (30 to 180 mm) Prey Fish Whole-Body Concentrations for Ecological Remedial Goal and Targets

Honeywell Data (2008-2018)

- Figure 1: Mercury Concentrations in Small Prey Fish (All SMUs)
- Figure 2: Calculated Whole-Body Mercury Concentrations in Small Pumpkinseed
- Figure 3: Total PCB Concentrations in Small Prey Fish (All SMUs)
- Figure 4: Calculated Whole-Body Total PCB Concentrations in Small Pumpkinseed
- Figure 5: DDT Concentrations in Small Prey Fish (All SMUs)
- Figure 6: Hexachlorobenzene Concentrations in Small Prey Fish (All SMUs)
- Figure 7: Calculated Whole-Body Hexachlorobenzene Concentrations in Small Pumpkinseed

Note, all species of small prey fish (whole body) collected by Honeywell are included in this data set (banded killifish, round goby, golden shiner, brook silverside, minnow, bluntnose minnow [alewife excluded]).

Set 3: Large (180 to 600 mm) Prey Fish Whole-Body Concentrations for Ecological Remedial Goal and Targets

Honeywell Data (2008-2018)

- Figure 1: Mercury Concentrations in Large Prey Fish (All SMUs)
- Figure 2: Calculated Whole Body Mercury Concentrations in Smallmouth Bass and Walleye
- Figure 3: Calculated Whole Body Mercury Concentrations in Common Carp and Large Pumpkinseed
- Figure 4: Total PCB Concentrations in Large Prey Fish (All SMUs)
- Figure 5: Calculated Whole Body Total PCB Concentrations in Smallmouth Bass and Walleye
- Figure 6: Calculated Whole Body Total PCB Concentrations in Common Carp and Large Pumpkinseed
- Figure 7: Hexachlorobenzene Concentrations in Large Prey Fish (All SMUs)
- Figure 8: Calculated Whole Body Hexachlorobenzene Concentrations in Smallmouth Bass and Walleye
- Figure 9: Calculated Whole Body Hexachlorobenzene Concentrations in Common Carp and Large Pumpkinseed
- Figure 10: DDT and Metabolites Concentrations in Large Prey Fish (All SMUs)

NYSDEC Data (2008-2018)

- DEC Figure 1a: Calculated Mercury (Whole Body) in Large Fish (180-600 mm), Largemouth Bass
- DEC Figure 1b: Calculated Total PCBs (Whole Body) in Large Fish (180-600 mm), Largemouth Bass
- DEC Figure 2a: Calculated DDTs (Whole Body) in Large Fish (180-600 mm), Largemouth Bass
- DEC Figure 2b: Calculated Hexachlorobenzene (Whole Body) in Large Fish (180-600 mm), Largemouth Bass
- DEC Figure 3a: Calculated Mercury (Whole Body) in Large Fish (180-600 mm), Yellow Perch
- DEC Figure 3b: Calculated Total PCBs (Whole Body) in Large Fish (180-600 mm), Yellow Perch
- DEC Figure 4a: Calculated DDTs (Whole Body) in Large Fish (180-600 mm), Yellow Perch
- DEC Figure 4b: Calculated Hexachlorobenzene (Whole Body) in Large Fish (180-600 mm), Yellow Perch

Set 4: Additional Reporting to Assess Potential Impacts of Remediation

For information on the potential impact of the implementation of the remediation on contaminant concentrations in fish tissue (as opposed to the risk to consumers of fish), the changes in concentration over time are reported. In these Set 4 figures, the data are presented in a way that controls factors which may influence the wet-weight concentrations but are independent of any exposure to the site-related contamination. This reduces the variability (e.g., noise) in the data.

For mercury, the variability due to fish age is corrected by using length as a surrogate for age. The wet-weight mercury concentration of each individual fish is adjusted by dividing the concentration (in mg/kg) by its length (in millimeters [mm]), providing a concentration as mg/kg per mm. For the organic contaminants, the amount of lipid in the fish has a major influence on the wet-weight concentrations (Sloan et al., 2002). For PCBs, dioxin/furans, DDTs, and hexachlorobenzene, the wet-weight concentrations for each individual fish are adjusted by dividing the concentration by its lipid content, providing a lipid-normalized concentration (e.g., mg PCBs/kg lipid).

The first subset of figures presents mercury data normalized to fish length and organic contaminants normalized to lipids for both sport fish and prey fish. As the normalized data are not compared to the goals (which are on a wet-weight basis) and all sport fish species for each contaminant are shown on one figure, the Honeywell data are presented as means plus and minus two standard errors rather than box-and-whisker plots to provide a simpler image.

The second subset of figures presents the normalized data by sample location for localized small and large prey fish species collected by Honeywell (note, whole-body prey fish were not collected by NYSDEC). These figures show normalized concentrations for the sediment management units (SMUs) from which the prey fish samples were collected. Note, Honeywell's fish sampling program did not include stations in SMU 1 prior to 2017.

Honeywell Data (2008-2018)

Subset 1

- Figure 1: Length-Normalized Mercury Concentrations in Sport Fish
- Figure 2: Length-Normalized Mercury Concentrations in Prey Fish (All SMUs)
- Figure 3: Lipid-Normalized Total PCB Concentrations in Smallmouth Bass and Walleye
- Figure 4: Lipid-Normalized Total PCB Concentrations in Common Carp and Pumpkinseed
- Figure 5: Lipid-Normalized Total PCB Concentrations in Small Prey Fish (All SMUs)
- Figure 6: Lipid-Normalized Total PCB Concentrations in Large Prey Fish (All SMUs)
- Figure 7: Lipid-Normalized Dioxin/Furan Total TEQ Concentrations in Smallmouth Bass and Walleye
- Figure 8: Lipid-Normalized Dioxin/Furan Total TEQ Concentrations in Common Carp and Pumpkinseed
- Figure 9: Lipid-Normalized DDT and Metabolites Concentrations in Small Prey Fish (All SMUs)
- Figure 10: Lipid-Normalized DDT and Metabolites Concentrations in Large Prey Fish (All SMUs)
- Figure 11: Lipid-Normalized Hexachlorobenzene Concentrations in Smallmouth Bass and Walleye
- Figure 12: Lipid-Normalized Hexachlorobenzene Concentrations in Common Carp and Pumpkinseed
- Figure 13: Lipid-Normalized Hexachlorobenzene Concentrations in Small Prey Fish (All SMUs)
- Figure 14: Lipid-Normalized Hexachlorobenzene Concentrations in Large Prey Fish (All SMUs)

Subset 2

- Figure 1: Length-Normalized Mercury Concentrations in Small Prey Fish By SMU
- Figure 2: Length-Normalized Mercury Concentrations in Small Pumpkinseed By SMU
- Figure 3: Length-Normalized Mercury Concentrations in Large Prey Fish By SMU
- Figure 4: Lipid-Normalized Total PCB Concentrations in Small Prey Fish By SMU
- Figure 5: Lipid-Normalized Total PCB Concentrations in Pumpkinseed By SMU
-
- Figure 6: Lipid-Normalized Total PCB Concentrations in Large Prey Fish By SMU
- Figure 7: Lipid-Normalized Dioxin/Furan Total TEQ Concentrations in Pumpkinseed By SMU
-
- Figure 8: Lipid-Normalized DDT and Metabolites Concentrations in Small Prey Fish By SMU
- Figure 9: Lipid-Normalized DDT and Metabolites Concentrations in Large Prey Fish By SMU
- Figure 10: Lipid-Normalized Hexachlorobenzene Concentrations in Pumpkinseed By SMU
-

- Figure 11: Lipid-Normalized Hexachlorobenzene Concentrations in Small Prey Fish By SMU
- Figure 12: Lipid-Normalized Hexachlorobenzene Concentrations in Large Prey Fish By SMU

NYSDEC Data (2008-2018)

Subset 1
- DEC Figure 1: Mercury – All Sport Fish Species (Fillet), Length Normalized
- DEC Figure 2a: Total PCBs – All Sport Fish Species (Fillet), Lipid Normalized
- DEC Figure 2b: DDTs – All Sport Fish Species (Fillet), Lipid Normalized
- DEC Figure 3: Hexachlorobenzene – All Sport Fish Species (Fillet), Lipid Normalized

Note, these Set 4 figures depicting the NYSDEC data are presented as means +/- one standard deviation for consistency with the First FYR Report.

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Attachment 3 Tables

TABLE 1

HONEYWELL FISH DATA USED IN THE ANALYSES (NUMBER OF SAMPLES)

Baseline Monitoring

	2008					2009					2010 (2)					2011				
Analyte	SMB	WEYE	BB	PKSD	Small Prey Fish	SMB	WEYE	BB	PKSD	Small Prey Fish	SMB	WEYE	BB	PKSD	Small Prey Fish	SMB	WEYE	BB	PKSD	Small Prey Fish
Mercury (1)	18	50	50	50	40	42	50	50	50	40	41	50	51	50	40	25	25	25	25	40
Total PCBs	12	12	12	12	10	12	12	0	0	0	12	12	12	12	10	12	12	12	12	0
PCDDs/PCDFs	5	5	5	5	0	0	0	0	0	0	5	5	5	5	0	5	5	5	5	0
Hexachlorobenzene	12	12	12	12	10	0	0	0	0	0	12	12	12	11	10	11	12	9	10	0
Total DDTs	12	12	12	12	10	12	12	0	0	0	12	12	12	12	10	12	12	12	12	0
Lipid	12	12	12	12	10	12	12	0	0	0	12	12	12	12	10	10	12	11	11	0

Monitoring During Remedial Action

	2012 (3)					2013					2014							2015						2016					
Analyte	SMB	WEYE	BB	PKSD	Small Prey Fish	SMB	WEYE	BB	PKSD	Small Prey Fish	SMB	WEYE	BB	PKSD	CP	Small Prey Fish	Large Prey Fish	SMB	WEYE	PKSD	CP	Small Prey Fish	Large Prey Fish	SMB	WEYE	PKSD	CP	Small Prey Fish	Large Prey Fish
Mercury	25	25	25	0	40	25	25	24	25	40	25	25	25	25	25	24	24	25	25	25	25	24	24	25	25	25	25	24	24
Total PCBs	12	12	12	0	10	25	25	25	25	40	25	25	25	25	25	24	24	25	25	25	25	24	24	25	25	25	25	24	24
PCDDs/PCDFs	5	5	5	0	0	0	0	0	0	0	12	13	6	1	9	0	0	12	12	12	12	0	0	0	0	0	0	0	0
Hexachlorobenzene	12	12	12	0	10	25	25	25	25	40	25	25	25	12	25	24	24	25	25	25	25	24	24	0	0	0	0	0	0
Total DDTs	12	12	12	0	10	25	25	25	25	40	0	0	0	0	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0
Lipid	12	12	12	0	10	25	25	25	25	40	25	25	25	25	25	24	24	25	25	25	25	24	24	25	25	25	25	24	24

Post-Construction Monitoring

	2017						2018					
Analyte	SMB	WEYE	PKSD	CP	Small Prey Fish	Large Prey Fish	SMB	WEYE	PKSD	CP	Small Prey Fish	Large Prey Fish
Mercury	25	25	25	25	24	24	25	25	25	25	24	24
Total PCBs	25	25	25	25	24	24	25	25	25	25	24	24
PCDDs/PCDFs	12	11	12	12	0	0	13	13	12	14	0	0
Hexachlorobenzene	25	25	20	25	24	24	25	25	25	25	24	24
Total DDTs	0	0	0	0	24	24	0	0	0	0	24	24
Lipid	25	25	25	25	24	24	25	25	25	25	24	24

SMB - Smallmouth Bass
WEYE - Walleye
BB - Brown Bullhead
PKSD - Pumpkinseed
CP - Carp

Notes:
1. Sample counts do not include fish plug samples collected in 2008 and 2009.
2. Results for organics and lipids from 2010 are not used in analysis. See text for discussion.
3. Adult sport fish and alewife prey fish were collected by Honeywell in June 2012 just prior to the commencement of dredging in late July 2012. Minnow prey fish were collected in August 2012.
4. Sport fish analyzed as fillet samples. Small prey fish (various species) and large prey fish (white sucker in 2014-2018) analyzed as whole-body samples.

TABLE 2
NYSDEC FISH DATA USED IN THE ANALYSES (NUMBER OF SAMPLES)

	Baseline Monitoring																			
	2008					**2009**					**2010**					**2011**				
Analyte	LMB	CP	YP	WP	CHC	LMB	CP	YP	WP	CHC	LMB	CP	YP	WP	CHC	LMB	CP	YP	WP	CHC
Mercury	45	0	0	0	0	50	0	0	0	0	50	16	15	15	10	53	0	15	14	1
Total PCBs	10	0	0	0	0	49	0	0	0	0	50	16	15	15	10	53	0	15	14	1
Total DDTs	10	0	0	0	0	49	0	0	0	0	50	16	15	15	10	53	0	15	14	1
Hexachlorobenzene	10	0	0	0	0	49	0	0	0	0	50	16	15	15	10	53	0	15	14	1
Lipid	10	0	0	0	0	50	0	0	0	0	50	16	15	15	10	53	0	15	14	1

	Monitoring During Remedial Action																								
	2012 (1)					**2013**					**2014**					**2015**					**2016**				
Analyte	LMB	CP	YP	WP	CHC	LMB	CP	YP	WP	CHC	LMB	CP	YP	WP	CHC	LMB	CP	YP	WP	CHC	LMB	CP	YP	WP	CHC
Mercury	50	0	15	15	5	50	10	0	0	0	41	0	0	0	0	53	0	0	0	0	55	0	19	0	0
Total PCBs	50	0	15	15	5	50	10	0	0	0	41	0	0	0	0	53	0	0	0	0	55	0	20	0	0
Total DDTs	50	0	15	15	5	50	10	0	0	0	41	0	0	0	0	53	0	0	0	0	55	0	20	0	0
Hexachlorobenzene	50	0	15	15	5	50	10	0	0	0	41	0	0	0	0	53	0	0	0	0	55	0	20	0	0
Lipid	50	0	15	15	5	50	10	0	0	0	41	0	0	0	0	53	0	0	0	0	55	0	20	0	0

	Post-Construction Monitoring									
	2017					**2018**				
Analyte	LMB	CP	YP	WP	CHC	LMB	CP	YP	WP	CHC
Mercury	50	0	0	0	0	50	0	20	0	0
Total PCBs	50	0	0	0	0	50	0	20	0	0
Total DDTs	50	0	0	0	0	50	0	20	0	0
Hexachlorobenzene	50	0	0	0	0	50	0	20	0	0
Lipid	50	0	0	0	0	50	0	20	0	0

LMB - Largemouth Bass
CP - Carp
YP - Yellow Perch
WP - White Perch
CHC - Channel Catfish

Notes:
1. Fish were collected by NYSDEC in May 2012 prior to the commencement of dredging in late July 2012.
2. Fish analyzed as fillet samples.

Table 3a
Summary of Fish Tissue Chemical Concentrations: Sport Fish Fillet (2015 - 2018)

Taxon	Chemical Name	Year	Sample Size	*(detects)*	Mean[1]	95% UCL Value[1]	95% UCL Calculation Type
Smallmouth Bass	Mercury (mg/kg)	2015	25	*(25)*	1.07	1.17	95% Student's-t UCL
		2016	25	*(25)*	0.92	1.02	95% Student's-t UCL
		2017	25	*(25)*	0.71	0.82	95% Student's-t UCL
		2018	25	*(25)*	0.79	0.91	95% Student's-t UCL
	Total PCBs (mg/kg)	2015	25	*(25)*	1.91	2.19	95% Student's-t UCL
		2016	25	*(25)*	1.20	1.50	95% Adjusted Gamma UCL
		2017	25	*(25)*	0.50	0.61	95% Student's-t UCL
		2018	25	*(25)*	0.47	0.57	95% Student's-t UCL
	Dioxin/Furan Total TEQ (ng/kg)	2015	12	*(12)*	1.90	2.44	95% Student's-t UCL
		2017	12	*(12)*	1.5	1.94	95% Student's-t UCL
		2018	13	*(13)*	1.04	1.33	95% Student's-t UCL
	Hexachlorobenzene (mg/kg)	2015	25	*(23)*	0.006	0.007	95% KM Adjusted Gamma UCL
		2017	25	*(6)*	0.002	0.003	95% KM (t) UCL
		2018	25	*(0)*	--	--	--
Walleye	Mercury (mg/kg)	2015	25	*(25)*	1.36	1.58	95% Student's-t UCL
		2016	25	*(25)*	1.14	1.33	95% Student's-t UCL
		2017	25	*(25)*	0.77	0.91	95% Adjusted Gamma UCL
		2018	25	*(25)*	0.71	0.81	95% Student's-t UCL
	Total PCBs (mg/kg)	2015	25	*(25)*	3.82	5.29	95% Adjusted Gamma UCL
		2016	25	*(25)*	2.51	3.25	95% Student's-t UCL
		2017	25	*(25)*	0.74	1.41	95% Chebyshev (Mean, Sd) UCL
		2018	25	*(25)*	0.96	1.21	95% Student's-t UCL
	Dioxin/Furan Total TEQ (ng/kg)	2015	12	*(12)*	2.09	2.64	95% Student's-t UCL
		2017	12	*(12)*	1.64	2.37	95% Student's-t UCL
		2018	13	*(13)*	1.81	2.52	95% Student's-t UCL
	Hexachlorobenzene (mg/kg)	2015	25	*(25)*	0.027	0.032	95% Student's-t UCL
		2017	25	*(17)*	0.004	0.007	95% KM Adjusted Gamma UCL
		2018	25	*(3)*	--	--	--
Common Carp	Mercury (mg/kg)	2015	25	*(25)*	0.2	0.31	95% H-UCL
		2016	25	*(25)*	0.20	0.24	95% Adjusted Gamma UCL
		2017	25	*(25)*	0.19	0.24	95% Student's-t UCL
		2018	25	*(20)*	0.10	0.14	95% KM Adjusted Gamma UCL
	Total PCBs (mg/kg)	2015	25	*(25)*	1.96	2.93	95% Adjusted Gamma UCL
		2016	25	*(25)*	1.80	2.65	95% Adjusted Gamma UCL
		2017	25	*(25)*	0.50	0.74	95% Adjusted Gamma UCL
		2018	25	*(25)*	0.27	0.44	95% Adjusted Gamma UCL
	Dioxin/Furan Total TEQ (ng/kg)	2015	12	*(12)*	5.94	14.76	95% Adjusted Gamma UCL
		2017	12	*(12)*	4.15	9.17	95% Adjusted Gamma UCL
		2018	14	*(14)*	1.08	3.24	95% H-UCL
	Hexachlorobenzene (mg/kg)	2015	25	*(23)*	0.038	0.081	Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)
		2017	25	*(13)*	0.004	0.006	95% KM (t) UCL
		2018	25	*(2)*	--	--	--
Pumpkinseed	Mercury (mg/kg)	2015	25	*(25)*	0.28	0.32	95% Student's-t UCL
		2016	25	*(25)*	0.19	0.24	95% Adjusted Gamma UCL
		2017	25	*(25)*	0.17	0.20	95% Student's-t UCL
		2018	25	*(16)*	0.088	0.11	95% KM (t) UCL
	Total PCBs (mg/kg)	2015	25	*(25)*	0.14	0.18	95% Adjusted Gamma UCL
		2016	25	*(17)*	0.05	0.21	KM H-UCL
		2017	25	*(25)*	0.096	0.13	95% Adjusted Gamma UCL
		2018	25	*(23)*	0.09	0.12	95% KM Adjusted Gamma UCL
	Dioxin/Furan Total TEQ (ng/kg)	2015	12	*(9)*	0.38	0.53	95% KM (t) UCL
		2017	12	*(12)*	0.27	0.33	95% Student's-t UCL
		2018	12	*(12)*	0.54	0.73	95% Student's-t UCL
	Hexachlorobenzene (mg/kg)	2015	25	*(1)*	--	--	--
		2017	20	*(0)*	--	--	--
		2018	23	*(0)*	--	--	--

Notes:
1. Mean and 95% UCL were calculated using ProUCL version 5.1 and were not calculated when 3 or fewer results were detects (USEPA,2015). 95% UCL is an estimate of the upper bound for the true population mean. For data sets with NDs, the stated statistical method was used for handling NDs rather than the substitution method (i.e., one-half of the detection/reporting limit).

Abbreviations:
-- Insufficient data to calculate Mean or 95% UCL; 3 or fewer results were detects
DDT: dichlorodiphenyltrichloroethane
KM: Kaplan-Meier
mg/kg: milligrams per kilogram
ng/kg: nanograms per kilogram
ND: non-detect
PCB: polychlorinated biphenyl
TEQ: toxicity equivalent quotient
UCL: upper confidence limit

Reference:
USEPA, 2015. ProUCL Version 5.1 User Guide. EPA/600/R-07/041 https://www.epa.gov/sites/production/files/2016-05/documents/proucl_5.1_user-guide.pdf Accessed May 22, 2020.

Table 3b
Summary of Fish Tissue Chemical Concentrations: Prey Fish Whole Body (2015 - 2018)

Taxon	Chemical Name	Year	Sample Size *(detects)*	Mean[1]	95% UCL Value[1]	95% UCL Calculation Type
Large Prey Fish	Mercury (mg/kg)	2015	24 *(23)*	0.19	0.24	95% KM (t) UCL
		2016	24 *(23)*	0.13	0.16	95% KM (t) UCL
		2017	24 *(24)*	0.093	0.14	95% Adjusted Gamma UCL
		2018	24 *(14)*	0.17	0.21	95% KM (t) UCL
	Total PCBs (mg/kg)	2015	24 *(24)*	1.56	1.99	95% Student's-t UCL
		2016	24 *(24)*	0.73	1.00	95% Adjusted Gamma UCL
		2017	24 *(24)*	0.36	0.50	95% Adjusted Gamma UCL
		2018	24 *(23)*	0.1	0.13	95% KM (t) UCL
	Sum of DDT and Metabolites (mg/kg)	2015	24 *(24)*	0.02	0.026	95% Adjusted Gamma UCL
		2017	24 *(24)*	0.016	0.021	95% Adjusted Gamma UCL
		2018	24 *(20)*	0.025	0.098	95% KM (Chebyshev) UCL
	Hexachlorobenzene (mg/kg)	2015	24 *(13)*	0.01	0.018	95% KM Adjusted Gamma UCL
		2017	24 *(10)*	0.002	0.002	95% KM (t) UCL
		2018	24 *(1)*	--	--	--
Small Prey Fish	Mercury (mg/kg)	2015	24 *(24)*	0.14	0.16	95% Student's-t UCL
		2016	24 *(24)*	0.087	0.099	95% Student's-t UCL
		2017	24 *(21)*	0.057	0.074	95% KM (t) UCL
		2018	24 *(11)*	0.072	0.087	95% KM (t) UCL
	Total PCBs (mg/kg)	2015	24 *(23)*	0.16	0.39	KM H-UCL
		2016	24 *(24)*	0.17	0.23	95% Adjusted Gamma UCL
		2017	24 *(24)*	0.11	0.25	95% Chebyshev (Mean, Sd) UCL
		2018	24 *(24)*	0.049	0.13	95% H-UCL
	Sum of DDT and Metabolites (mg/kg)	2015	24 *(13)*	0.002	0.003	95% KM Adjusted Gamma UCL
		2017	24 *(23)*	0.005	0.009	KM H-UCL
		2018	24 *(24)*	0.006	0.008	95% Student's-t UCL
	Hexachlorobenzene (mg/kg)	2015	24 *(3)*	--	--	--
		2017	24 *(3)*	--	--	--
		2018	24 *(0)*	--	--	--

Notes:
1. Mean and 95% UCL were calculated using ProUCL version 5.1 and were not calculated when 3 or fewer results were detects (USEPA,2015). 95% UCL is an estimate of the upper bound for the true population mean. For data sets with NDs, the stated statistical method was used for handling NDs rather than the substitution method (i.e., one-half of the detection/reporting limit).

Abbreviations:
-- Insufficient data to calculate Mean or 95% UCL; 3 or fewer results were detects
DDT: dichlorodiphenyltrichloroethane
KM: Kaplan-Meier
mg/kg: milligrams per kilogram

ND: non-detect
PCB: polychlorinated biphenyl
UCL: upper confidence limit

Reference:
USEPA, 2015. ProUCL Version 5.1 User Guide. EPA/600/R-07/041 https://www.epa.gov/sites/production/files/2016-05/documents/proucl_5.1_user-guide.pdf Accessed May 22, 2020.

Table 3c

Summary of Fish Tissue Chemical Concentrations: Sport Fish Calculated Whole Body[1] (2015 - 2018)

Taxon	Size[2]	Chemical Name	Year	Sample Size	*(detects)*	Mean[3]	95% UCL Value[3]	95% UCL Calculation Type
Smallmouth Bass	Large	Mercury (mg/kg)	2015	25	*(25)*	0.75	0.82	95% Student's-t UCL
			2016	25	*(25)*	0.65	0.71	95% Student's-t UCL
			2017	25	*(25)*	0.50	0.58	95% Student's-t UCL
			2018	25	*(25)*	0.55	0.64	95% Student's-t UCL
		Total PCBs (mg/kg)	2015	25	*(25)*	4.78	5.48	95% Student's-t UCL
			2016	25	*(25)*	3.01	3.74	95% Adjusted Gamma UCL
			2017	25	*(25)*	1.25	1.51	95% Student's-t UCL
			2018	25	*(25)*	1.19	1.42	95% Student's-t UCL
		Hexachlorobenzene (mg/kg)	2015	25	*(23)*	0.013	0.017	95% KM Adjusted Gamma UCL
			2017	25	*(6)*	0.005	0.007	95% KM (t) UCL
			2018	25	*(0)*	--	--	--
Walleye	Large	Mercury (mg/kg)	2015	25	*(25)*	0.96	1.10	95% Student's-t UCL
			2016	24	*(24)*	0.77	0.90	95% Student's-t UCL
			2017	25	*(25)*	0.54	0.64	95% Adjusted Gamma UCL
			2018	25	*(25)*	0.50	0.57	95% Student's-t UCL
		Total PCBs (mg/kg)	2015	25	*(25)*	9.55	13.23	95% Adjusted Gamma UCL
			2016	24	*(24)*	5.98	7.85	95% Student's-t UCL
			2017	25	*(25)*	1.84	3.52	95% Chebyshev (Mean, Sd) UCL
			2018	25	*(25)*	2.40	3.04	95% Student's-t UCL
		Hexachlorobenzene (mg/kg)	2015	25	*(25)*	0.062	0.073	95% Student's-t UCL
			2017	25	*(17)*	0.01	0.015	95% KM Adjusted Gamma UCL
			2018	25	*(3)*	--	--	--
Common Carp	Large	Mercury (mg/kg)	2015	13	*(13)*	0.11	0.14	95% Adjusted Gamma UCL
			2016	9	*(9)*	0.10	0.12	95% Student's-t UCL
			2017	10	*(10)*	0.10	0.14	95% Student's-t UCL
			2018	18	*(13)*	0.036	0.048	95% KM (t) UCL
		Total PCBs (mg/kg)	2015	13	*(13)*	1.54	4.61	95% H-UCL
			2016	9	*(9)*	1.60	2.16	95% Student's-t UCL
			2017	10	*(10)*	0.64	1.88	95% Chebyshev (Mean, Sd) UCL
			2018	18	*(18)*	0.26	0.41	95% Adjusted Gamma UCL
		Hexachlorobenzene (mg/kg)	2015	13	*(11)*	0.067	0.30	95% KM (Chebyshev) UCL
			2017	10	*(3)*	--	--	--
			2018	18	*(2)*	--	--	--
Pumpkinseed	Large	Mercury (mg/kg)	2015	2	*(2)*	--	--	--
			2016	8	*(8)*	0.21	0.27	95% Student's-t UCL
			2017	5	*(5)*	0.17	0.23	95% Student's-t UCL
			2018	5	*(4)*	0.10	0.15	95% KM (t) UCL
		Total PCBs (mg/kg)	2015	2	*(2)*	--	--	--
			2016	8	*(6)*	0.14	0.22	95% KM (t) UCL
			2017	5	*(5)*	0.22	0.27	95% Student's-t UCL
			2018	5	*(5)*	0.28	0.42	95% Student's-t UCL
		Hexachlorobenzene (mg/kg)	2015	2	*(0)*	--	--	--
			2017	5	*(0)*	--	--	--
			2018	5	*(0)*	--	--	--
	Small	Mercury (mg/kg)	2015	23	*(23)*	0.19	0.22	95% Student's-t UCL
			2016	17	*(17)*	0.097	0.13	95% Adjusted Gamma UCL
			2017	20	*(20)*	0.11	0.13	95% Student's-t UCL
			2018	20	*(12)*	0.052	0.063	95% KM (t) UCL
		Total PCBs (mg/kg)	2015	23	*(23)*	0.36	0.46	95% Adjusted Gamma UCL
			2016	17	*(11)*	0.31	0.91	95% KM (Chebyshev) UCL
			2017	20	*(20)*	0.25	0.35	95% Adjusted Gamma UCL
			2018	20	*(18)*	0.21	0.29	95% KM Adjusted Gamma UCL
		Hexachlorobenzene (mg/kg)	2015	23	*(1)*	--	--	--
			2017	15	*(0)*	--	--	--
			2018	18	*(0)*	--	--	--

Notes:

1. Although not collected as prey fish, remedial goals and target concentrations may be compared to contaminant concentrations in whole body sportfish (i.e., specifically Smallmouth Bass, Walleye, Pumpkinseed, and Common Carp in the OLMMP) where fillet data are converted to whole body data using "conversion factors developed in the Onondaga Lake Baseline Ecological Risk Assessment (BERA) (i.e., 0.7 for mercury, 2.5 for PCBs, and 2.3 for DDTs and hexachlorobenzene) (TAMS 2002b)" (Parsons 2018). For these calculations, fish with lengths 180–600 mm and 30–180 mm are compared to goal and target concentrations for large and small prey fish, respectively.
2. Small fish defined as 30 - 180 mm. Large fish defined as 180 - 600 mm.
3. Mean and 95% UCL were calculated using ProUCL version 5.1 and were not calculated when 3 or fewer results were detects (USEPA,2015). 95% UCL is an estimate of the upper bound for the true population mean. For data sets with NDs, the stated statistical method was used for handling NDs rather than the substitution method (i.e., one-half of the detection/reporting limit).

Abbreviations:

-- Insufficient data to calculate Mean or 95% UCL; 3 or fewer results were detects

DDT: dichlorodiphenyltrichloroethane
KM: Kaplan-Meier
mg/kg: milligrams per kilogram
mm: millimeter
OLMMP: Onondaga Lake Monitoring and Maintenance Plan
PCB: polychlorinated biphenyl
ND: non-detect
UCL: upper confidence limit

Reference:

Parsons, 2018. *Onondaga Lake Monitoring and Maintenance Plan* . Prepared for Honeywell. June 2018.

USEPA, 2015. ProUCL Version 5.1 User Guide. EPA/600/R-07/041 https://www.epa.gov/sites/production/files/2016-05/documents/proucl_5.1_user-guide.pdf Accessed May 22, 2020.

Table 4a.
Summary of NYSDEC Fish Tissue Chemical Concentrations: Sport Fish Fillet Data (2015 - 2018)

Taxon	Chemical Name	Year	Sample Size	*(detects)*	Mean[1]	95% UCL Value[2]	95% UCL Calculation Type from ProUCL
Largemouth Bass	Mercury (mg/kg)	2015	53	*(53)*	0.898	0.963	95% H-UCL
		2016	55	*(55)*	0.809	0.868	95% Student's-t UCL
		2017	50	*(50)*	0.852	0.936	95% Student's-t UCL
		2018	50	*(50)*	0.915	0.989	95% Student's-t UCL
	Total PCBs (mg/kg)	2015	53	*(53)*	0.873	1.033	95% Approximate Gamma UCL
		2016	55	*(55)*	0.481	0.579	95% Approximate Gamma UCL
		2017	50	*(50)*	0.926	1.046	95% Student's-t UCL
		2018	50	*(50)*	0.844	0.962	95% Student's-t UCL
	Total DDTs (mg/kg)	2015	53	*(53)*	0.023	0.028	95% Approximate Gamma UCL
		2016	55	*(55)*	0.017	0.021	95% Approximate Gamma UCL
		2017	50	*(50)*	0.032	0.038	95% Student's-t UCL
		2018	50	*(50)*	0.032	0.037	95% Student's-t UCL
	Hexachlorobenzene (mg/kg)	2015	53	*(36)*	0.009	0.010	95% GROS Approximate Gamma UCL
		2016	55	*(8)*	0.002	0.002	95% KM (t) UCL
		2017	50	*(0)*	*0.001 U*	--	--
		2018	50	*(0)*	*0.001 U*	--	--
Yellow Perch	Mercury (mg/kg)	2015					
		2016	19	*(19)*	0.529	0.611	95% Student's-t UCL
		2017					
		2018	20	*(20)*	0.376	0.452	95% Student's-t UCL
	Total PCBs (mg/kg)	2015					
		2016	20	*(20)*	0.119	0.187	95% H-UCL
		2017					
		2018	20	*(20)*	0.228	0.279	95% Student's-t UCL
	Total DDTs (mg/kg)	2015					
		2016	20	*(20)*	0.003	0.004	95% Modified-t UCL
		2017					
		2018	20	*(19)*	0.007	0.009	95% KM (t) UCL
	Hexachlorobenzene (mg/kg)	2015					
		2016	20	*(0)*	*0.001 U*	--	--
		2017					
		2018	20	*(0)*	*0.001 U*	--	--

Notes:

1. For calculation of the mean for data sets with non-detects (NDs), USEPA's ProUCL version 5.1 was used for handling NDs rather than the substitution method (i.e., one-half of the reported concentration).

2. 95% UCL was calculated using USEPA's ProUCL version 5.1. 95% UCL is an estimate of the upper bound for the true population mean; 95% UCL was not calculated when 3 or fewer results were detects. For data sets with NDs, the stated statistical method was used for handling NDs rather than the substitution method (i.e., one-half of the reported concentration).

Abbreviations:

-- Insufficient data to calculate 95% UCL; 3 or fewer results were detects

DDT: dichlorodiphenyltrichloroethane

mg/kg: milligrams per kilogram

PCB: polychlorinated biphenyl

UCL: upper confidence limit

U: non detect

Table 4b.
Summary of NYSDEC Fish Tissue Chemical Concentrations: Sport Fish Calculated Whole Body[1] (2015 - 2018)

Taxon	Chemical Name	Year	Sample Size *(detects)*		Mean[2]	95% UCL Value[3]	95% UCL Calculation Type from ProUCL
Whole Body (calculated) Largemouth Bass	Mercury (mg/kg)	2015	53	*(53)*	0.629	0.674	95% H-UCL
		2016	55	*(55)*	0.566	0.607	95% Student's-t UCL
		2017	50	*(50)*	0.596	0.655	95% Student's-t UCL
		2018	50	*(50)*	0.641	0.692	95% Student's-t UCL
	Total PCBs (mg/kg)	2015	53	*(53)*	2.181	2.583	95% Approximate Gamma UCL
		2016	55	*(55)*	1.204	1.448	95% Approximate Gamma UCL
		2017	50	*(50)*	2.315	2.616	95% Student's-t UCL
		2018	50	*(50)*	2.111	2.403	95% Student's-t UCL
	Total DDTs (mg/kg)	2015	53	*(53)*	0.053	0.064	95% Approximate Gamma UCL
		2016	55	*(55)*	0.039	0.049	95% Approximate Gamma UCL
		2017	50	*(50)*	0.073	0.085	95% Student's-t UCL
		2018	50	*(50)*	0.073	0.082	95% Student's-t UCL
	Hexachlorobenzene (mg/kg)	2015	53	*(36)*	0.016	0.018	95% GROS Approximate Gamma UCL
		2016	55	*(8)*	0.005	0.005	95% KM (t) UCL
		2017	50	*(0)*	*0.002 U*	--	--
		2018	50	*(0)*	*0.002 U*	--	--
Whole Body (calculated) Yellow Perch	Mercury (mg/kg)	2015					
		2016	18	*(18)*	0.384	0.440	95% Student's-t UCL
		2017					
		2018	20	*(20)*	0.263	0.316	95% Student's-t UCL
	Total PCBs (mg/kg)	2015					
		2016	19	*(19)*	0.297	0.422	95% Adjusted Gamma UCL
		2017					
		2018	20	*(20)*	0.570	0.697	95% Student's-t UCL
	Total DDTs (mg/kg)	2015					
		2016	19	*(19)*	0.008	0.010	95% Modified-t UCL
		2017					
		2018	20	*(19)*	0.015	0.018	95% KM (t) UCL
	Hexachlorobenzene (mg/kg)	2015					
		2016	19	*(0)*	*0.002 U*	--	--
		2017					
		2018	20	*(0)*	*0.002 U*	--	--

Notes:

1. Although not collected as prey fish, remedial goals and target concentrations may be compared to contaminant concentrations in whole body sportfish (i.e., specifically Largemouth Bass and Yellow Perch) where fillet data are converted to whole body concentrations using “conversion factors developed in the Onondaga Lake Baseline Ecological Risk Assessment (BERA) (i.e., 0.7 for mercury, 2.5 for PCBs, and 2.3 for DDTs and hexachlorobenzene) (TAMS 2002b)” (Parsons 2018). For these calculations, fish with lengths 180–600 mm are compared to the goal and target concentrations for large prey fish.

2. For calculation of the mean for data sets with non-detects (NDs), USEPA's ProUCL version 5.1 was used for handling NDs rather than the substitution method (i.e., one-half of the reported concentration).

3. 95% UCL was calculated using USEPA's ProUCL version 5.1. 95% UCL is an estimate of the upper bound for the true population mean; 95% UCL was not calculated when 3 or fewer results were detects. For data sets with NDs, the stated statistical method was used for handling NDs rather than the substitution method (i.e., one-half of the reported concentration).

Abbreviations:

-- Insufficient data to calculate 95% UCL; 3 or fewer results were detects

DDT: dichlorodiphenyltrichloroethane

mg/kg: milligrams per kilogram

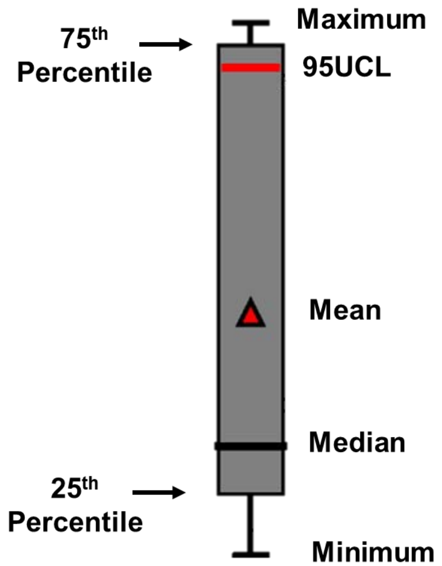
PCB: polychlorinated biphenyl

UCL: upper confidence limit

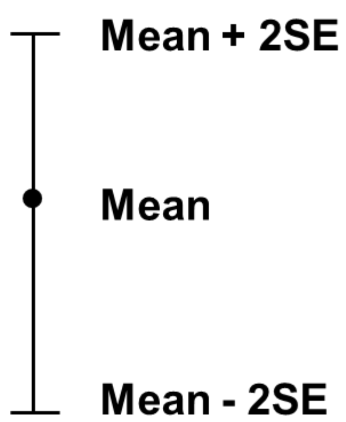
U: non detect

Attachment 3 Figures

Box and Whisker Plot



Mean and Standard Errors Plot



Plot Notes:
- Maximum: maximum concentration
- 95%UCL: estimate of the upper bound for the true population mean; calculated using ProUCL Version 5.1; not calculated when 3 or fewer results were detects. For data sets with NDs, ProUCL selected the statistical method. The substitution method (i.e., one-half of the MDL or RL) was not used.
- Mean: mean or average concentration; calculated by ProUCL using the same statistical method used for 95%UCL unless 3 or fewer results were detects. In that case and for standard error plots, the arithmetic mean was calculated with non-detects substituted at 1/2 MDL for mercury and 1/2 RL for most organic analytes.
- Median: median or midpoint concentration
- Minimum: minimum concentration
- 25th and 75th Percentiles: concentrations below which 25% and 75% of concentrations are found
- 2SE: two times the standard error of the mean
- △ Open symbol indicates 3 or fewer results were detects in box and whisker plots, and ND in standard error plots.
- "ND" indicates all results were non-detects and no statistics are shown.
- "^" indicates mean value is above axis range in standard error plots; 2SE values above the axis range are not annotated.

Analyte-Specific Details:
- Total PCB is the sum of detected Aroclors.
- For Dioxin/Furan Total TEQ, non-detects summed at 1/2 MDL, except for 2014 and 2015, which used 1/2 RDL; plots for 2018 data show non-detects at 0 and 1/2 MDL
- 2010 organic analyte data are excluded from temporal plots due to analytical issues.
- Dioxin/furans, DDT and metabolites, and hexachlorobenzene were not analyzed on an annual basis.

Fish Details:
- Sport fish for comparison to human health criteria and targets
  - Smallmouth Bass, Walleye, Pumpkinseed, and Common Carp
  - Collection of Common Carp began in 2014
  - NYSDEC standard fillets
- Small prey fish for comparison to ecological criteria and targets
  - Primarily Banded Killifish but Golden Shiner, Brook Silverside, Minnow, Bluntnose Minnow, and Round Goby were collected if Banded Killifish are unavailable (Alewife excluded).
  - Whole body composite samples
- Large prey fish for comparison to ecological criteria and targets
  - White Sucker
  - Collection began in 2014
  - Individual whole-body samples
- All ages and both sexes were combined.
- In 2012, in-lake remediation began in late July; fish were sampled mid-June to early-July.

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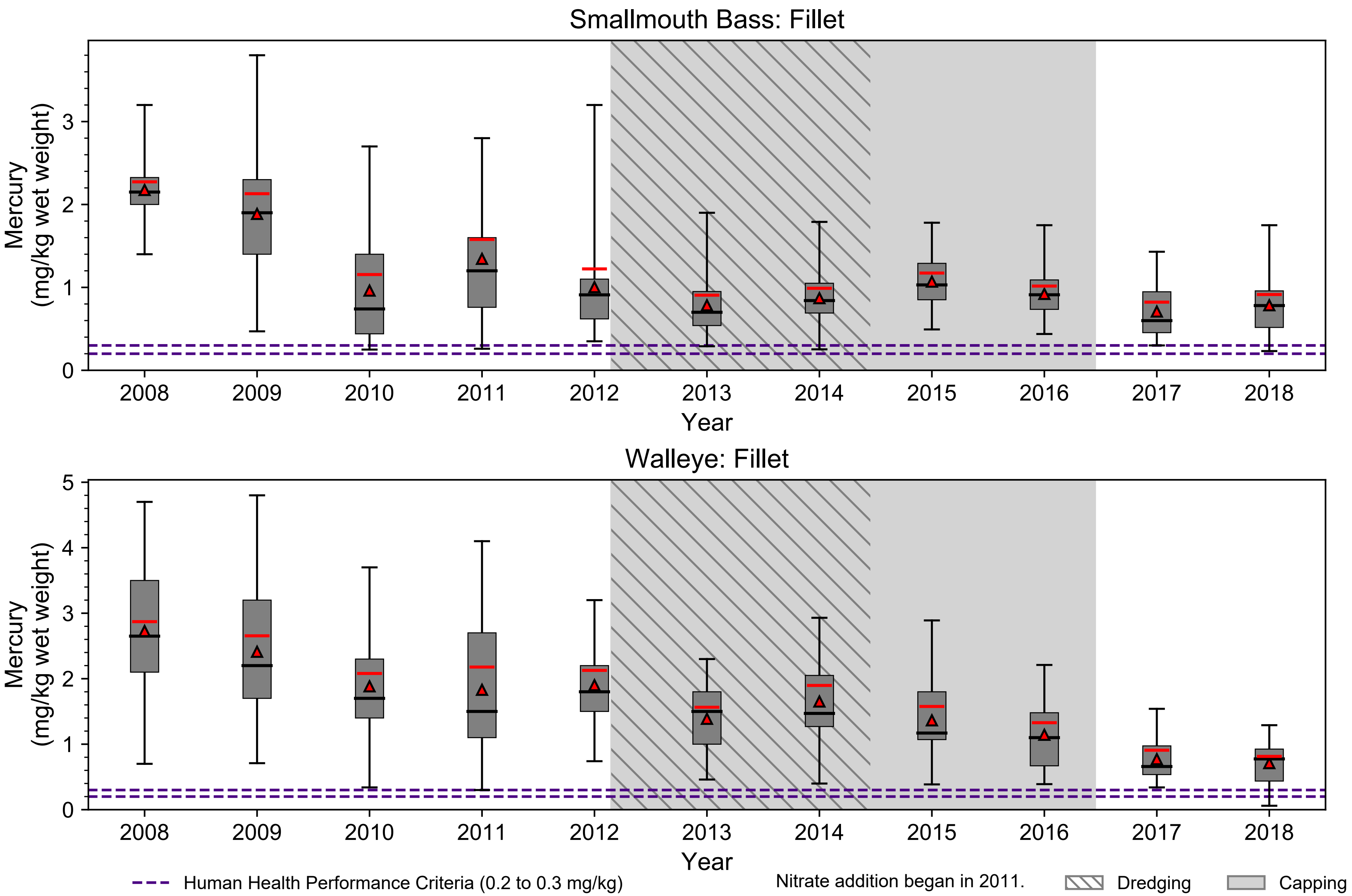
Figure 1
Figure Nomenclature, Data Treatment, and Analyte-Specific Details

Set 1:
Sport Fish Fillet Concentrations
for Human Health RGs and Targets

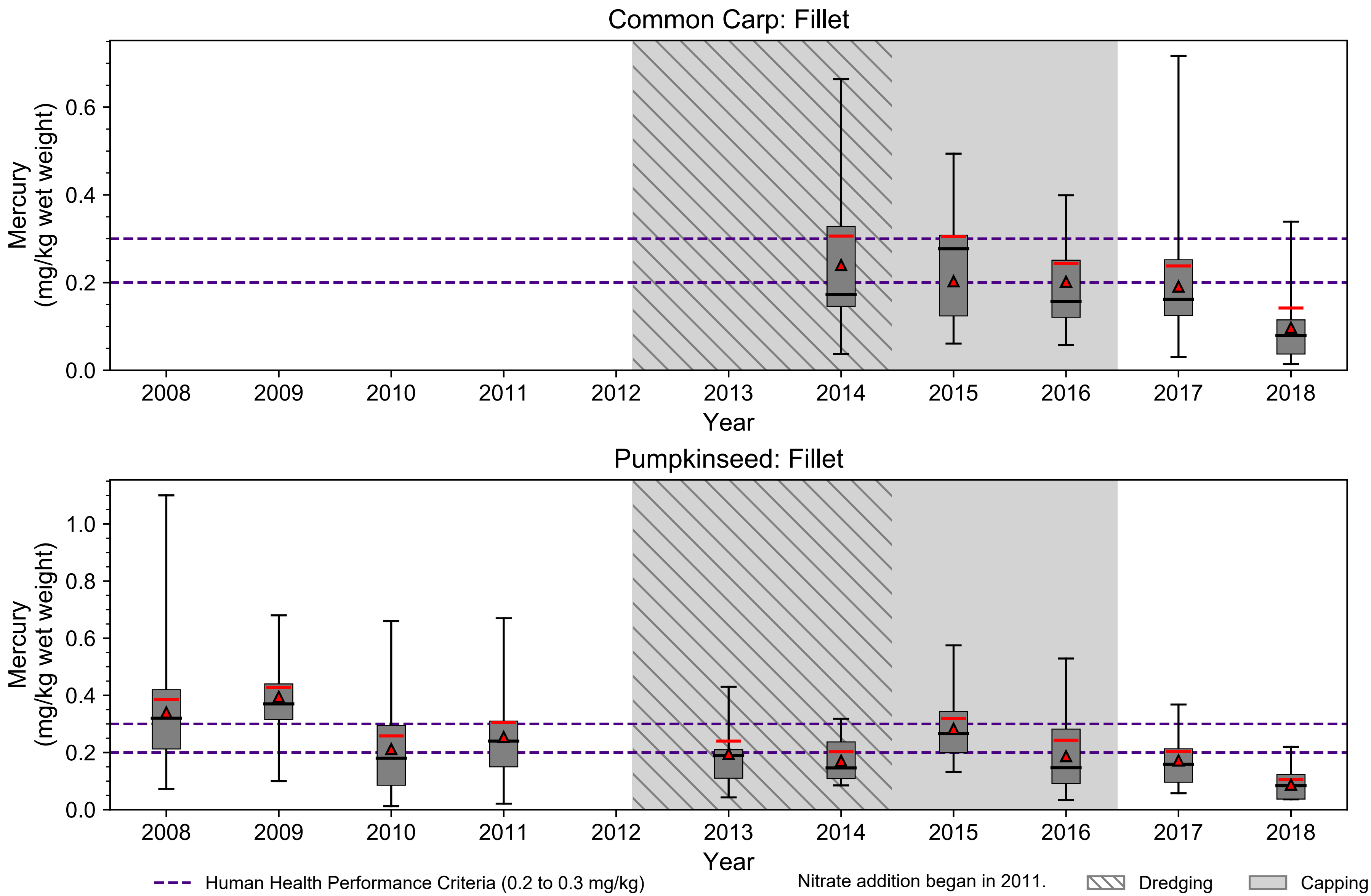
Honeywell Set 1 Data (2008-2018)

September 2020



Set 1, Figure 1
Mercury Concentrations in Smallmouth Bass and Walleye

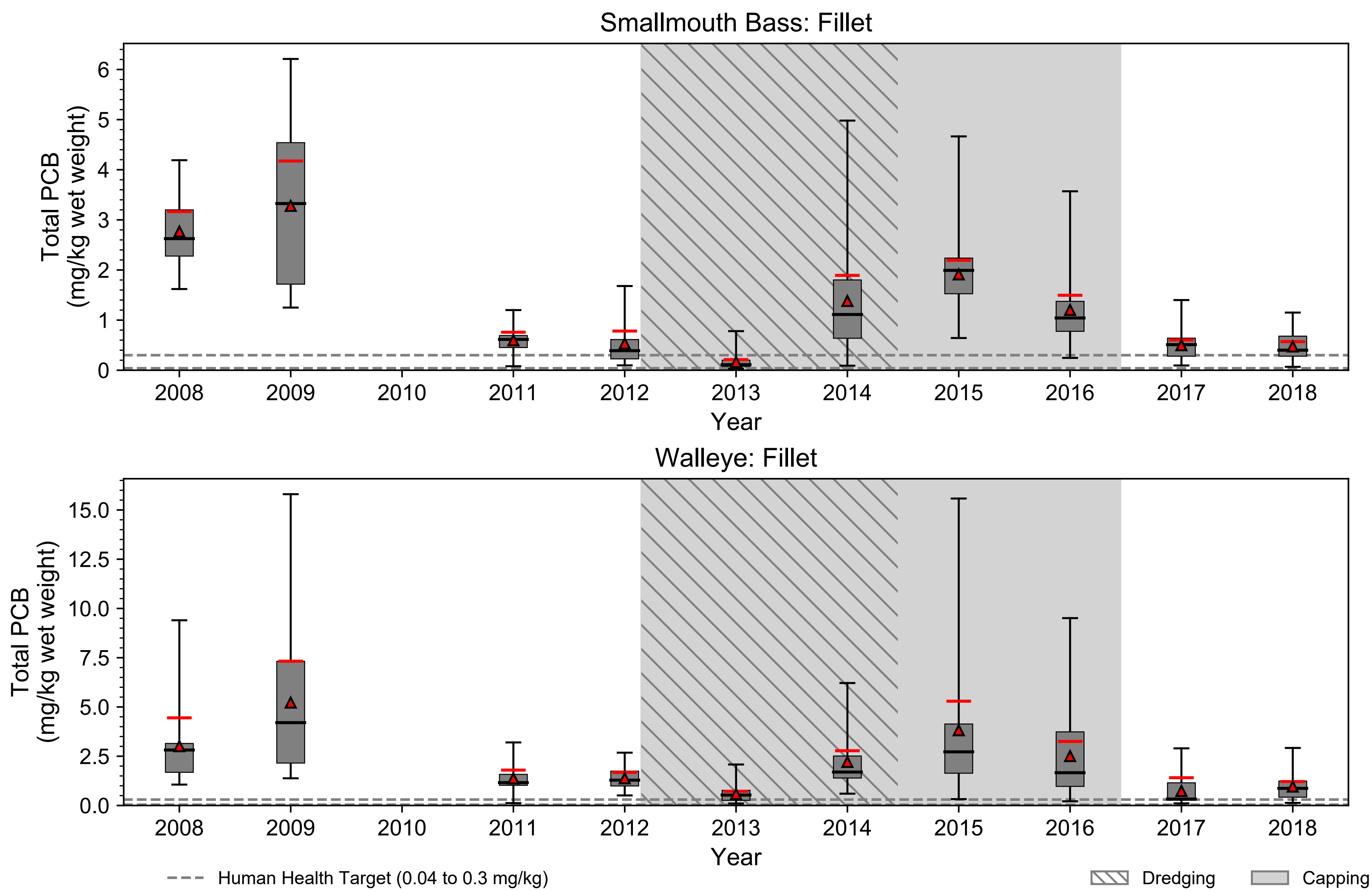
ANCHOR QEA



Set 1, Figure 2

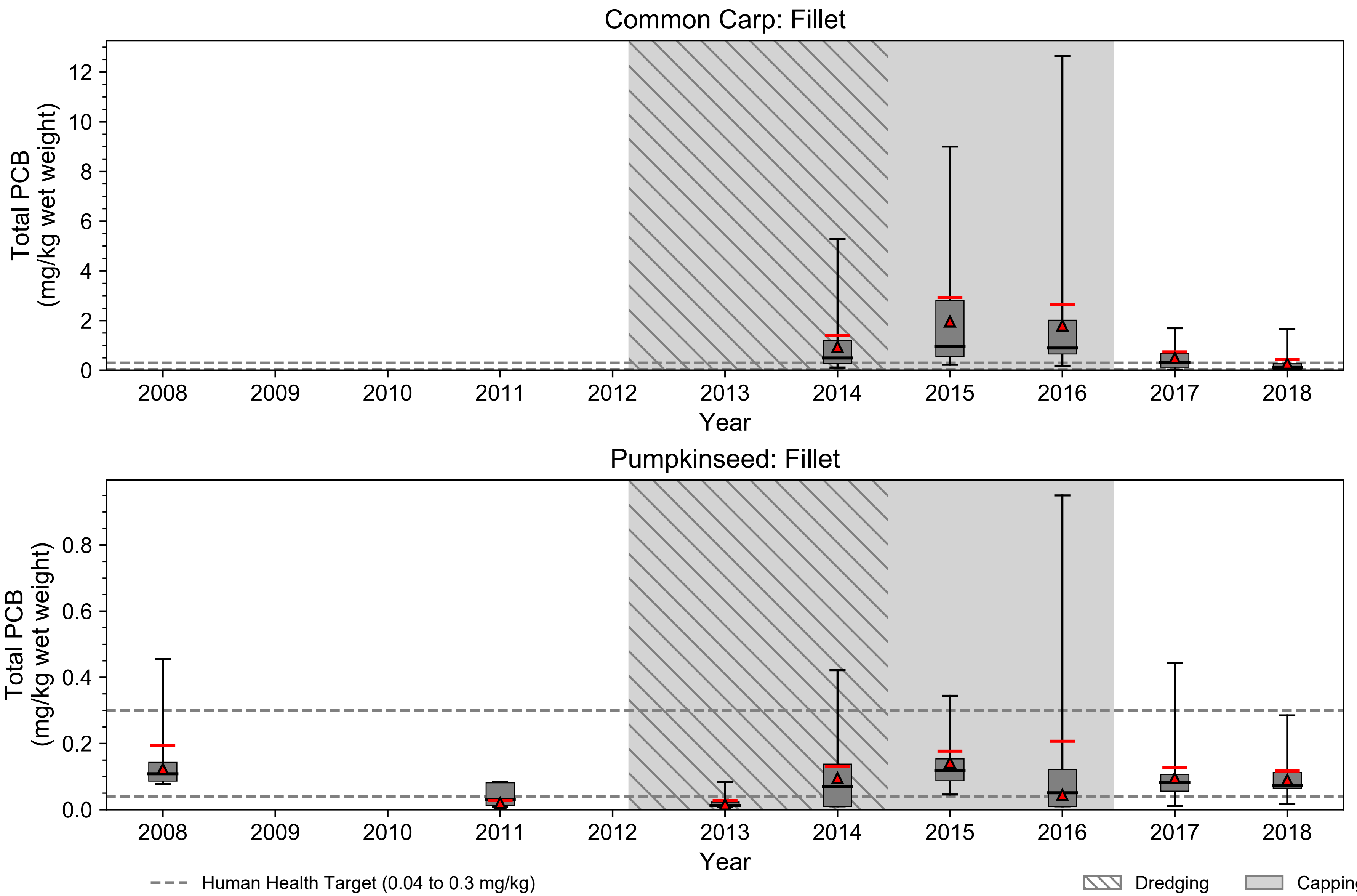
Mercury Concentrations in Common Carp and Pumpkinseed

ANCHOR QEA



Set 1, Figure 3
Total PCB Concentrations in Smallmouth Bass and Walleye

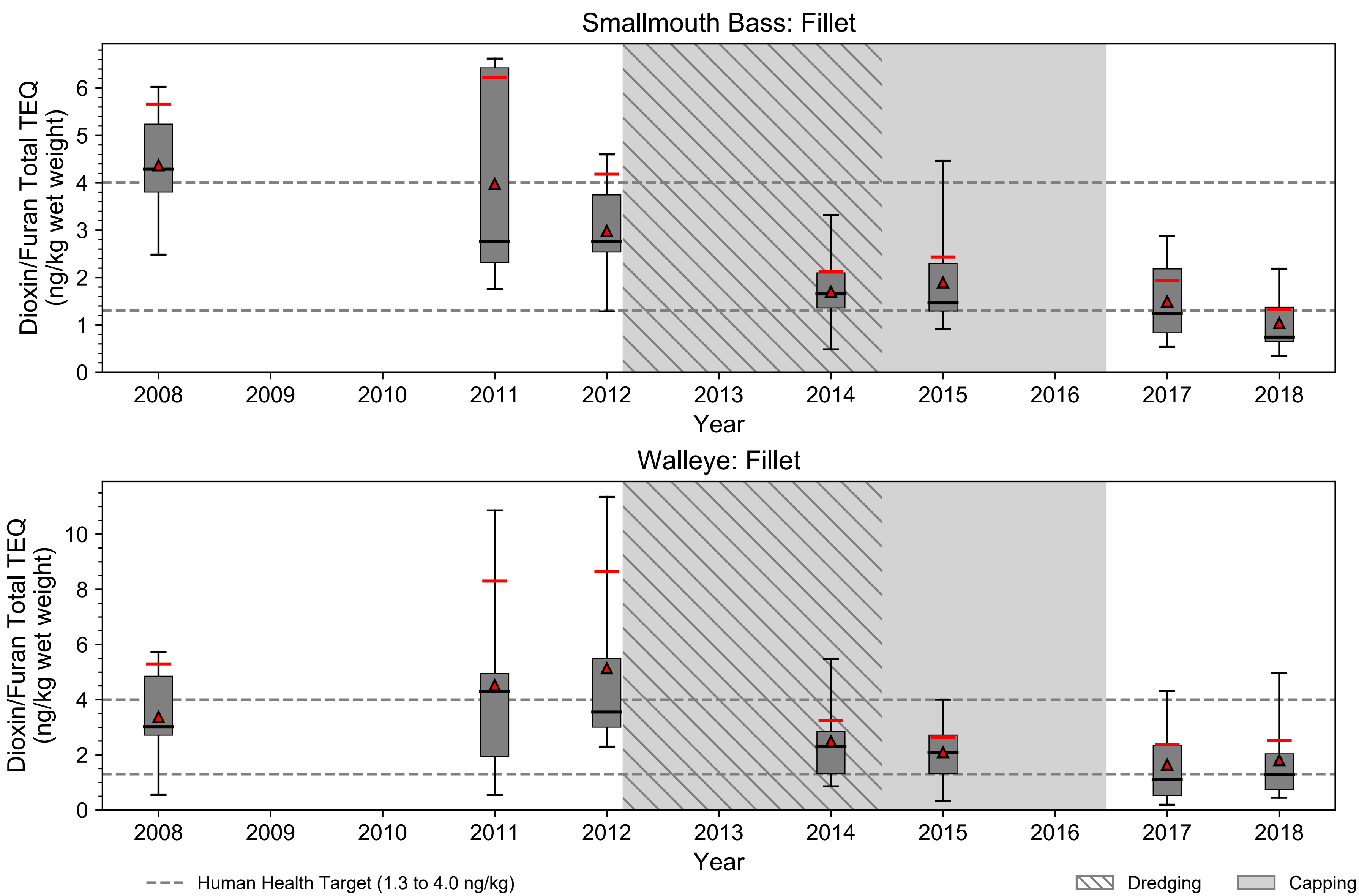
ANCHOR QEA



Set 1, Figure 4

Total PCB Concentrations in Common Carp and Pumpkinseed

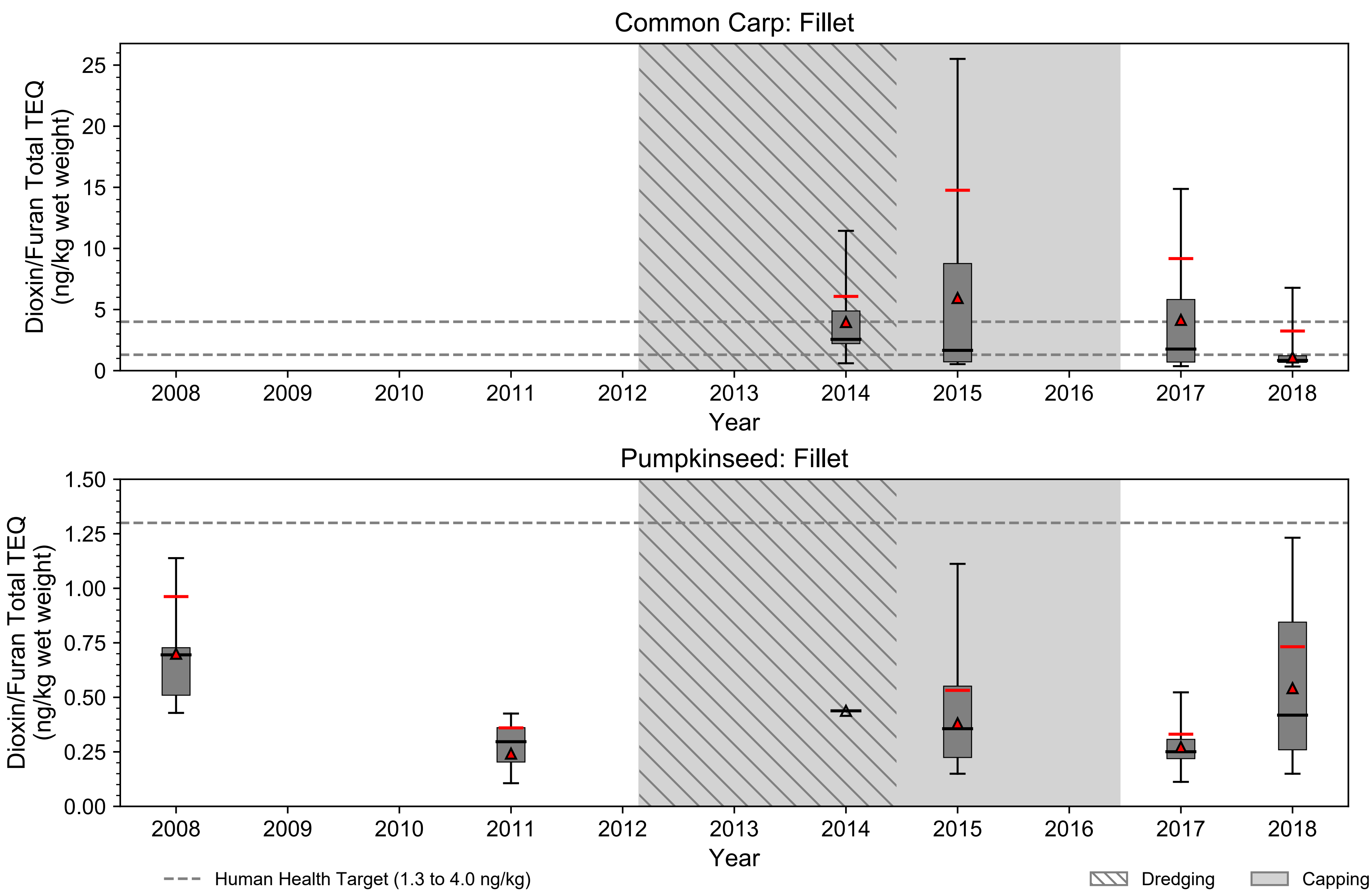
ANCHOR QEA



Set 1, Figure 5

Dioxin/Furan Total TEQ Concentrations in Smallmouth Bass and Walleye

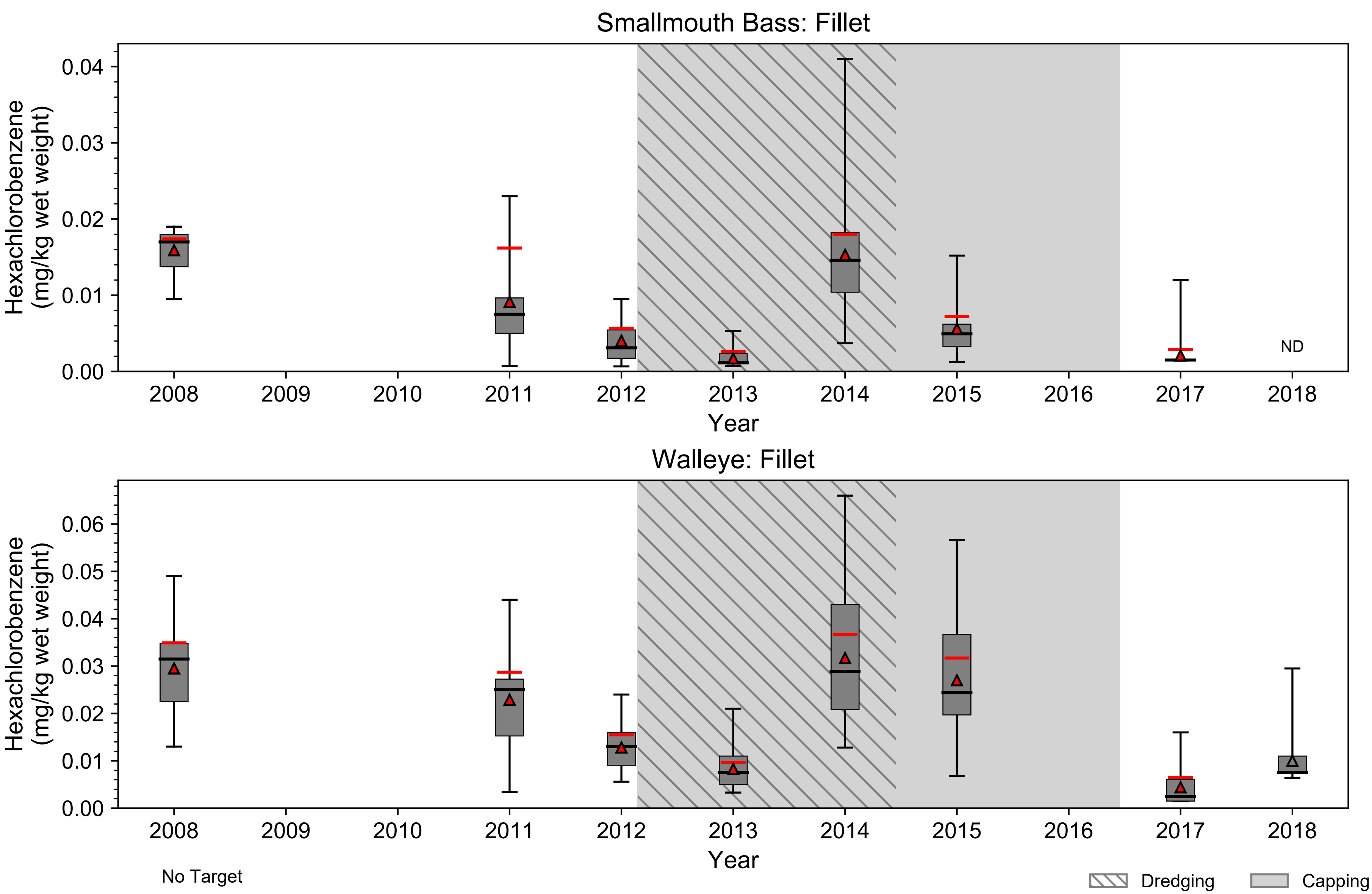
ANCHOR QEA



Set 1, Figure 6

Dioxin/Furan Total TEQ Concentrations in Common Carp and Pumpkinseed

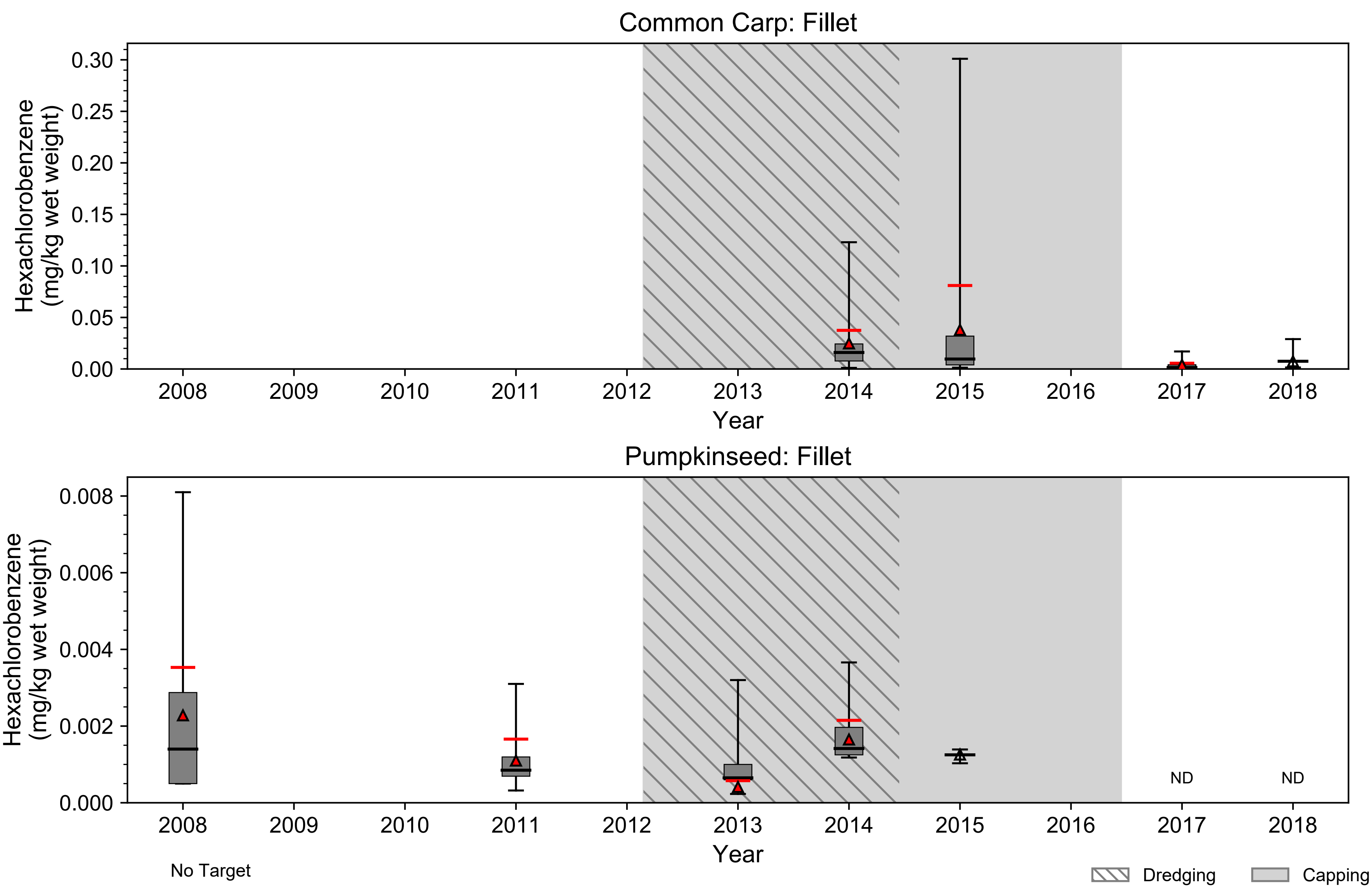
ANCHOR QEA



Set 1, Figure 7

Hexachlorobenzene Concentrations in Smallmouth Bass and Walleye

ANCHOR QEA



Set 1, Figure 8
Hexachlorobenzene Concentrations in Common Carp and Pumpkinseed

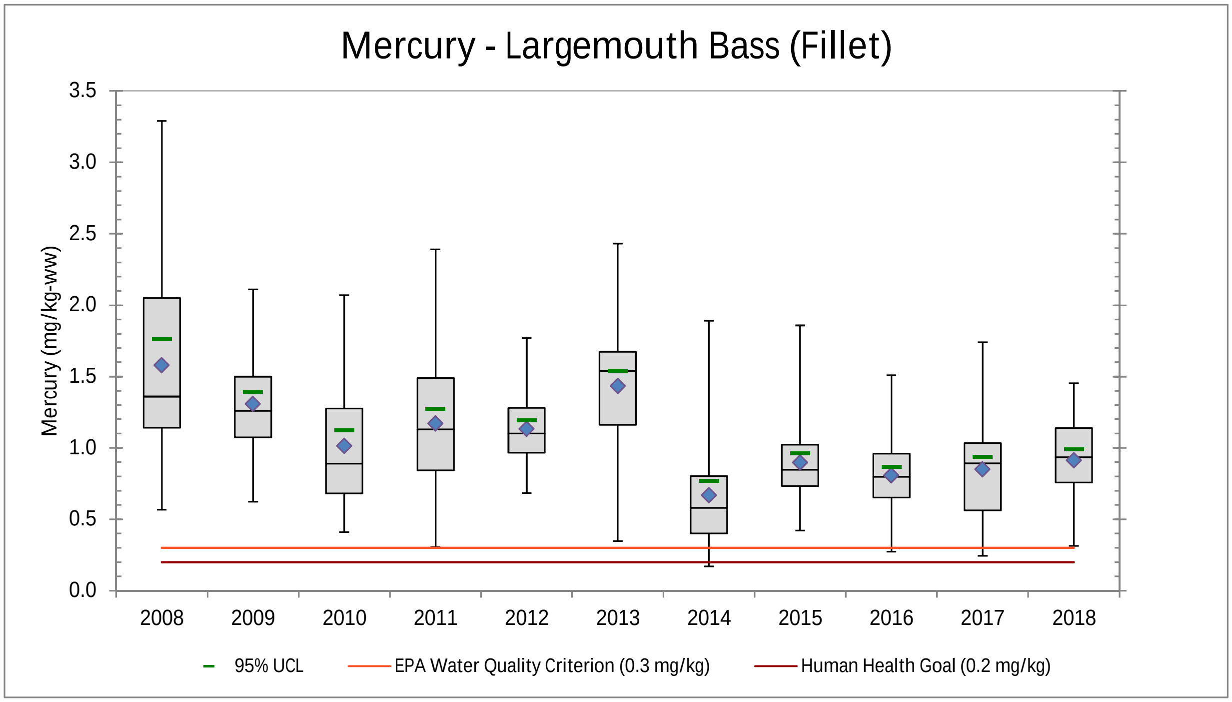
ANCHOR QEA

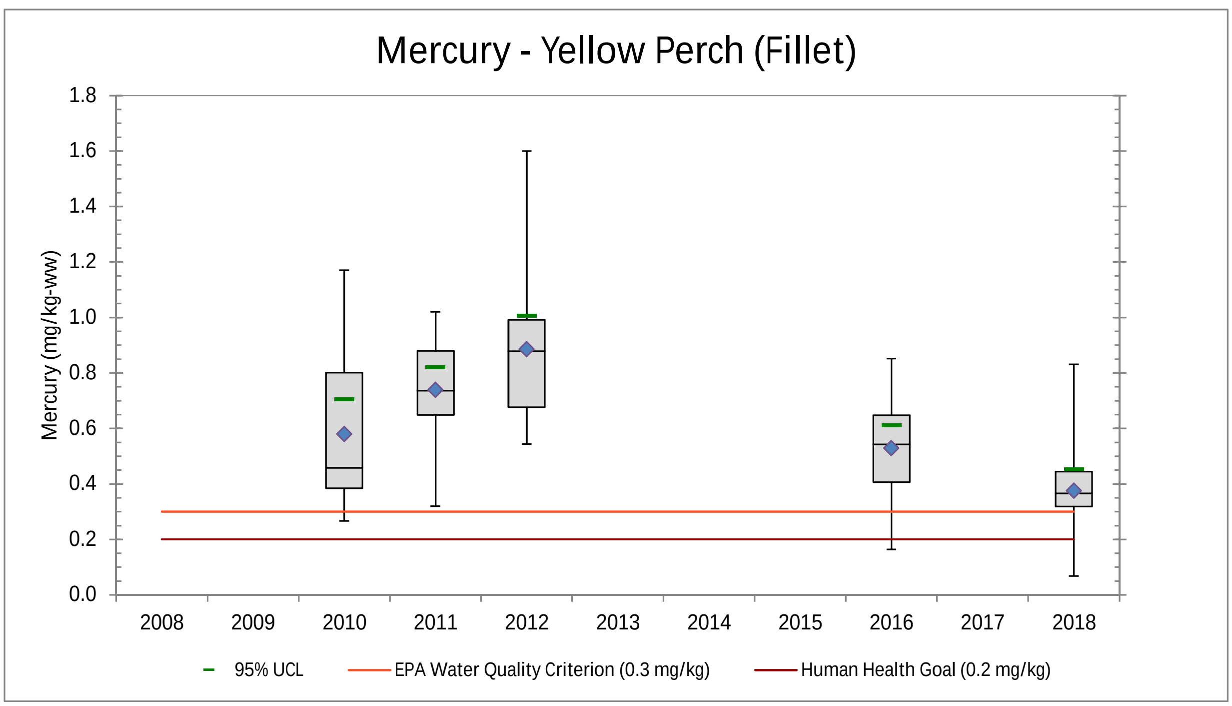
NYSDEC Set 1 Data (2008-2018)

September 2020

Set 1, DEC Figure 1

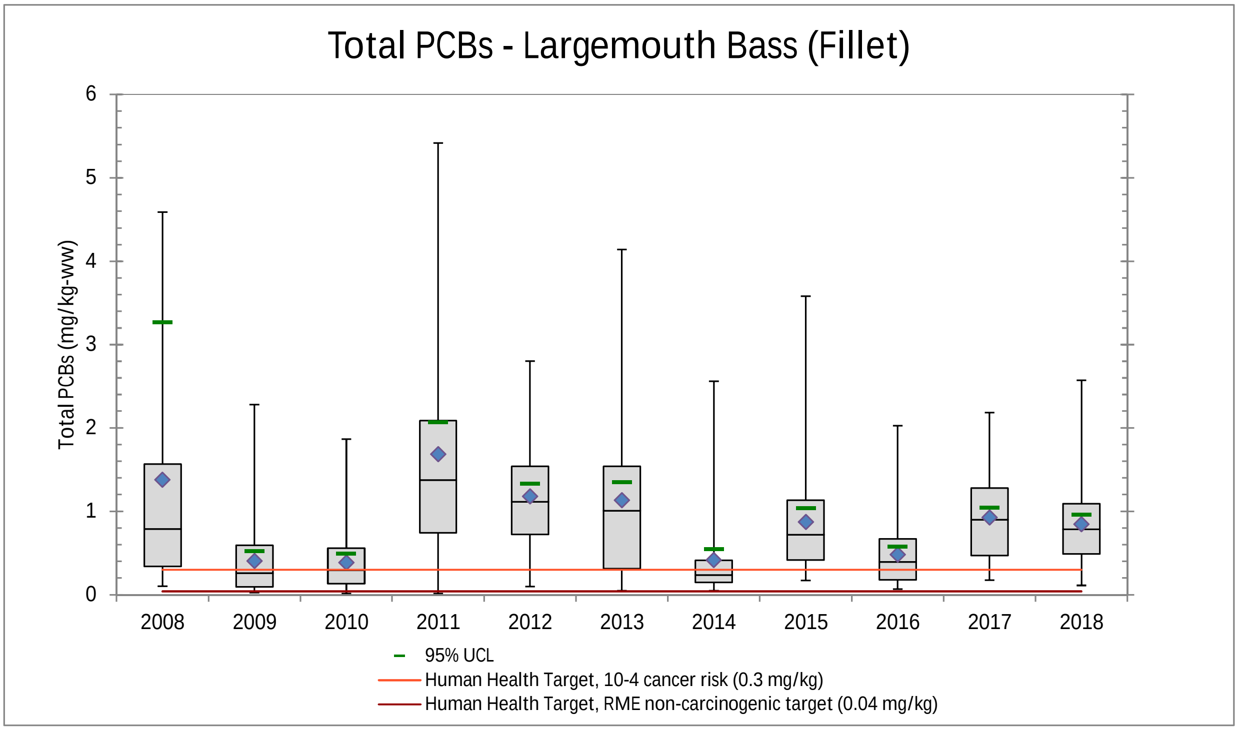
NYSDEC Mercury Data - Largemouth Bass and Yellow Perch

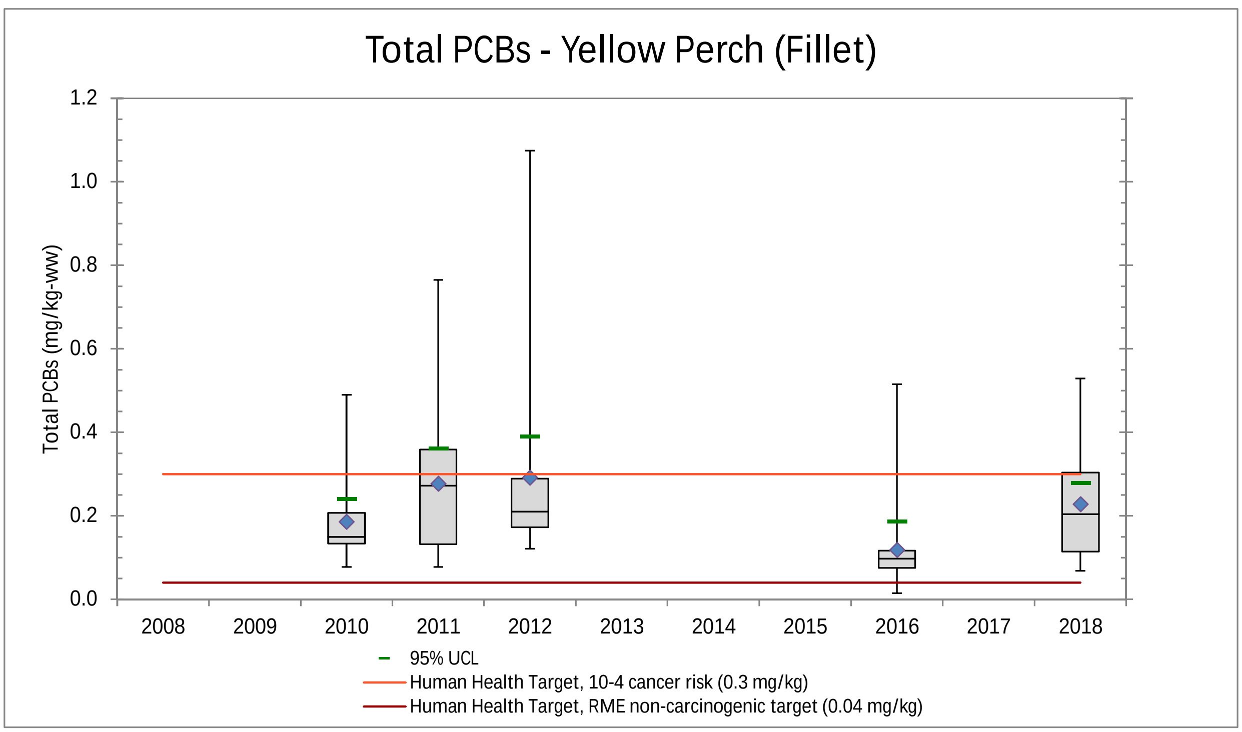




Set 1, DEC Figure 2

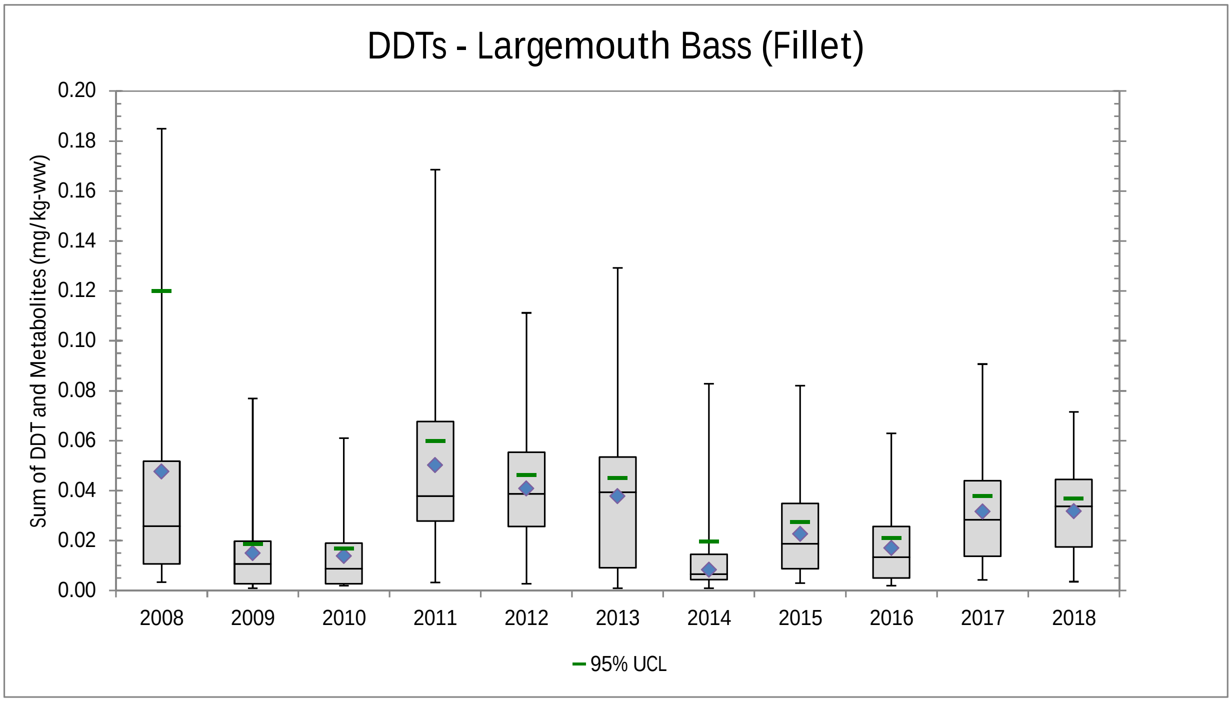
NYSDEC Total PCBs Data - Largemouth Bass and Yellow Perch

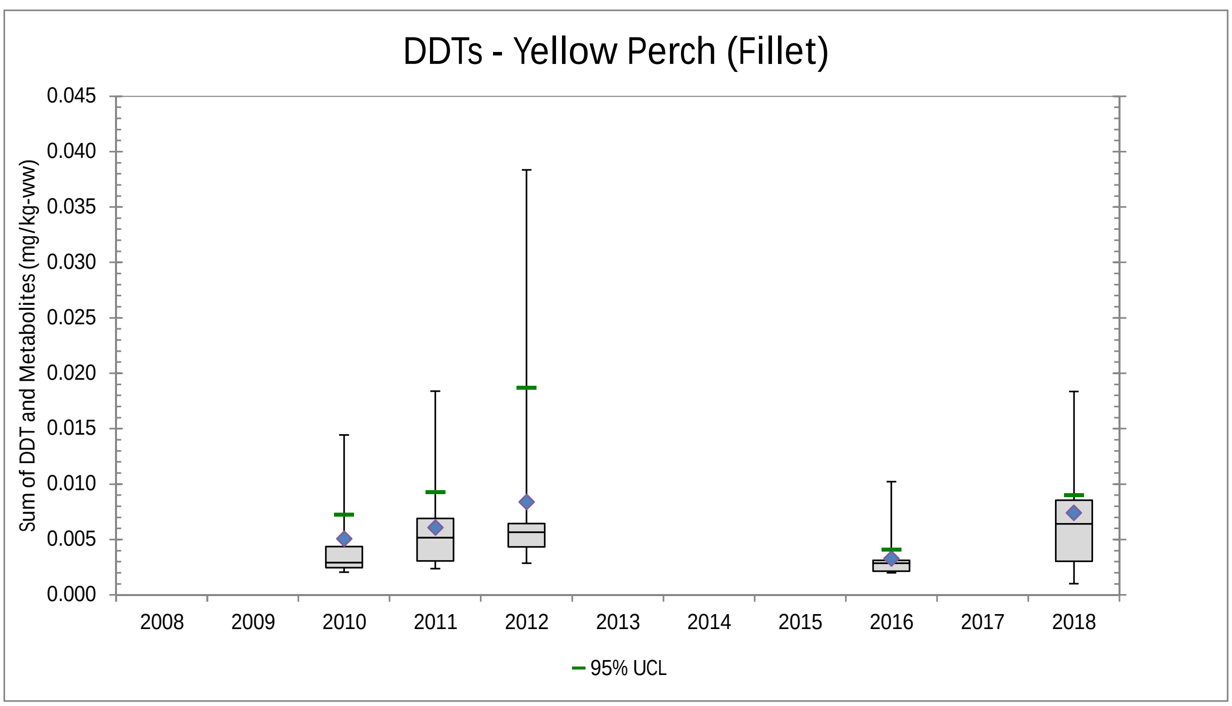




Set 1, DEC Figure 3

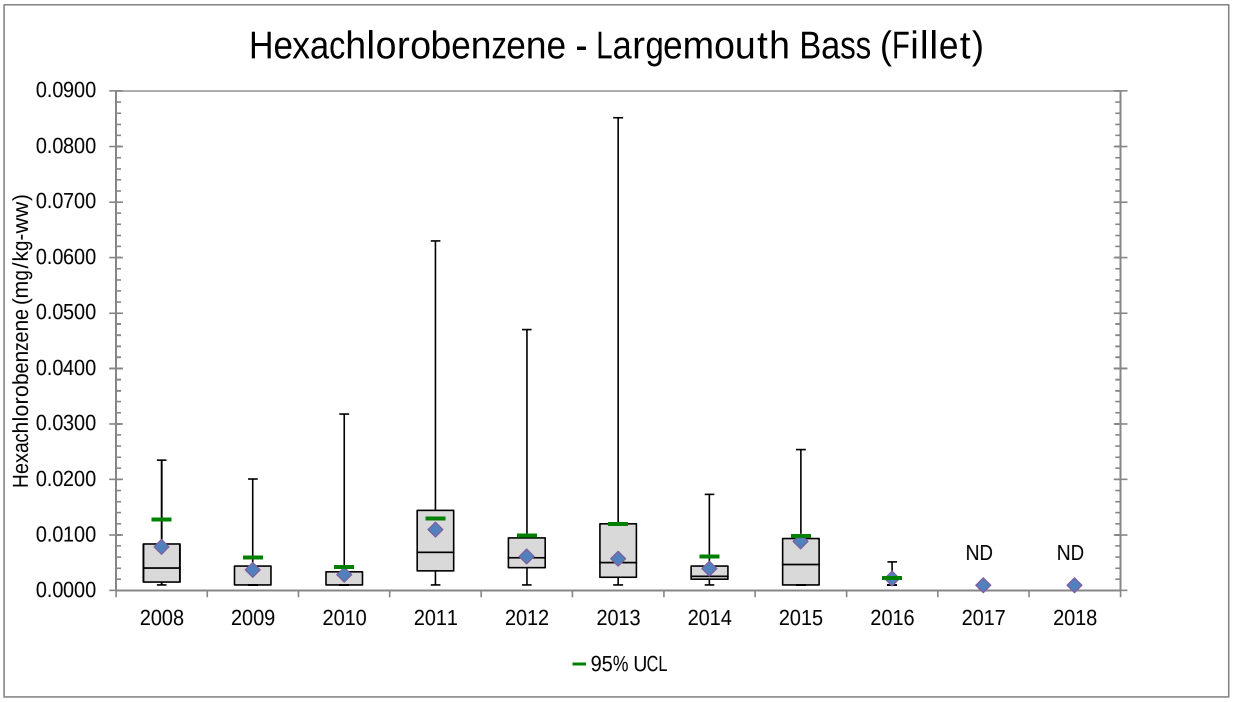
NYSDEC DDTs Data - Largemouth Bass and Yellow Perch

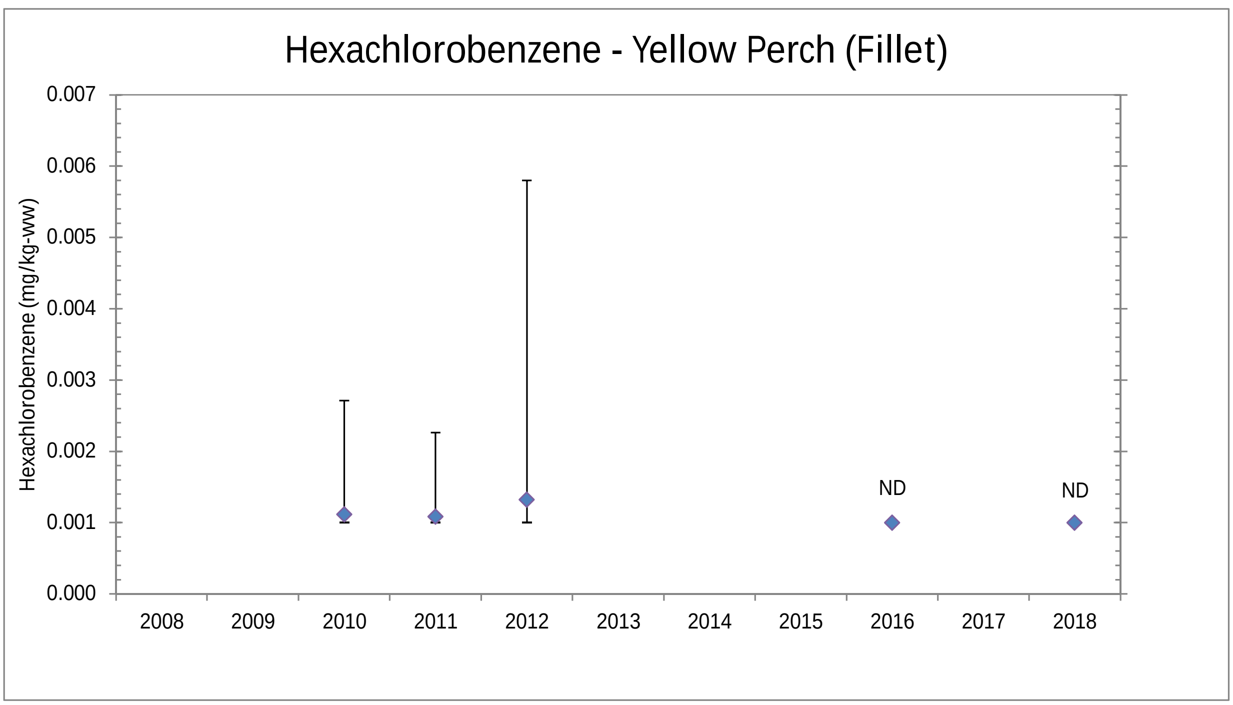




Set 1, DEC Figure 4

NYSDEC Hexachlorobenzene Data - Largemouth Bass and Yellow Perch

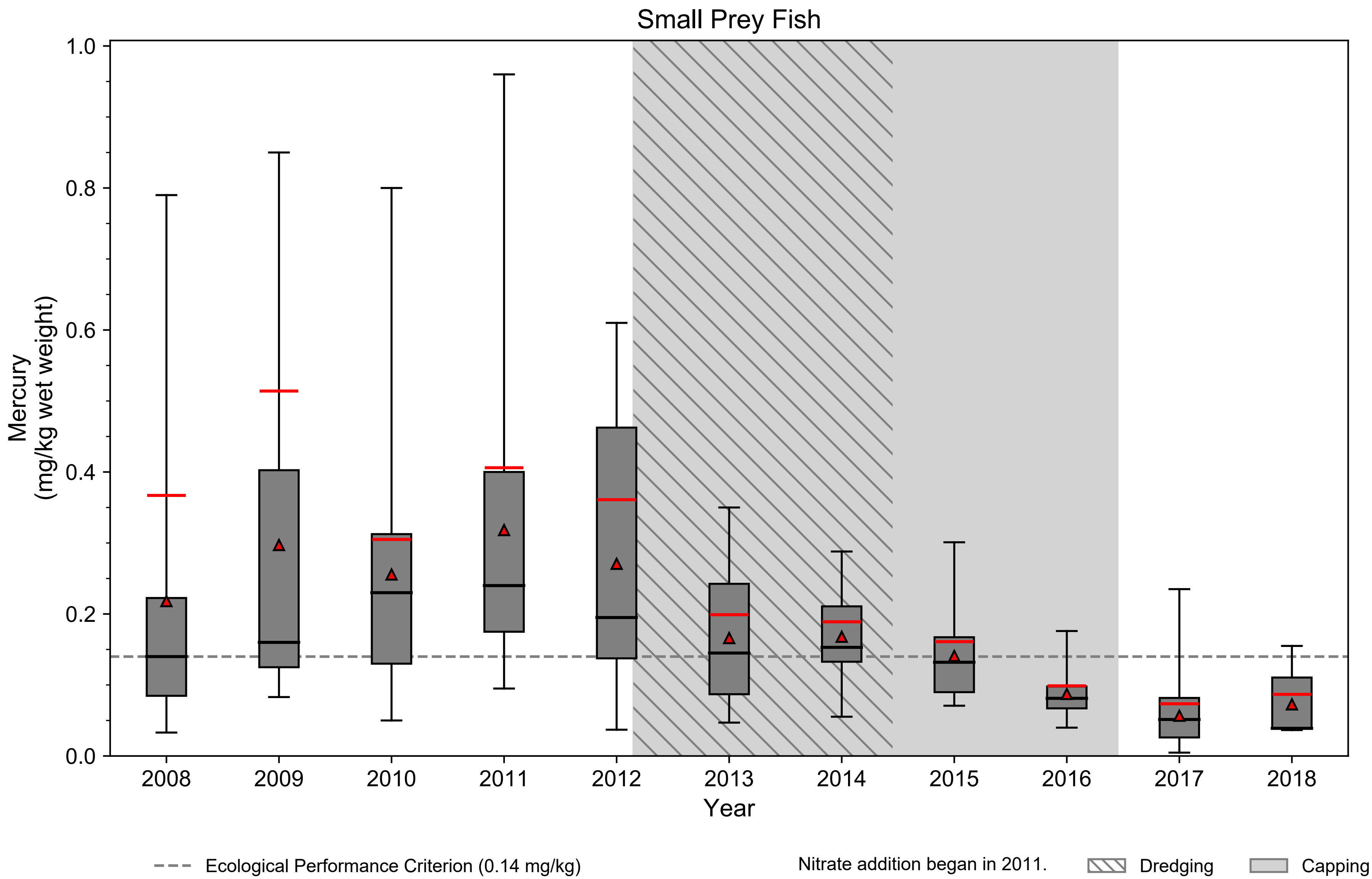




Set 2:
Small (30 to 180 mm) Prey Fish Whole-Body Concentrations for Ecological Remedial Goal and Targets

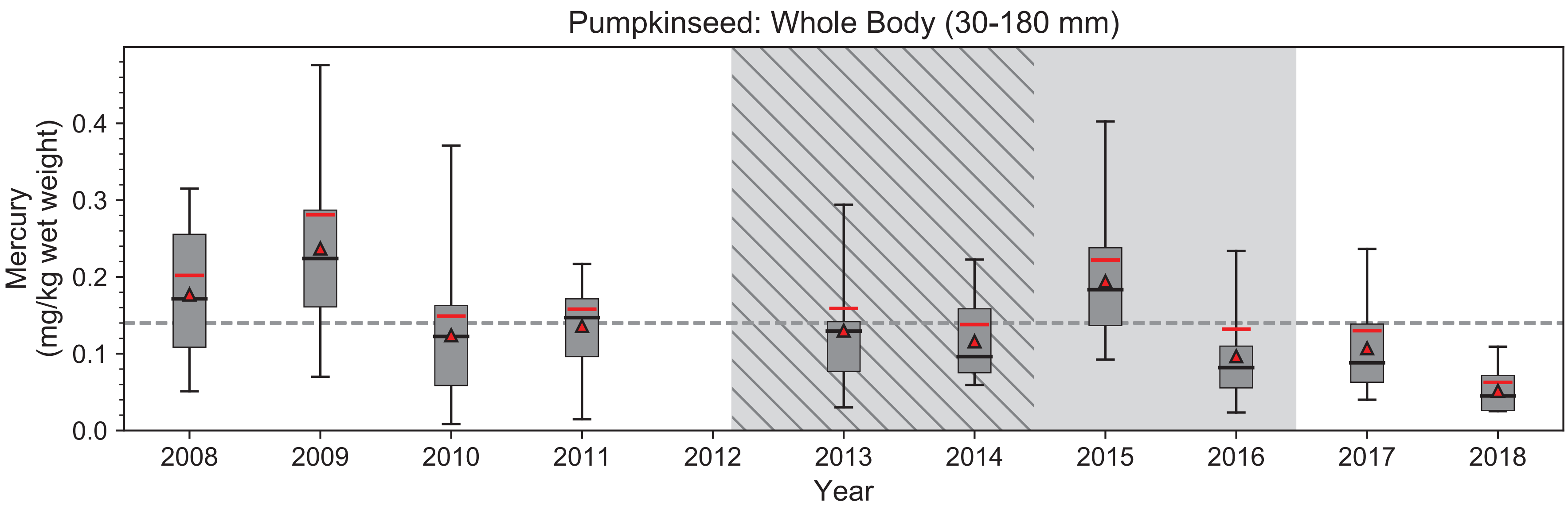
Honeywell Set 2 Data (2008-2018)

September 2020



Set 2, Figure 1
Mercury Concentrations in Small Prey Fish (All SMUs)

ANCHOR QEA



Ecological Performance Criterion (0.14 mg/kg)

Nitrate addition began in 2011.

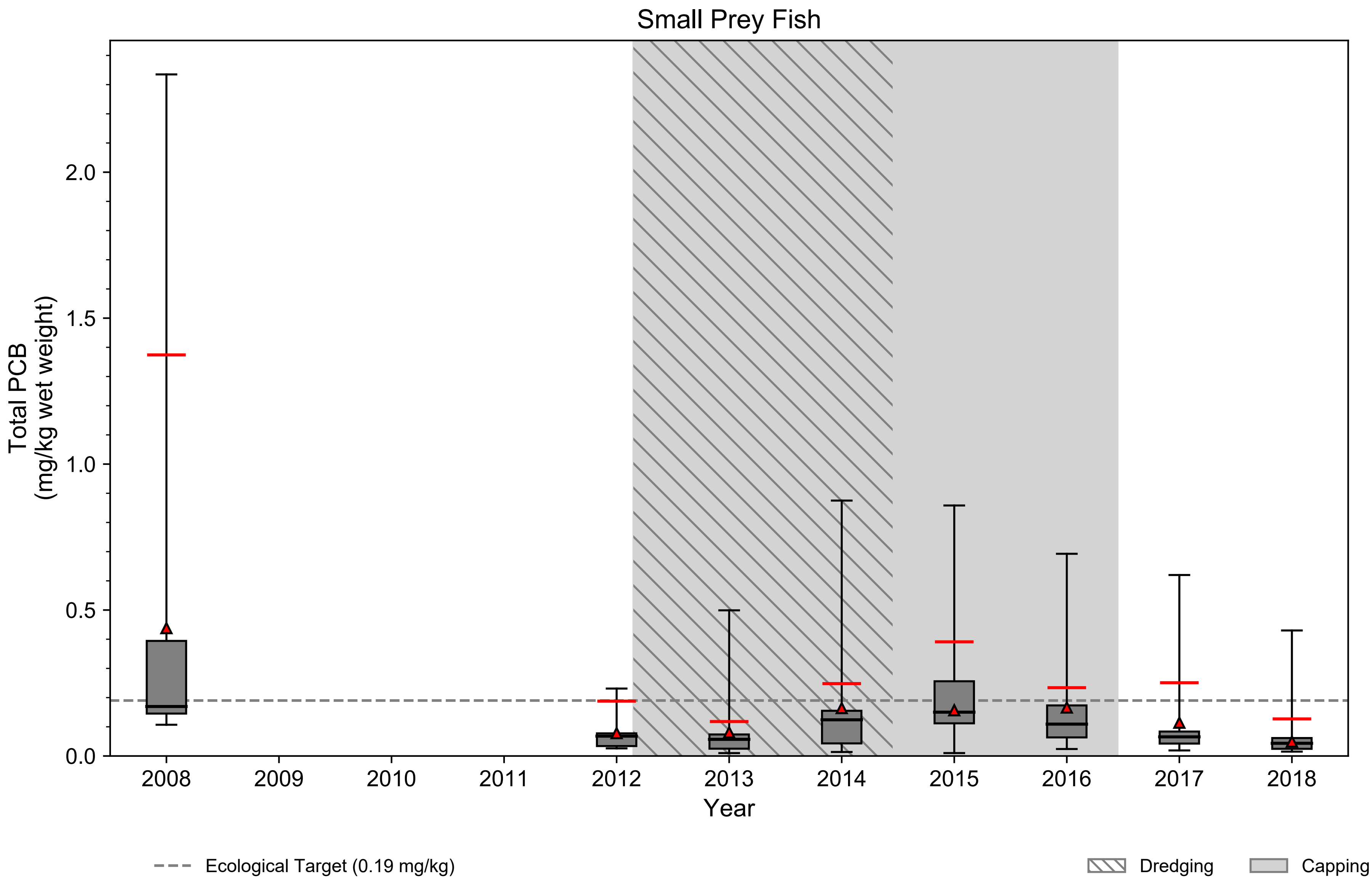
Dredging

Capping

Set 2, Figure 2

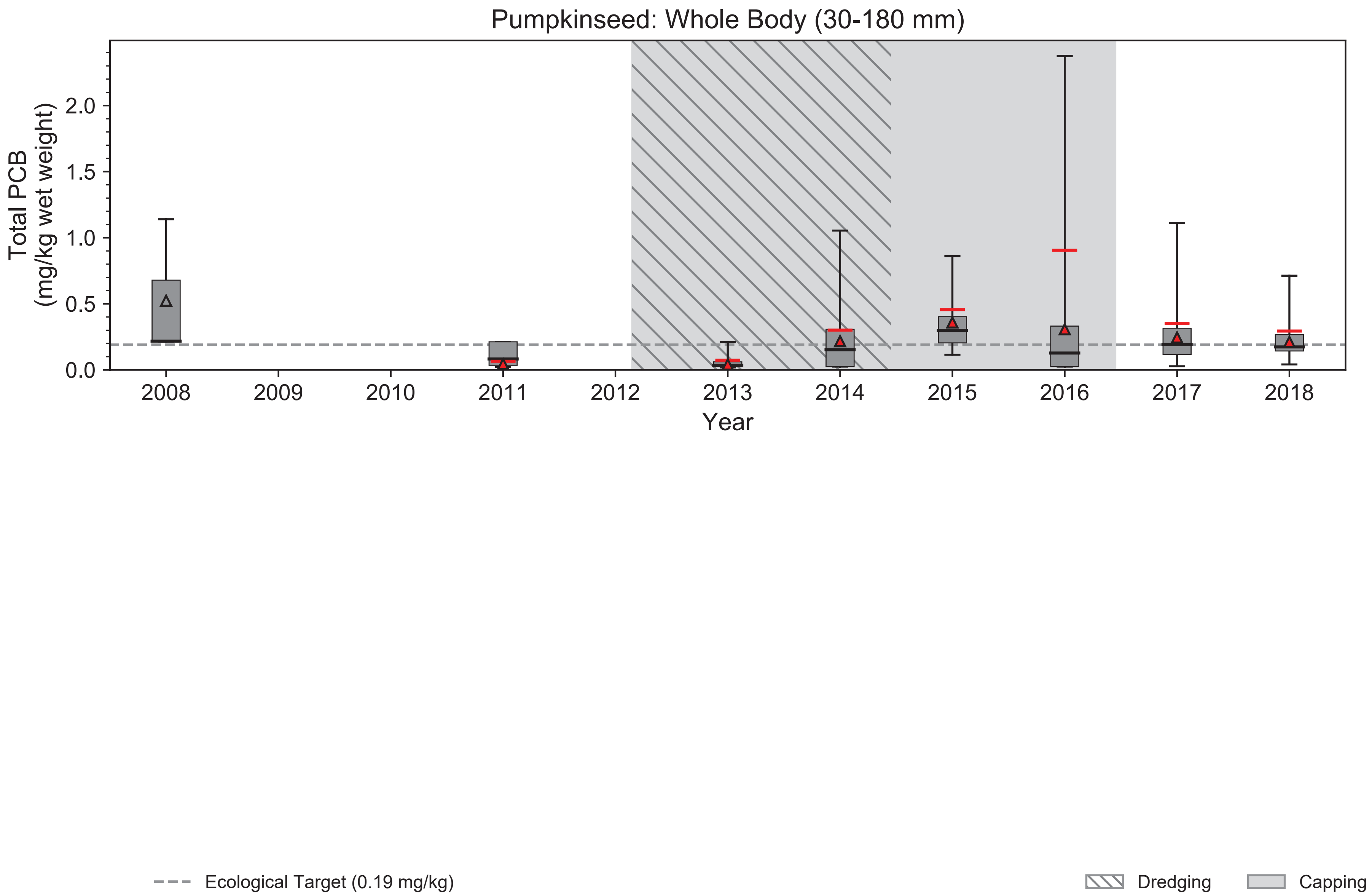
Calculated Whole Body Mercury Concentrations in Small Pumpkinseed

ANCHOR QEA



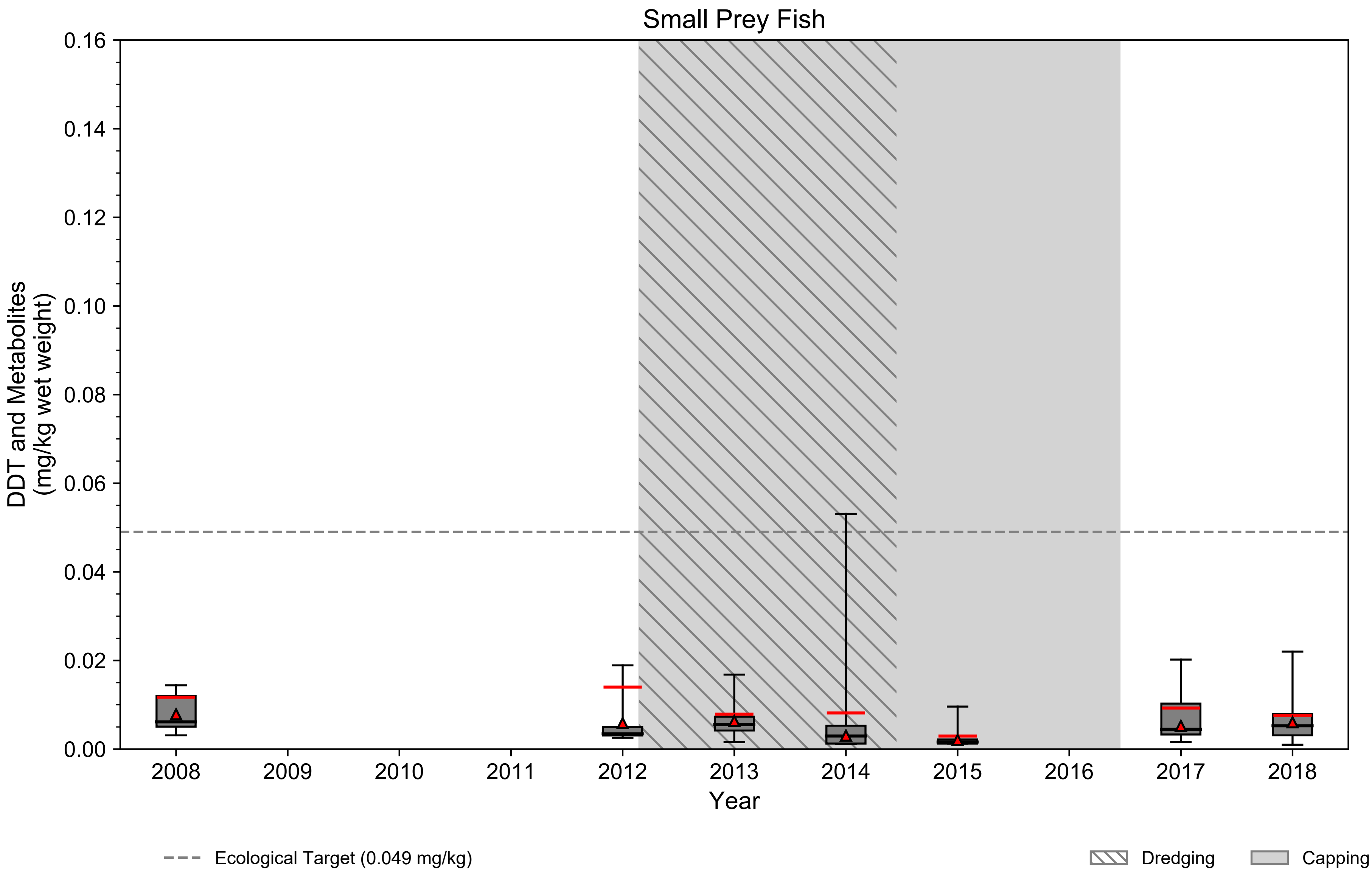
Set 2, Figure 3
Total PCB Concentrations in Small Prey Fish (All SMUs)

ANCHOR QEA

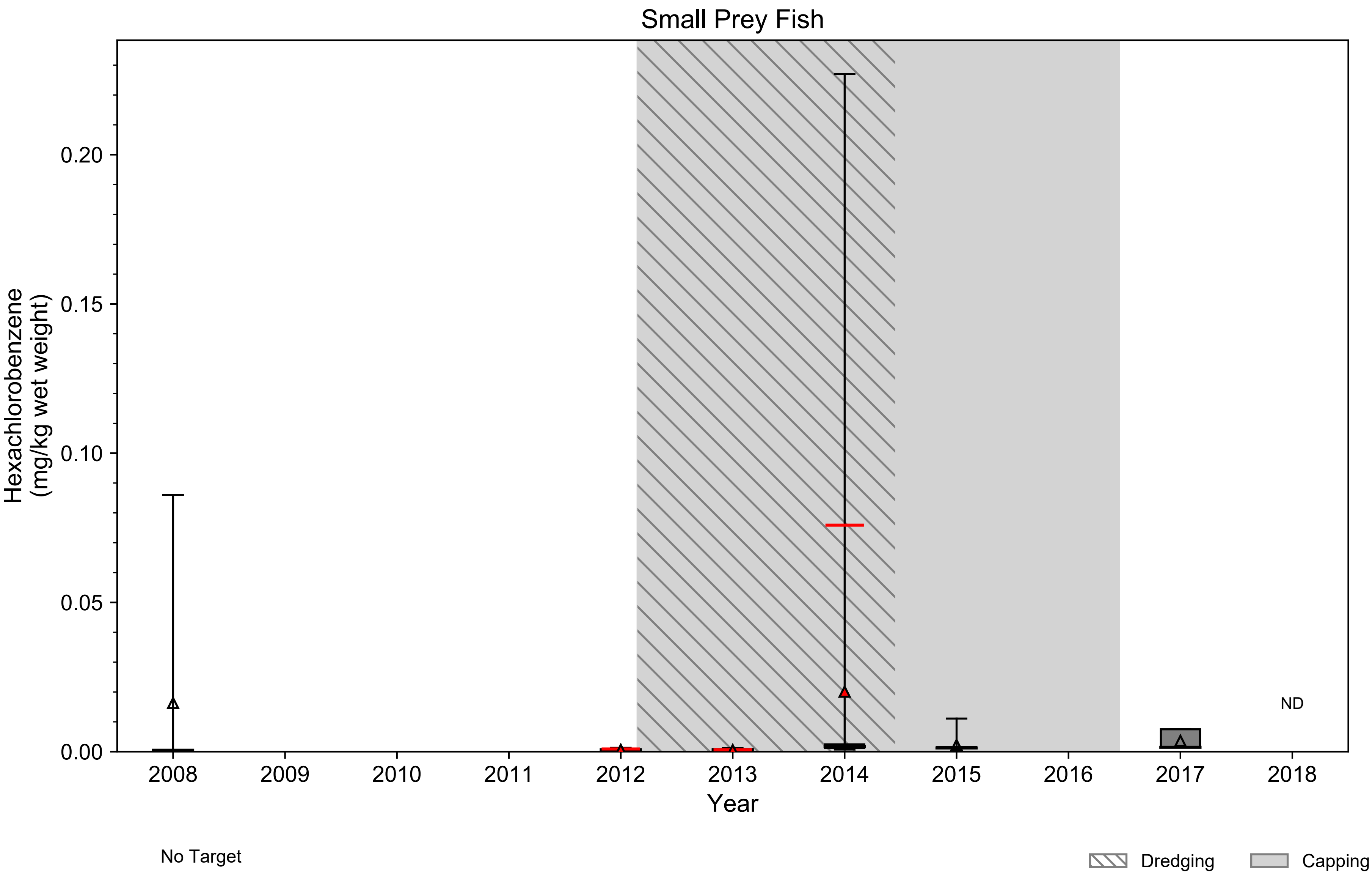


Set 2, Figure 4

Calculated Whole Body Total PCB Concentrations in Small Pumpkinseed

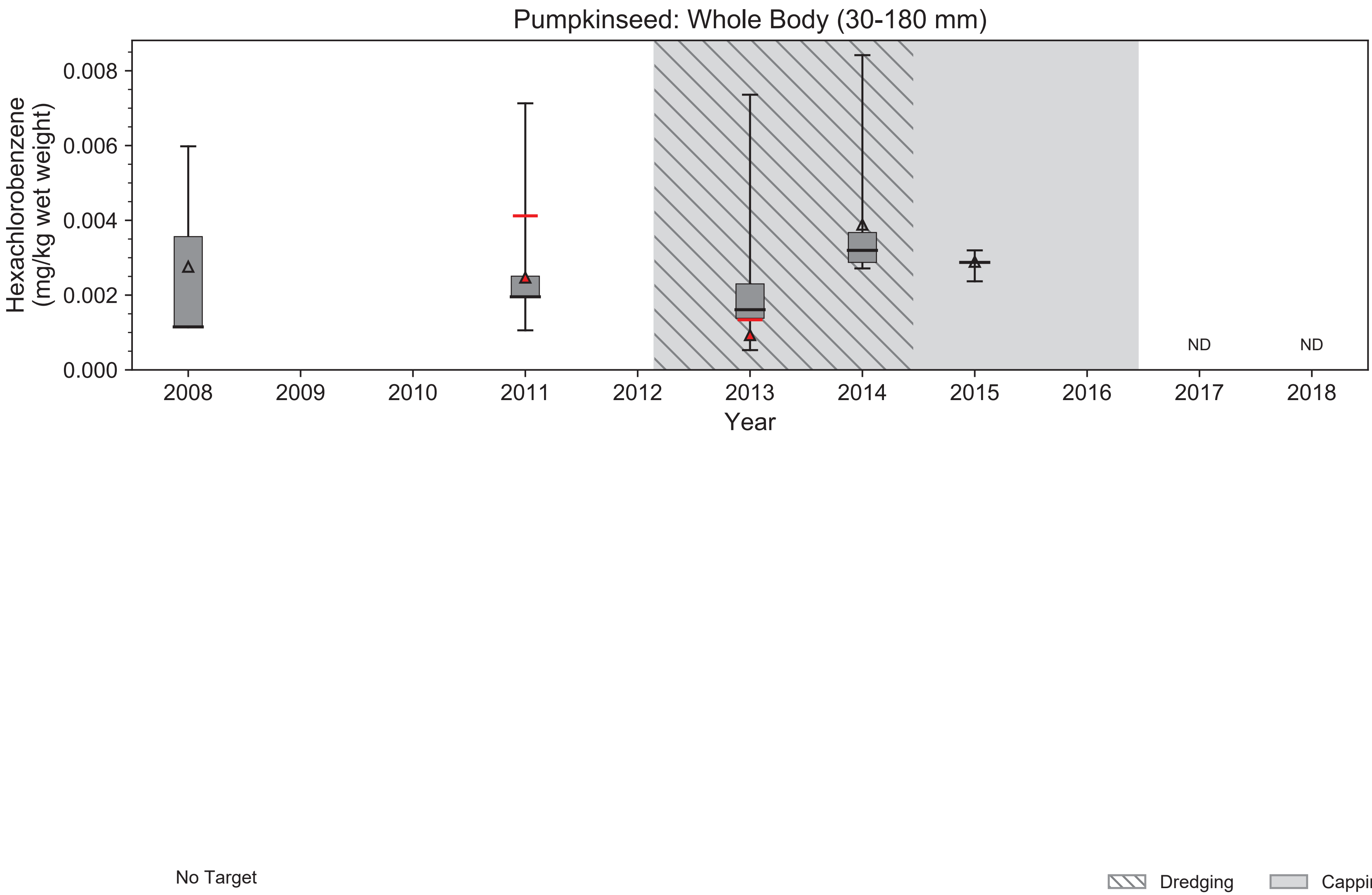


Set 2, Figure 5
DDT Concentrations in Small Prey Fish (All SMUs)



Set 2, Figure 6
Hexachlorobenzene Concentrations in Small Prey Fish (All SMUs)

ANCHOR QEA



Set 2, Figure 7

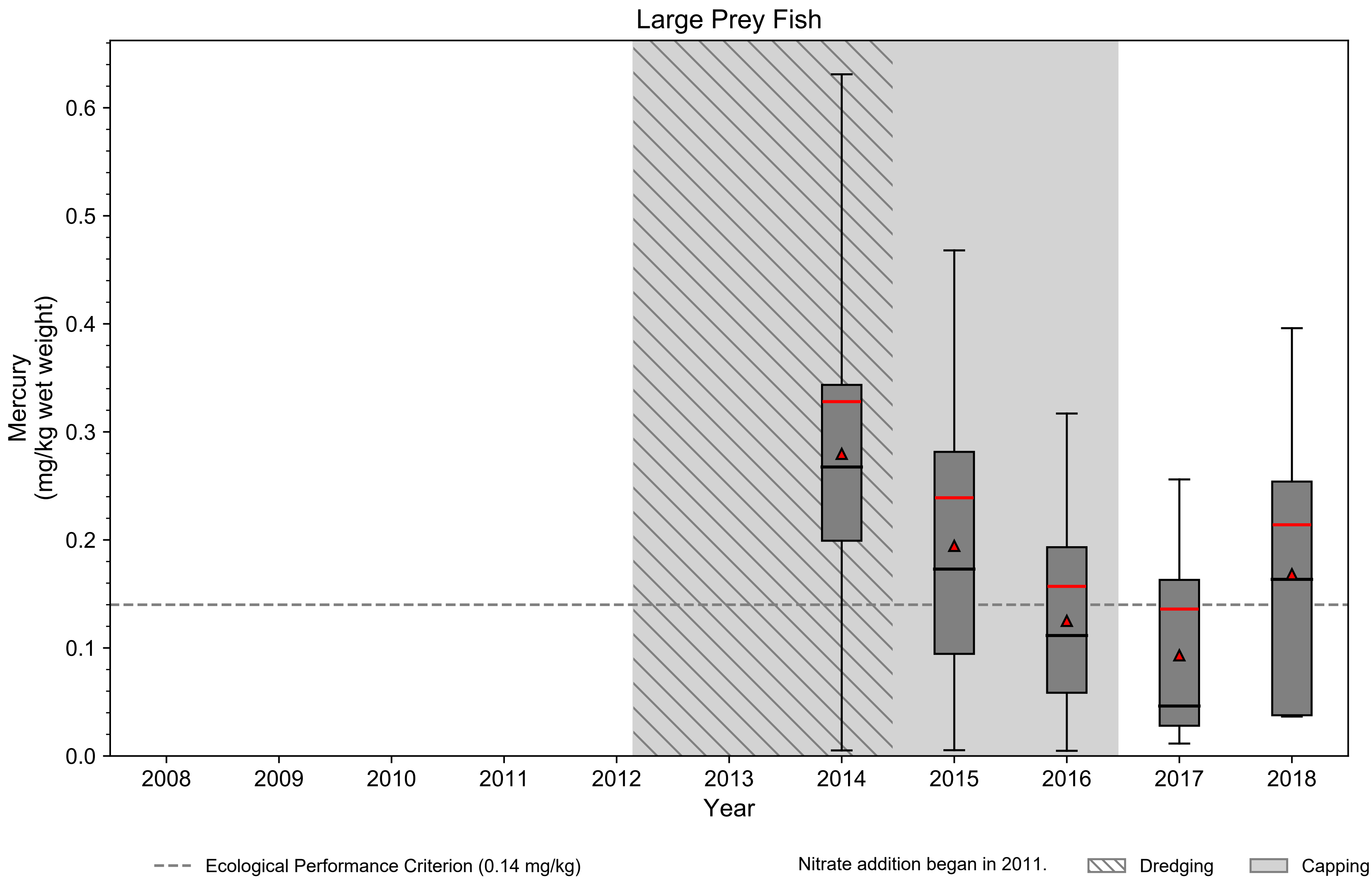
Calculated Whole Body Hexachlorobenzene Concentrations in Small Pumpkinseed

ANCHOR QEA

Set 3:
Large (180 to 600 mm) Prey Fish Whole-Body Concentrations for Ecological Remedial Goal and Targets

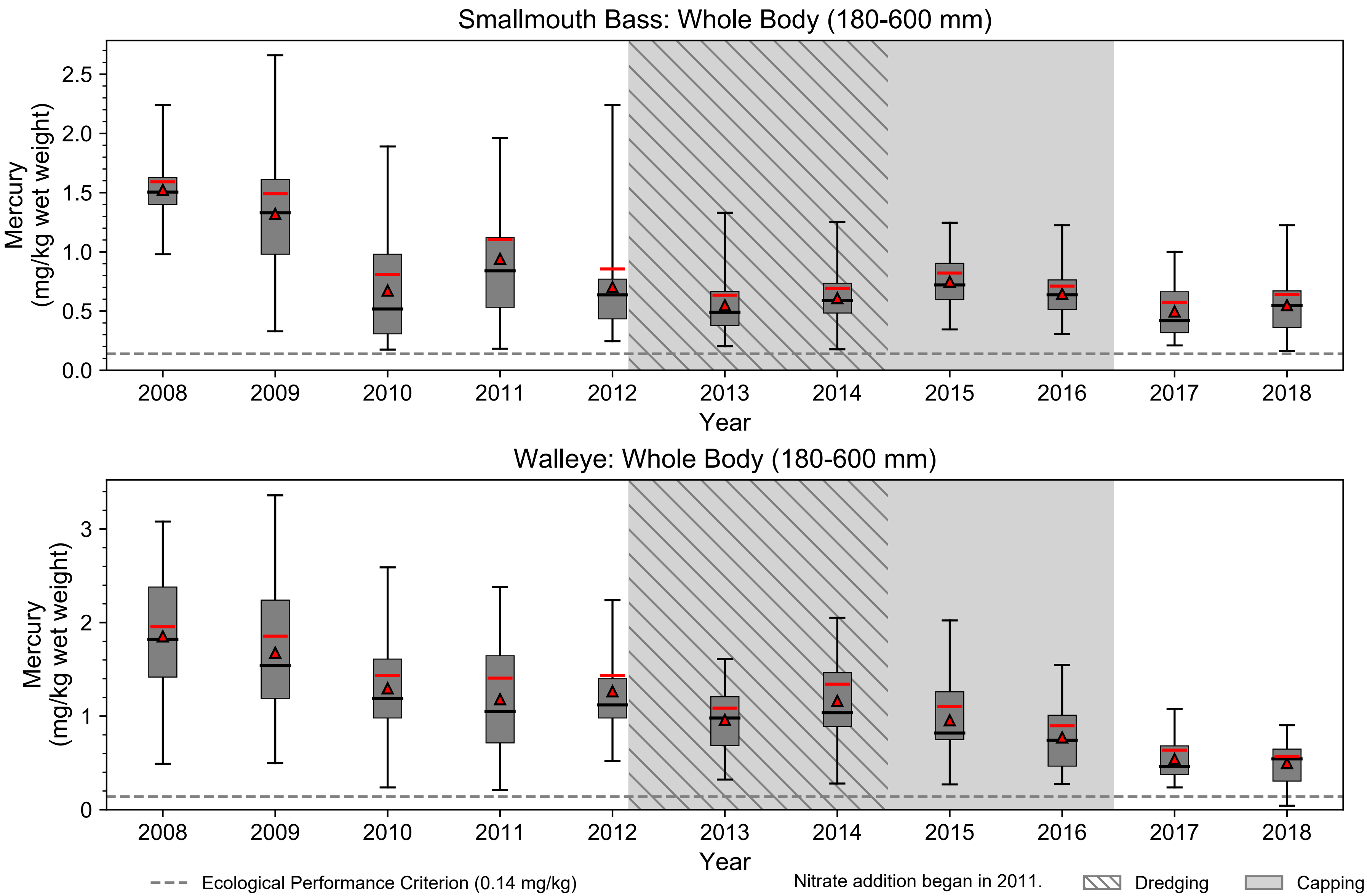
Honeywell Set 3 Data (2008-2018)

September 2020



Set 3, Figure 1

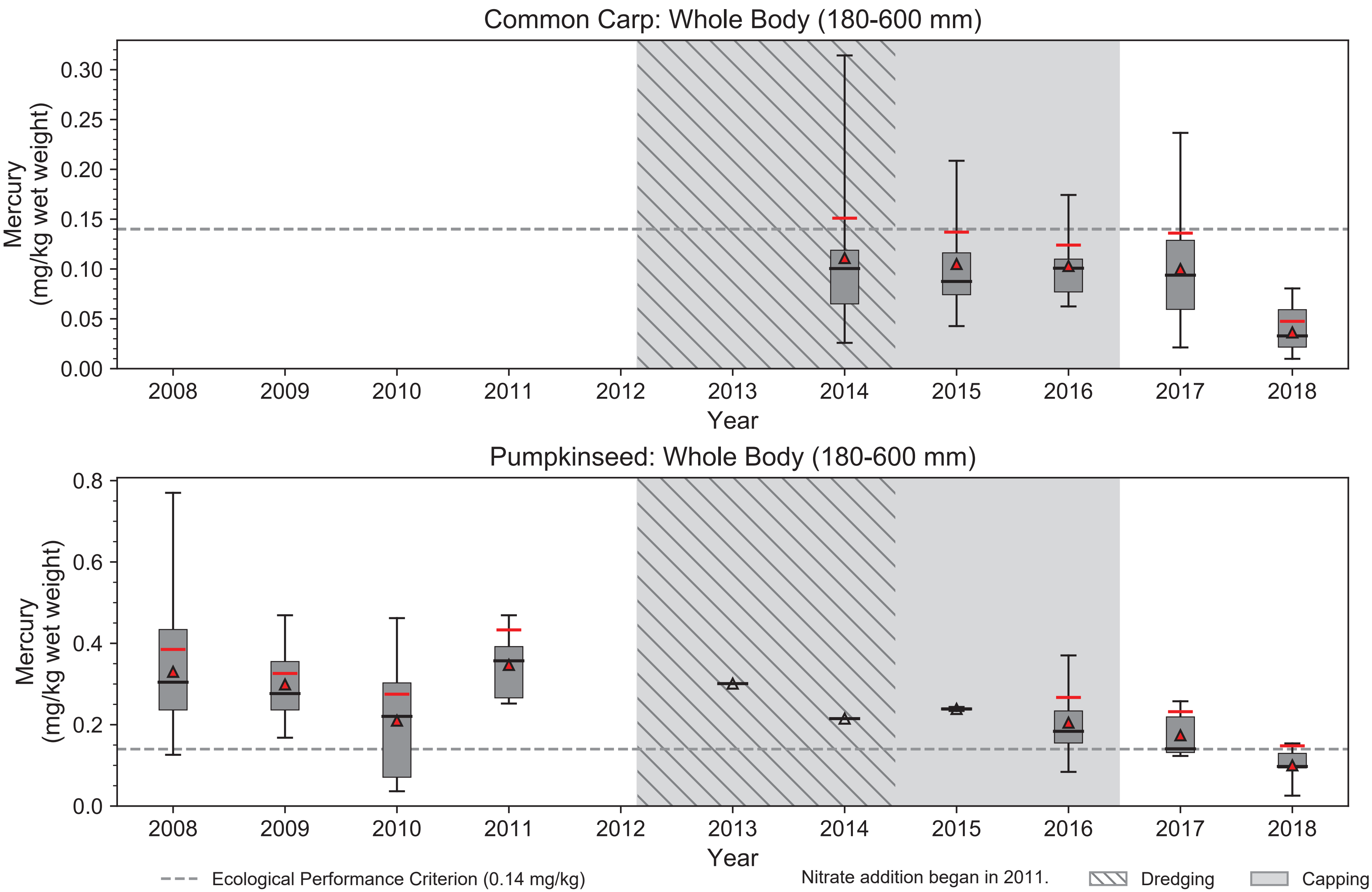
Mercury Concentrations in Large Prey Fish (All SMUs)



Set 3, Figure 2

Calculated Whole Body Mercury Concentrations in Smallmouth Bass and Walleye

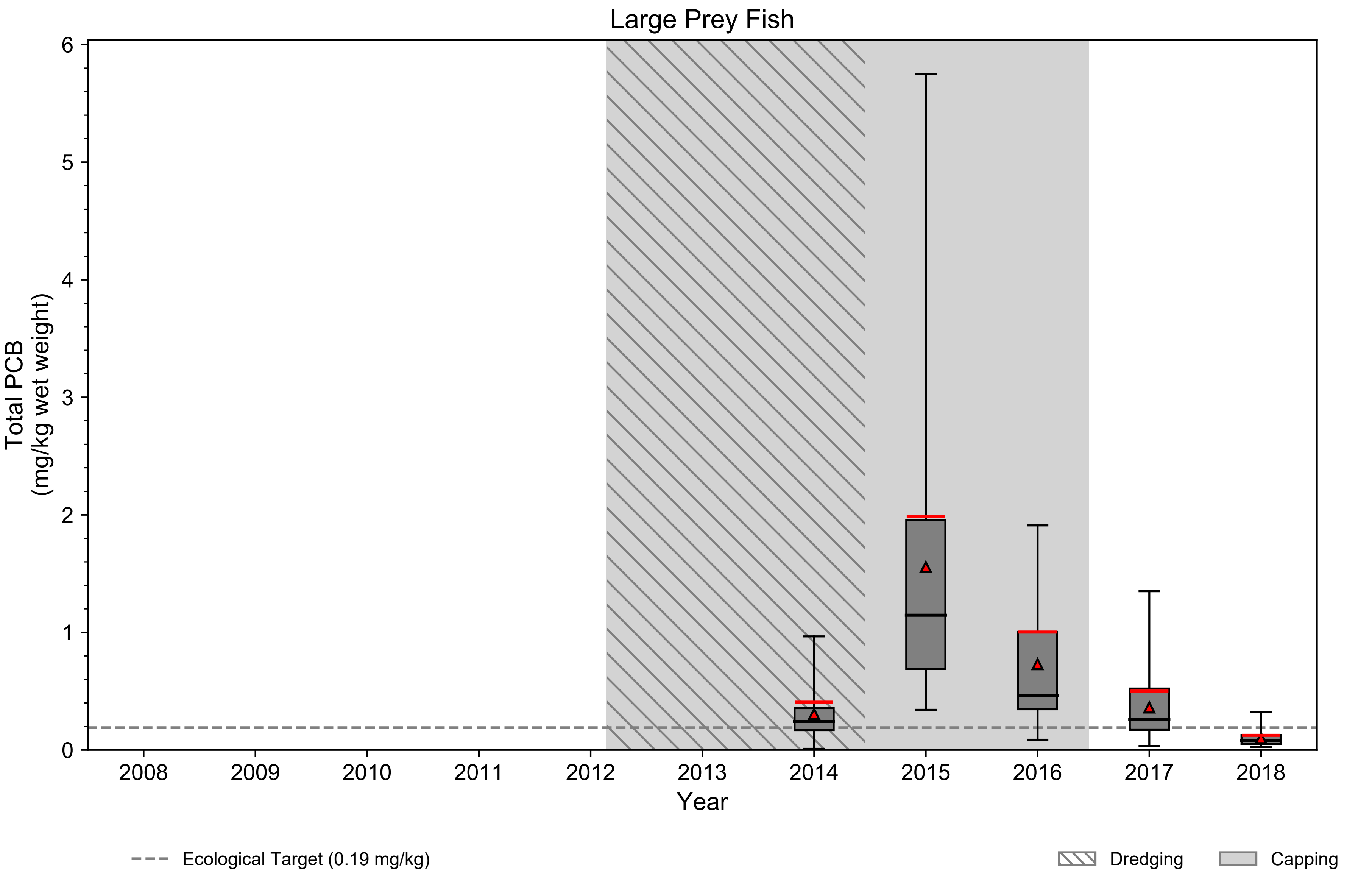
ANCHOR QEA



Set 3, Figure 3

Calculated Whole Body Mercury Concentrations in Common Carp and Large Pumpkinseed

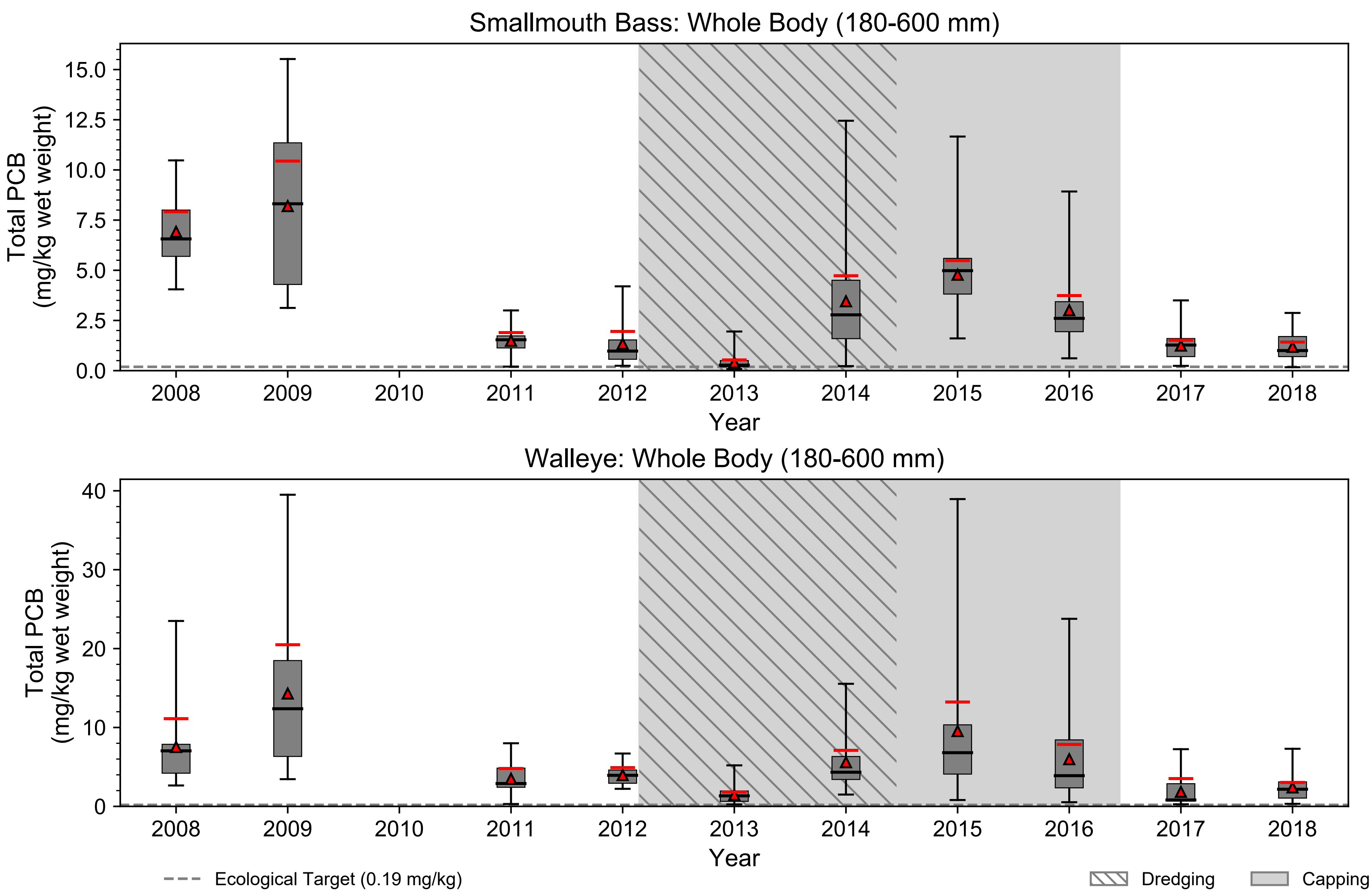
ANCHOR QEA



Set 3, Figure 4

Total PCB Concentrations in Large Prey Fish (All SMUs)

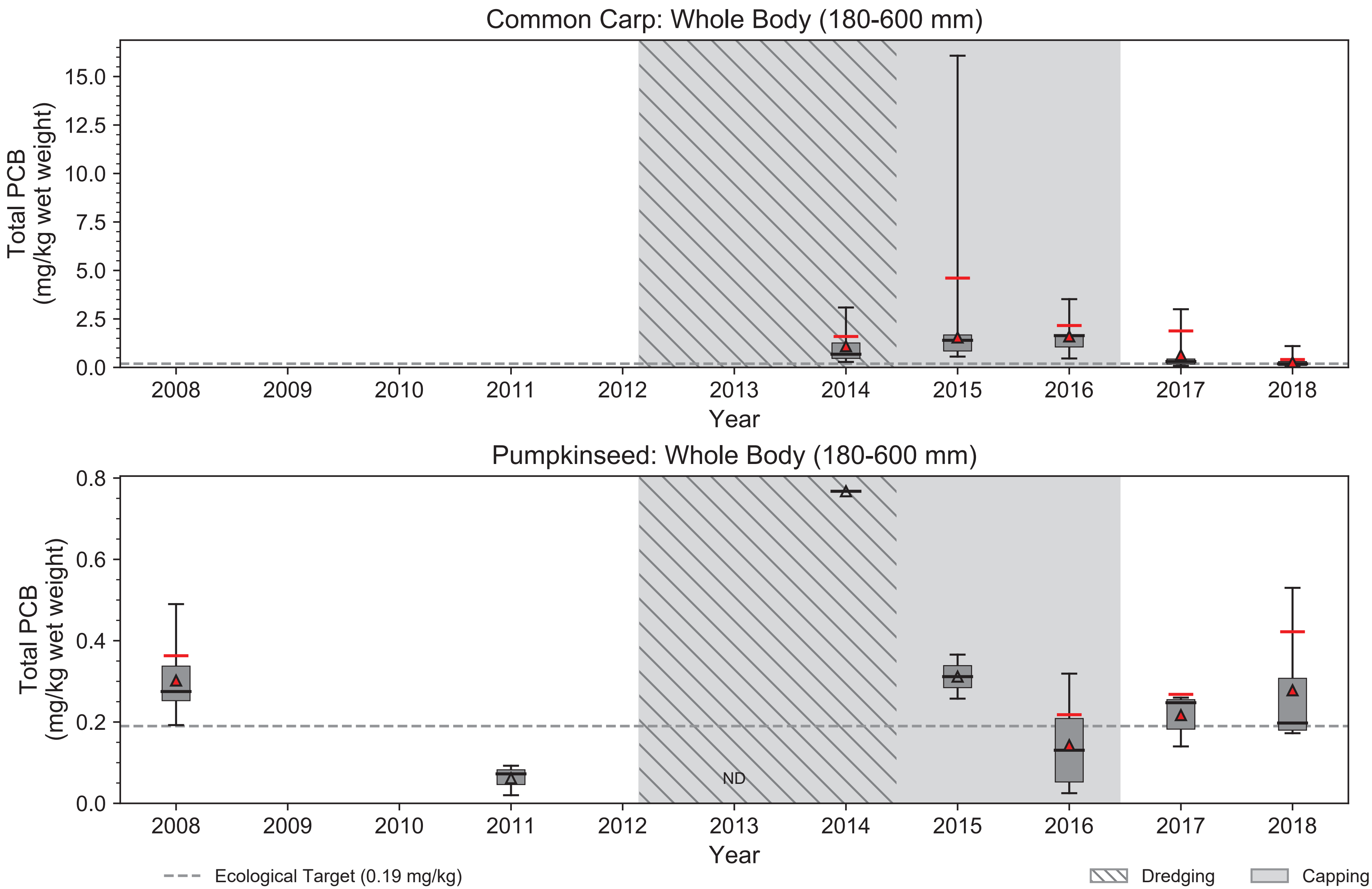
ANCHOR QEA



Set 3, Figure 5

Calculated Whole Body Total PCB Concentrations in Smallmouth Bass and Walleye

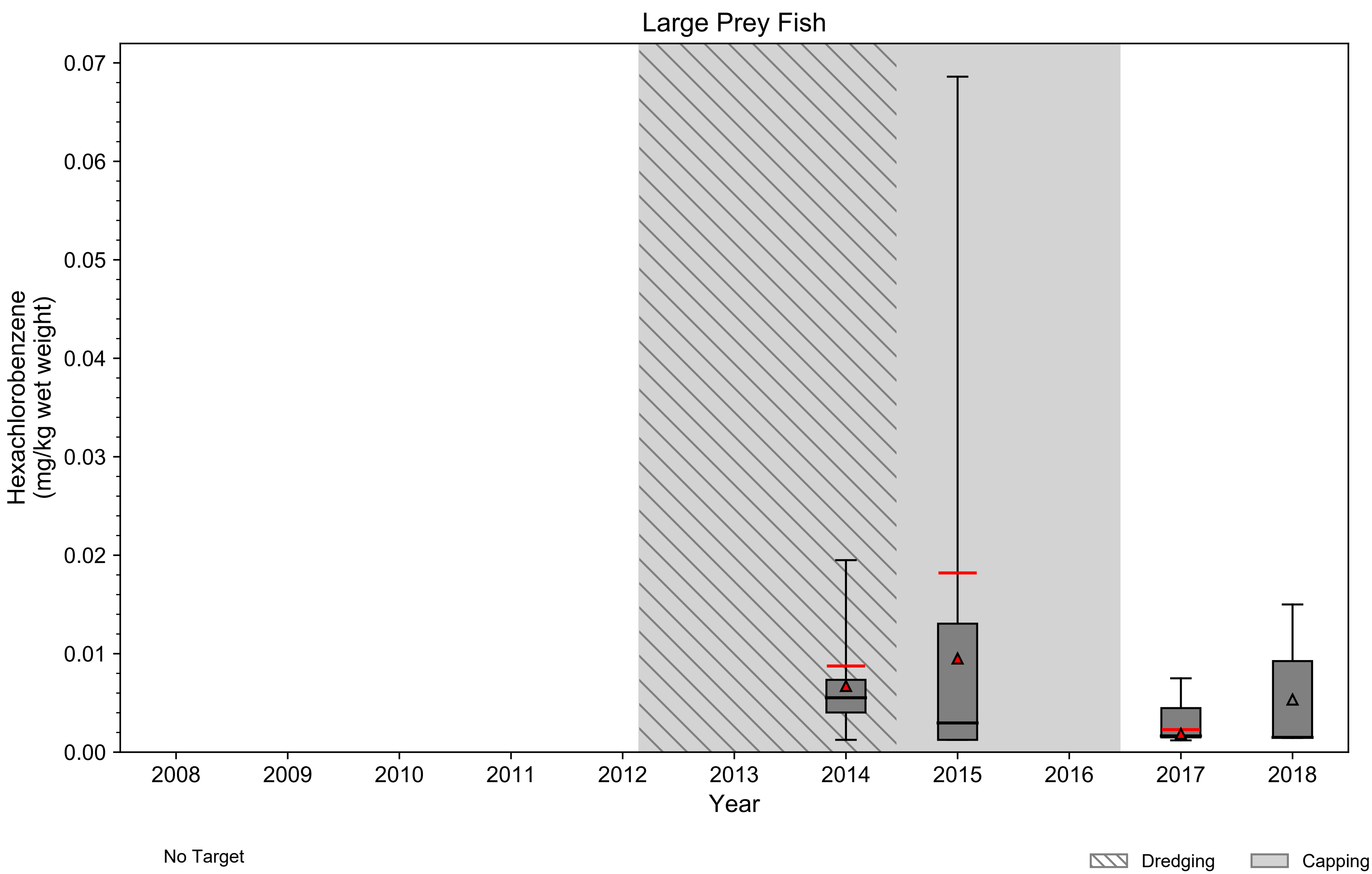
ANCHOR QEA



Set 3, Figure 6

Calculated Whole Body Total PCB Concentrations in Common Carp and Large Pumpkinseed

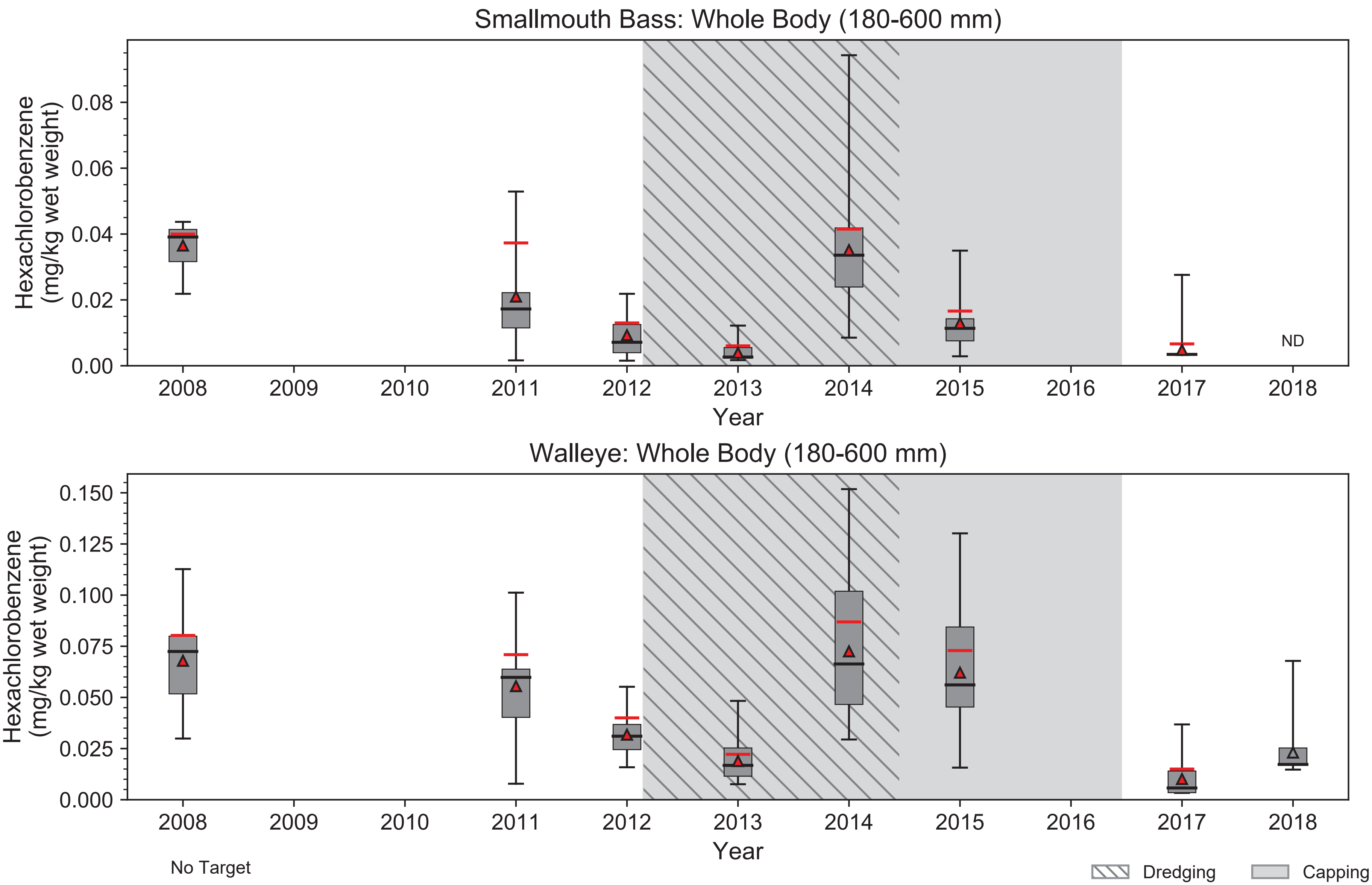
ANCHOR QEA



Set 3, Figure 7

Hexachlorobenzene Concentrations in Large Prey Fish (All SMUs)

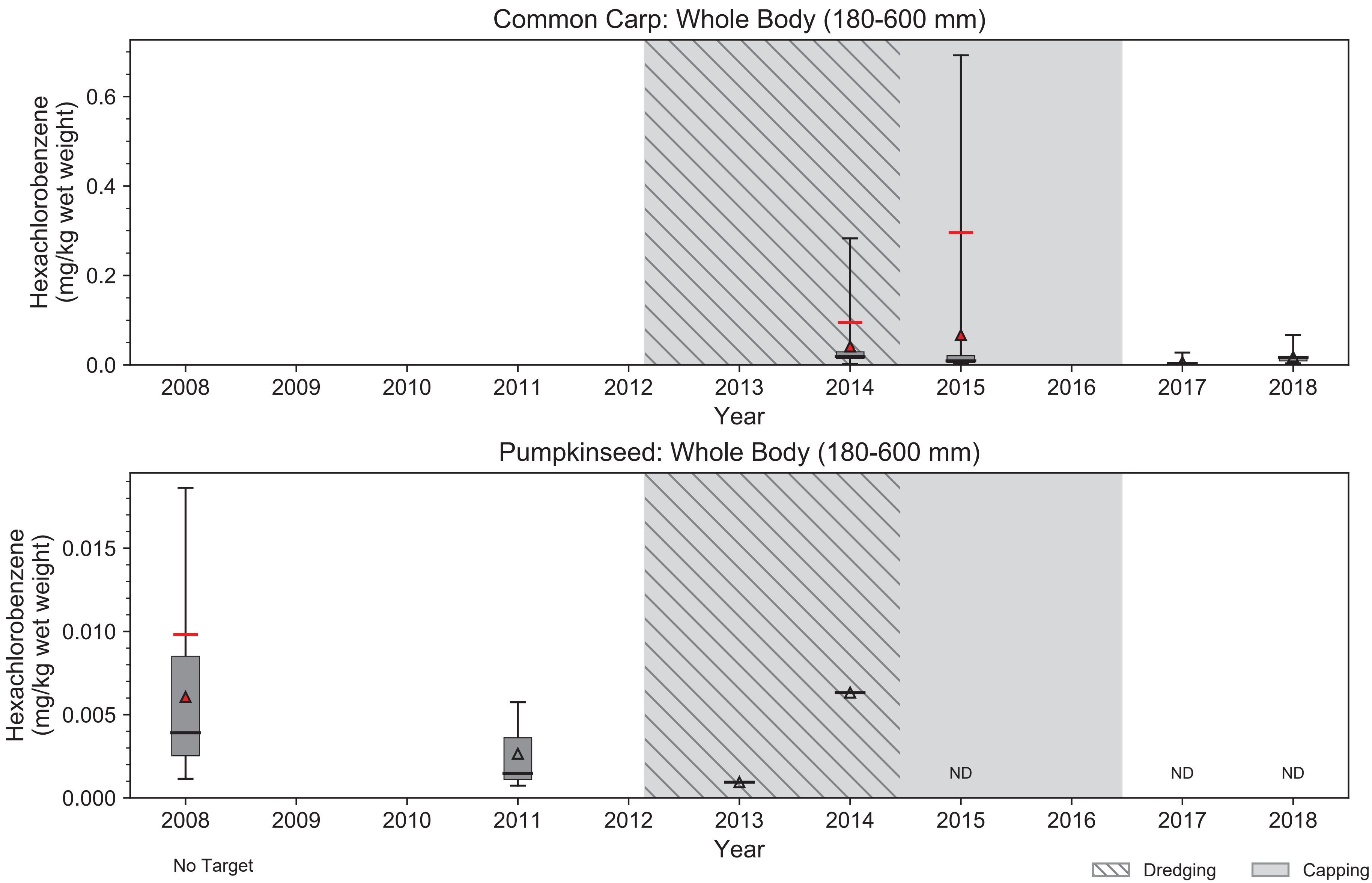
ANCHOR QEA



Set 3, Figure 8

Calculated Whole Body Hexachlorobenzene Concentrations in Smallmouth Bass and Walleye

ANCHOR QEA

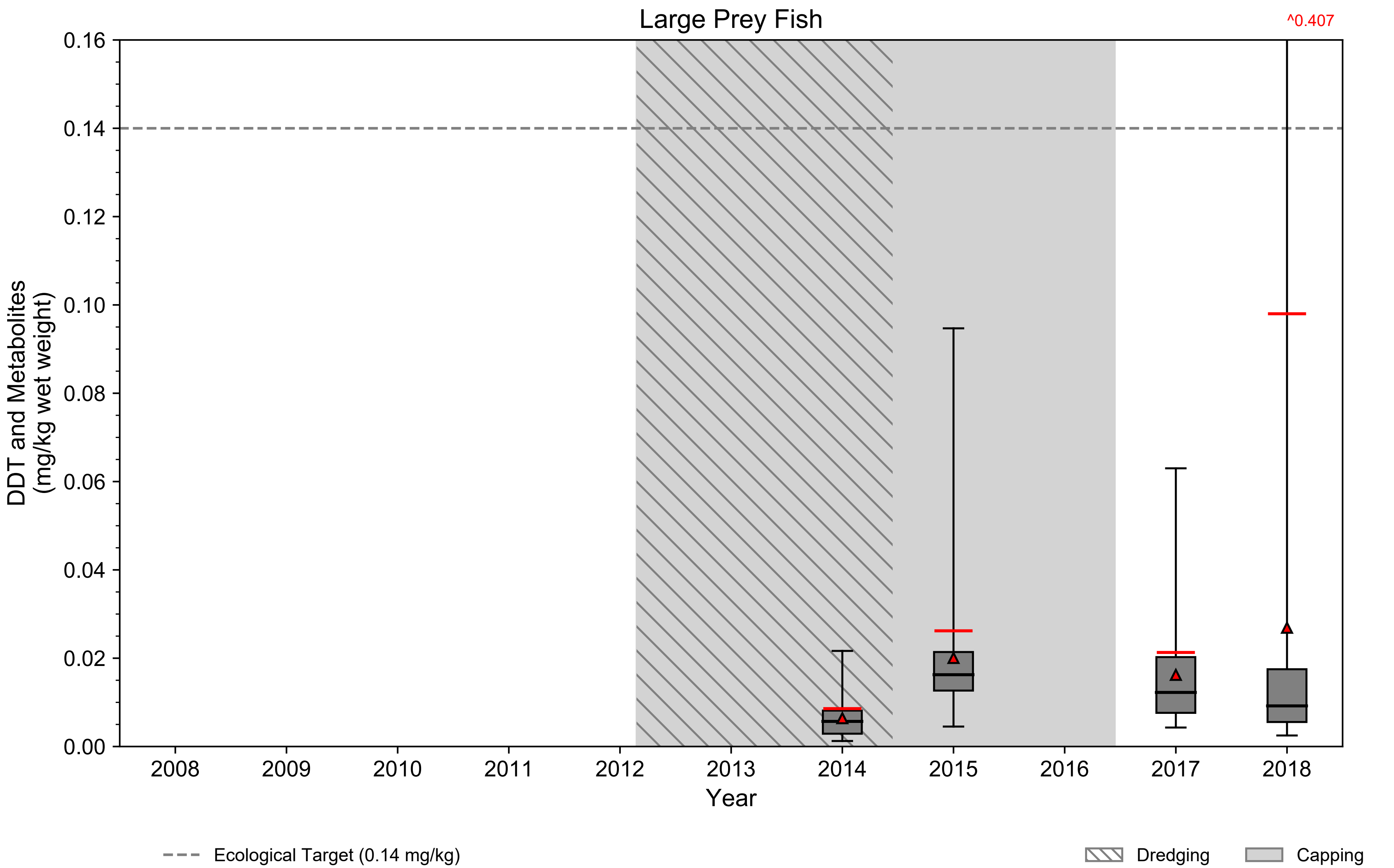


Set 3, Figure 9

Calculated Whole Body Hexachlorobenzene Concentrations in Common Carp and Large Pumpkinseed

ANCHOR QEA

BOSWKST3 - \\helios\AQ\Honeywell\Onondaga_Lake_OLMMS_(E60287)\ANALYSIS\FISH\2018_OMM\Python\2020_Final\temporal_sportfish_whole_body_or_fillet_20200402.py 9/10/2020 8:42:42



Set 3, Figure 10

DDT and Metabolites Concentrations in Large Prey Fish (All SMUs)

"^" indicates result value above axis range.
Preliminary Draft.

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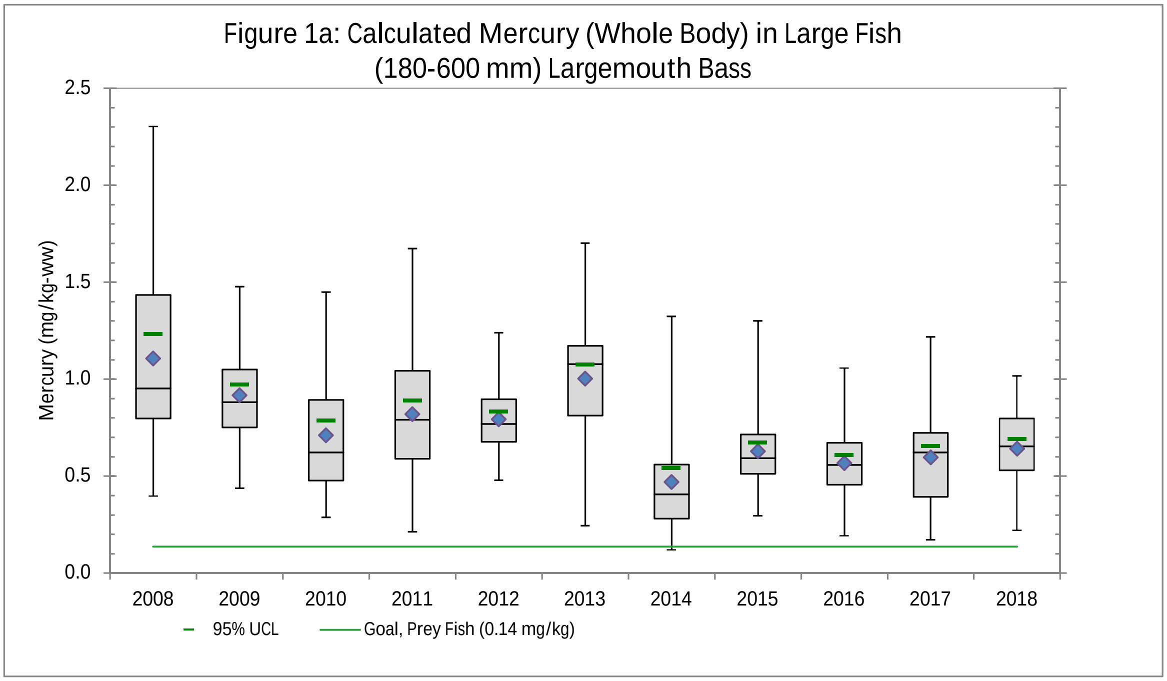
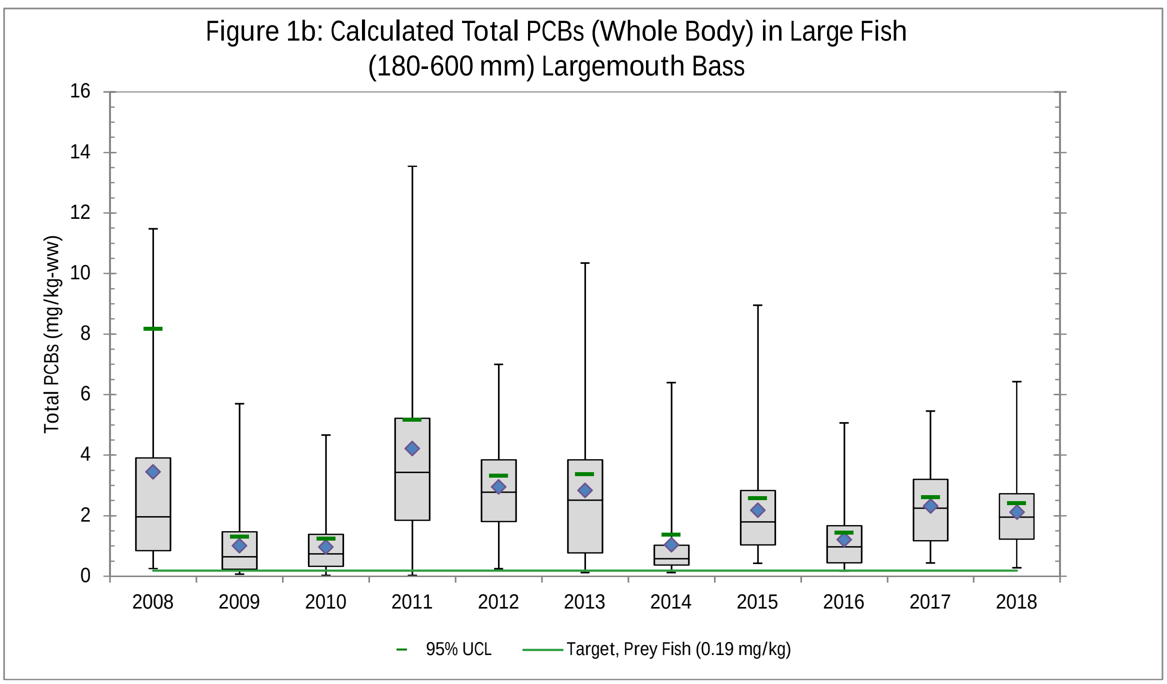
NYSDEC Set 3 Data (2008-2018)

September 2020

Set 3, DEC Figure 1

Large Prey Fish Calculated Concentrations - Largemouth Bass
Mercury and Total PCBs





Set 3, DEC Figure 2

Large Prey Fish Calculated Concentrations - Largemouth Bass
DDTs and Hexachlorobenzene

Figure 2a: Calculated DDTs (Whole Body) in Large Fish (180-600 mm) Largemouth Bass

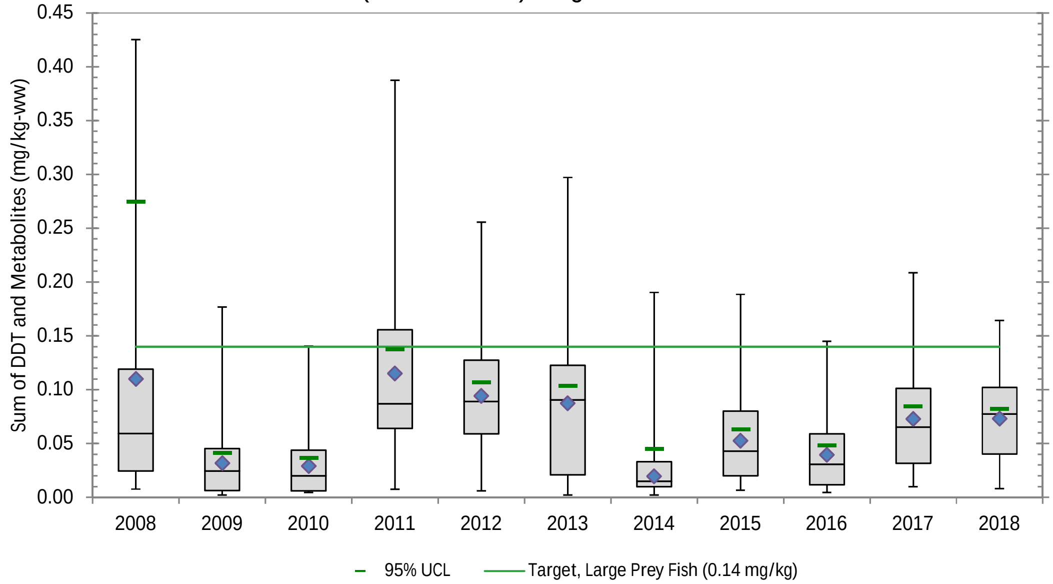
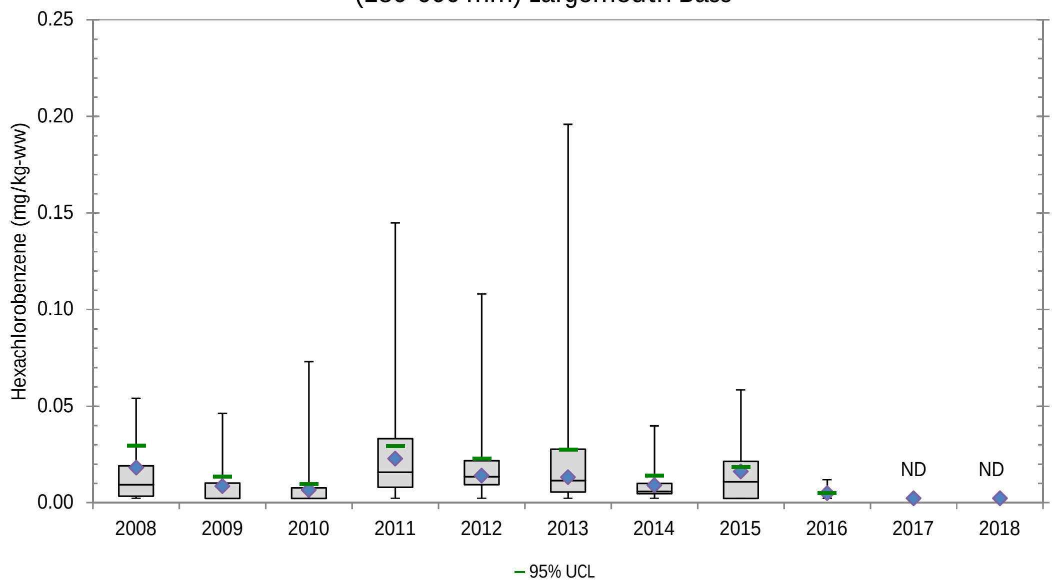
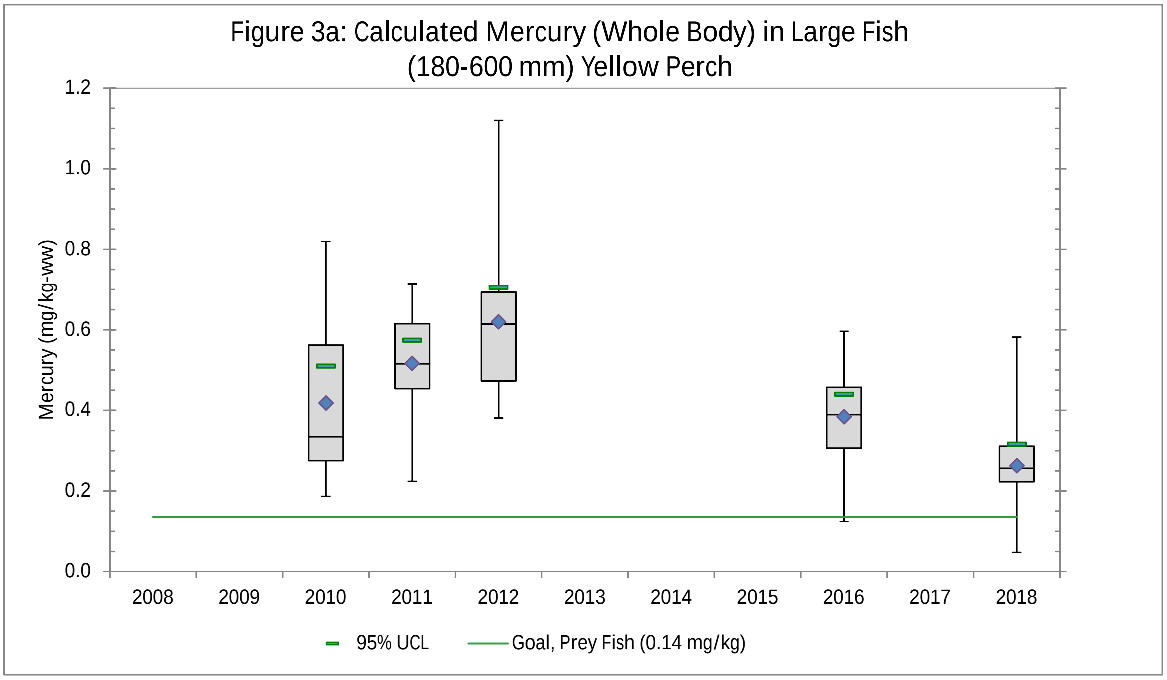


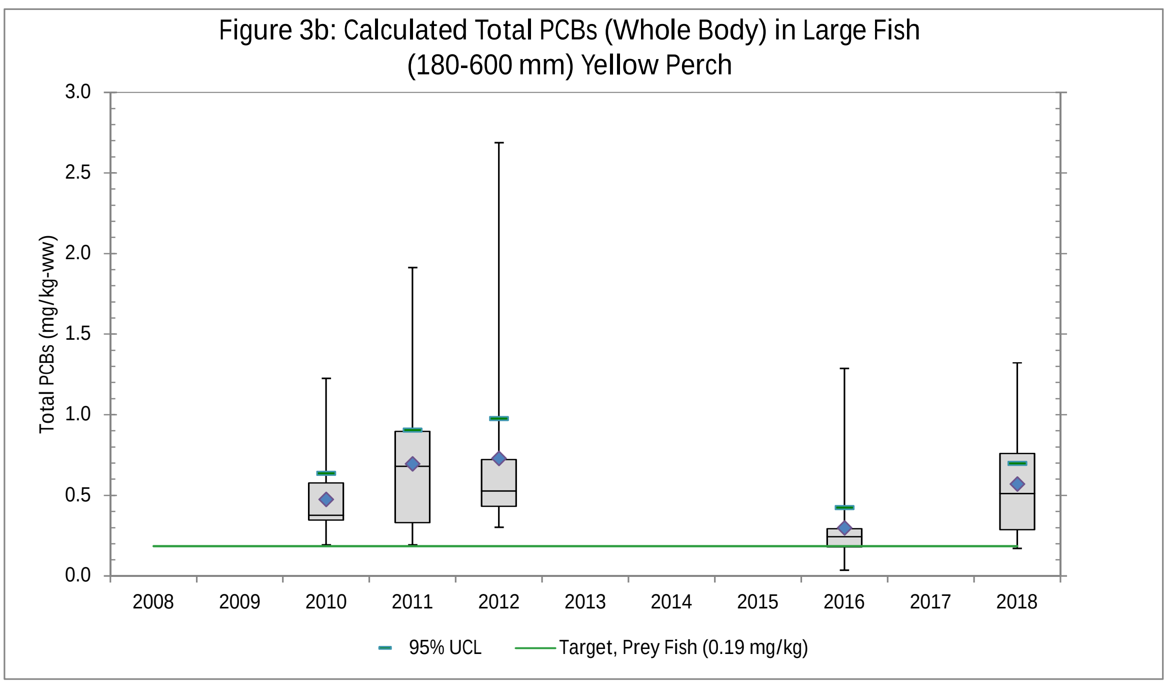
Figure 2b: Calculated Hexachlorobenzene (Whole Body) in Large Fish (180-600 mm) Largemouth Bass



Set 3, DEC Figure 3

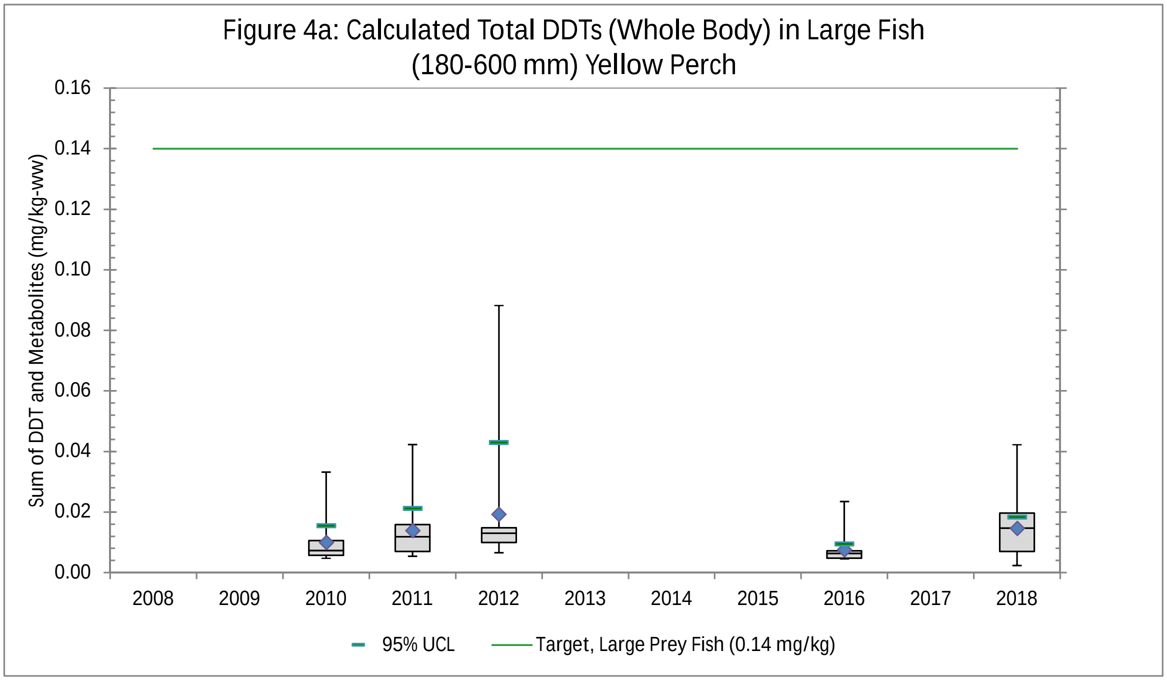
Large Prey Fish Calculated Concentrations - Yellow Perch
Mercury and Total PCBs

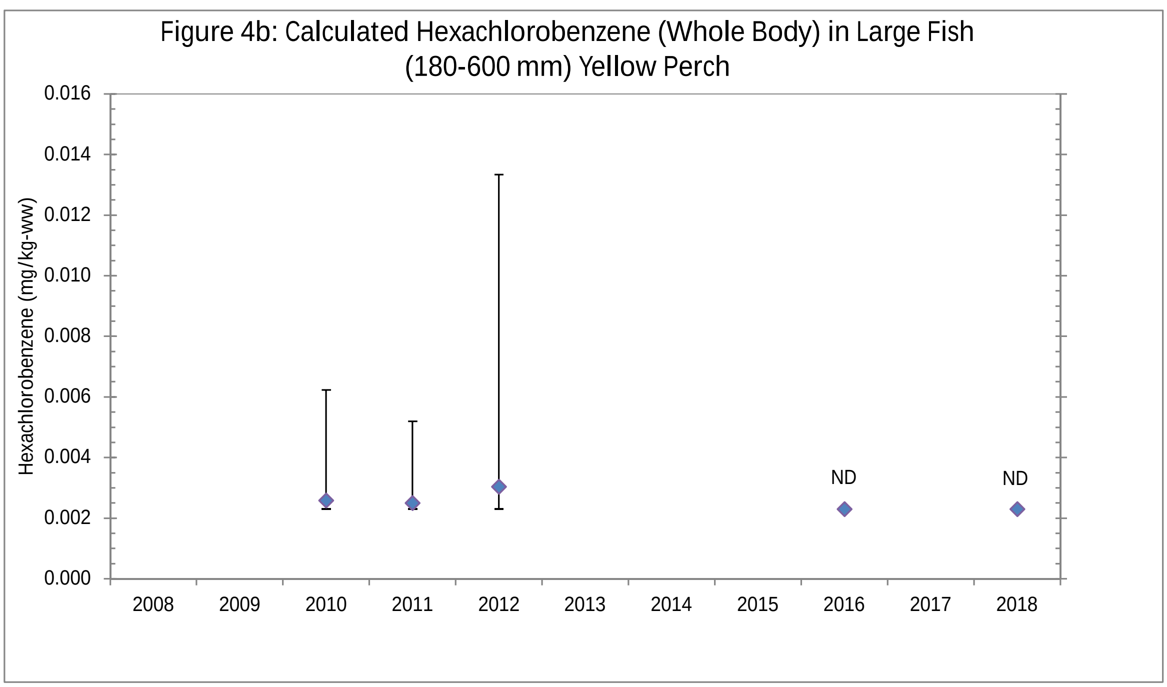




Set 3, DEC Figure 4

Large Prey Fish Calculated Concentrations - Yellow Perch
DDTs and Hexachlorobenzene

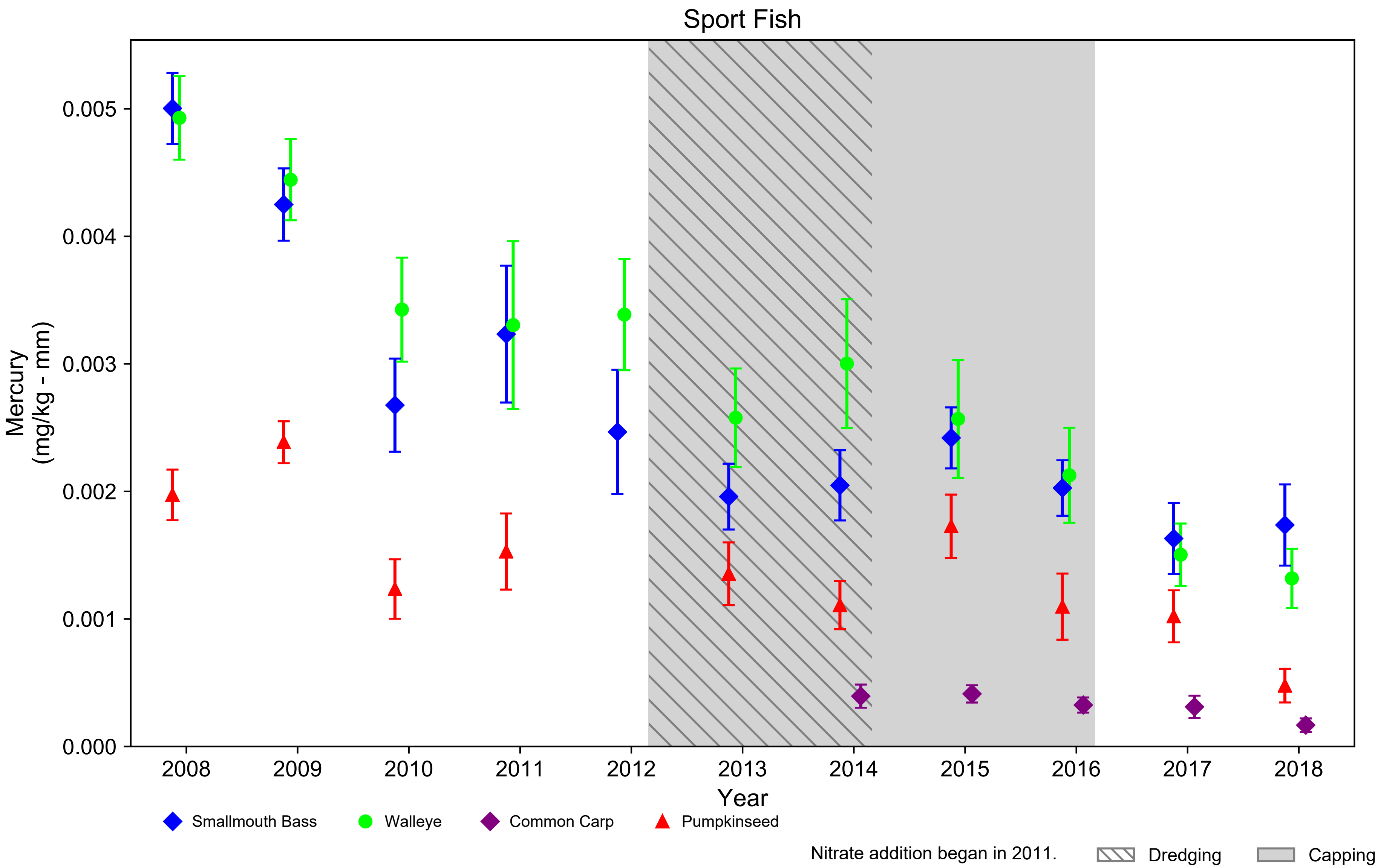




Set 4:
Additional Reporting to Assess Potential Impacts of Remediation

Honeywell Set 4 Data (2008-2018)

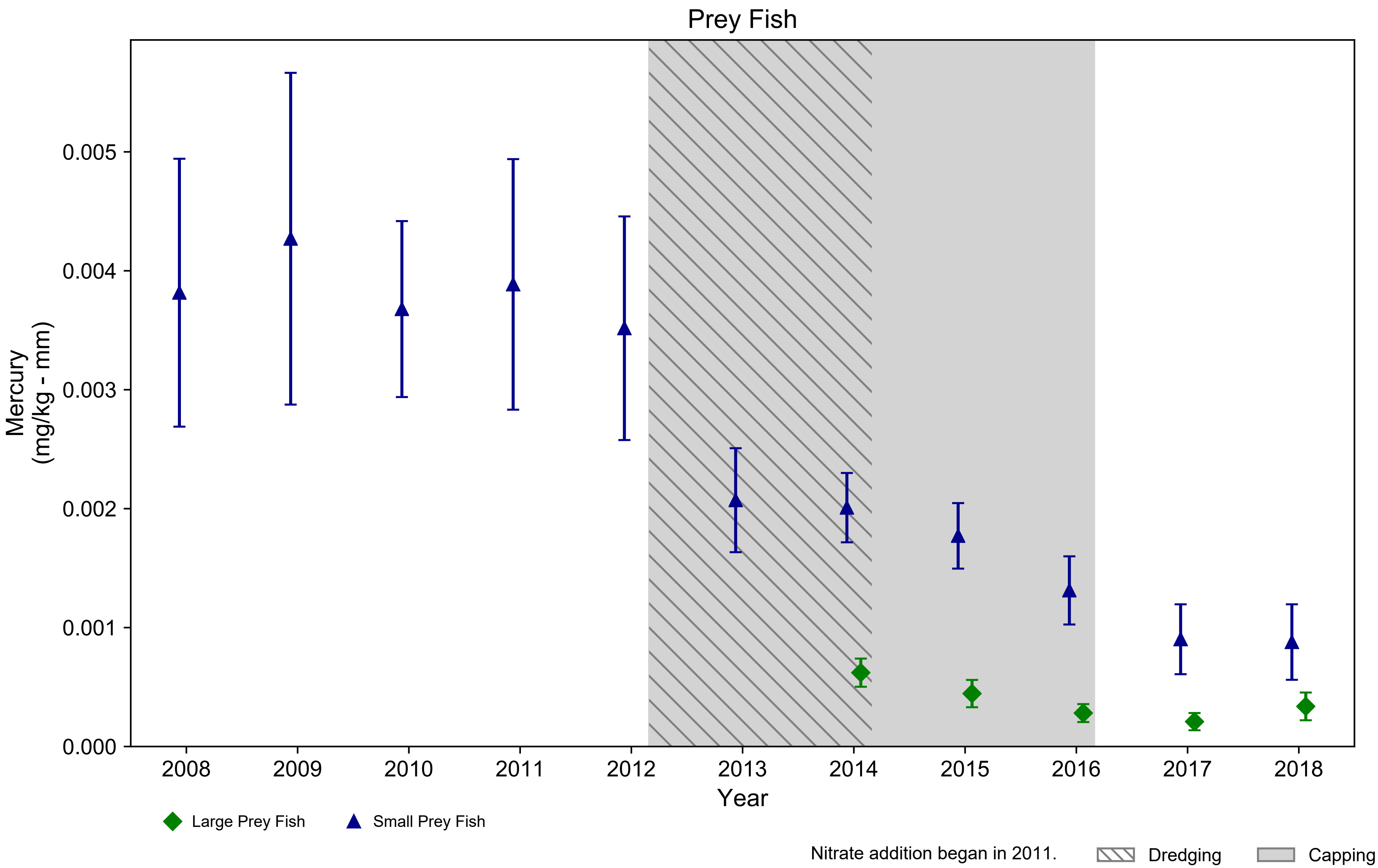
September 2020



Set 4, Subset 1, Figure 1

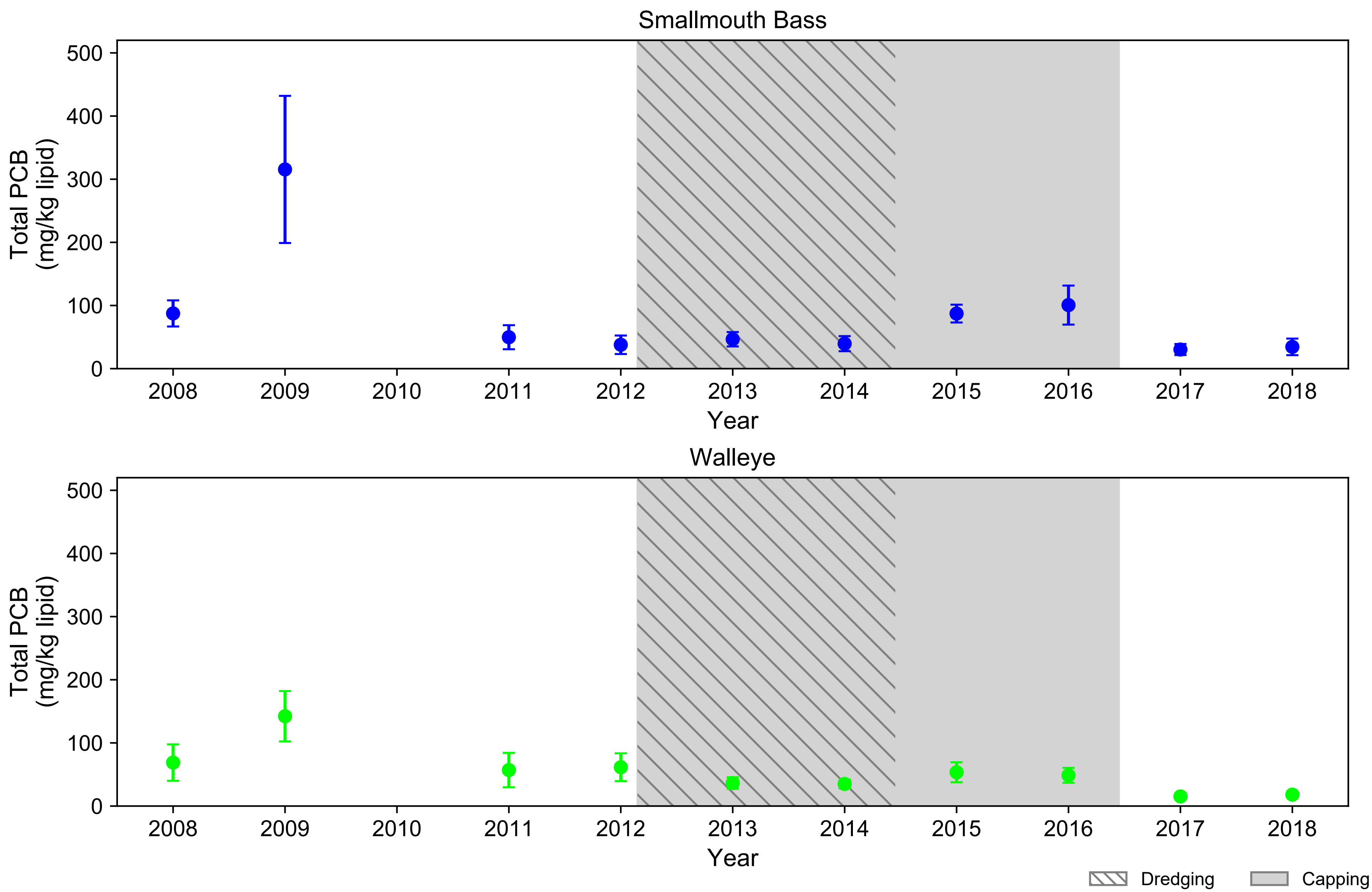
Length-Normalized Mercury Concentrations in Sport Fish

ANCHOR QEA



Set 4, Subset 1, Figure 2

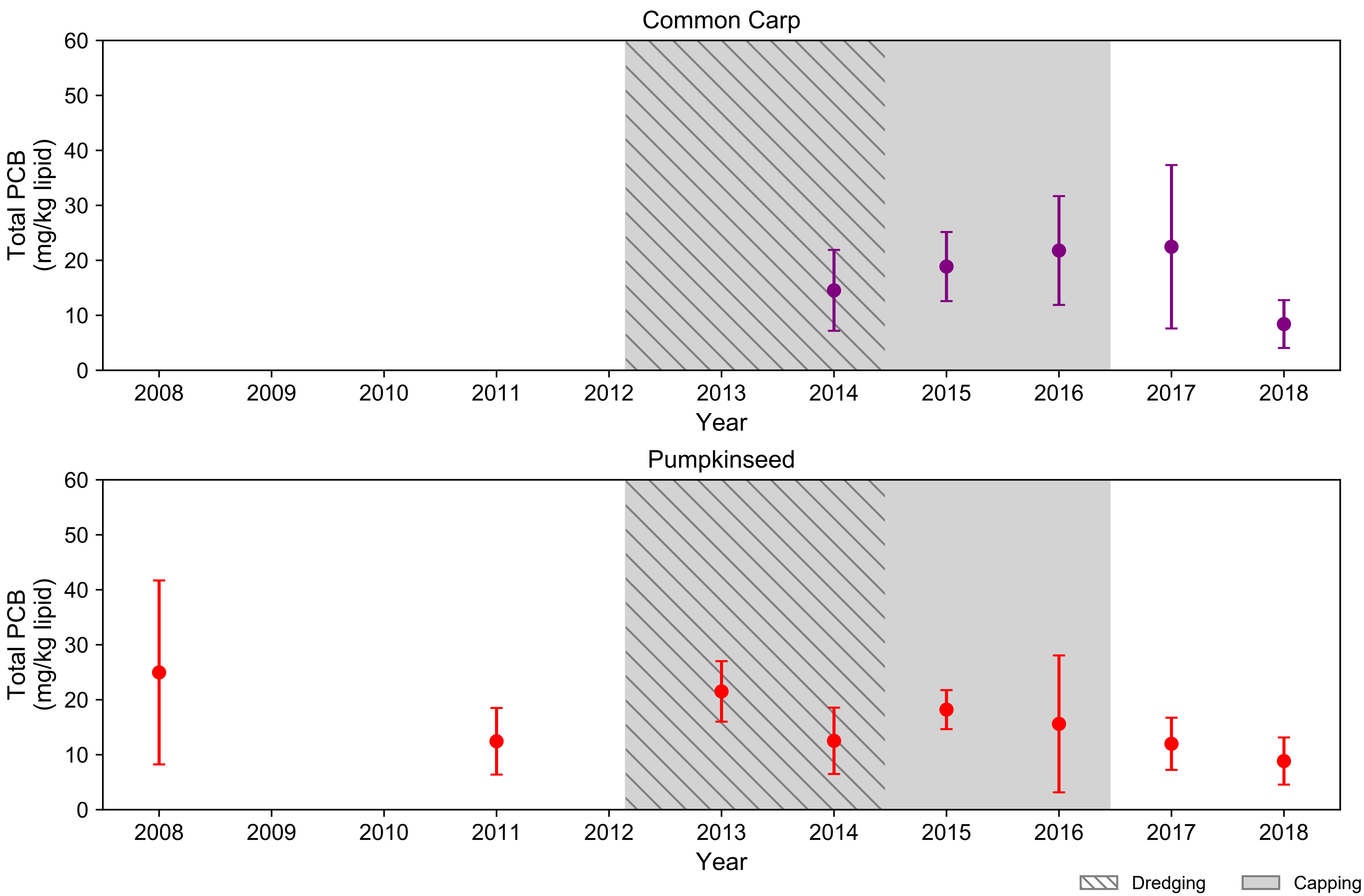
Length-Normalized Mercury Concentrations in Prey Fish (All SMUs)



Set 4, Subset 1, Figure 3

Lipid-Normalized Total PCB Concentrations in Smallmouth Bass and Walleye

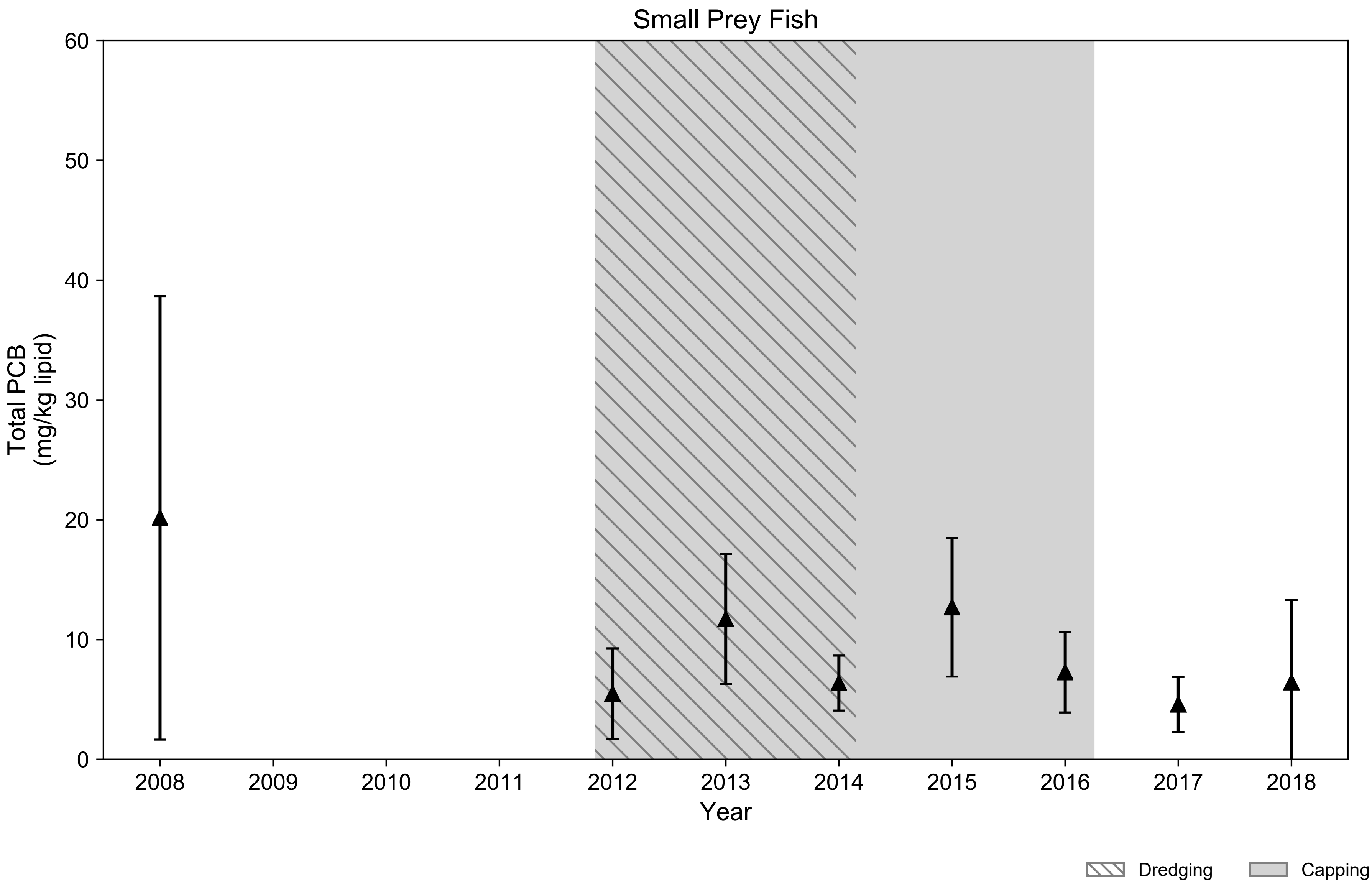
ANCHOR QEA



Set 4, Subset 1, Figure 4

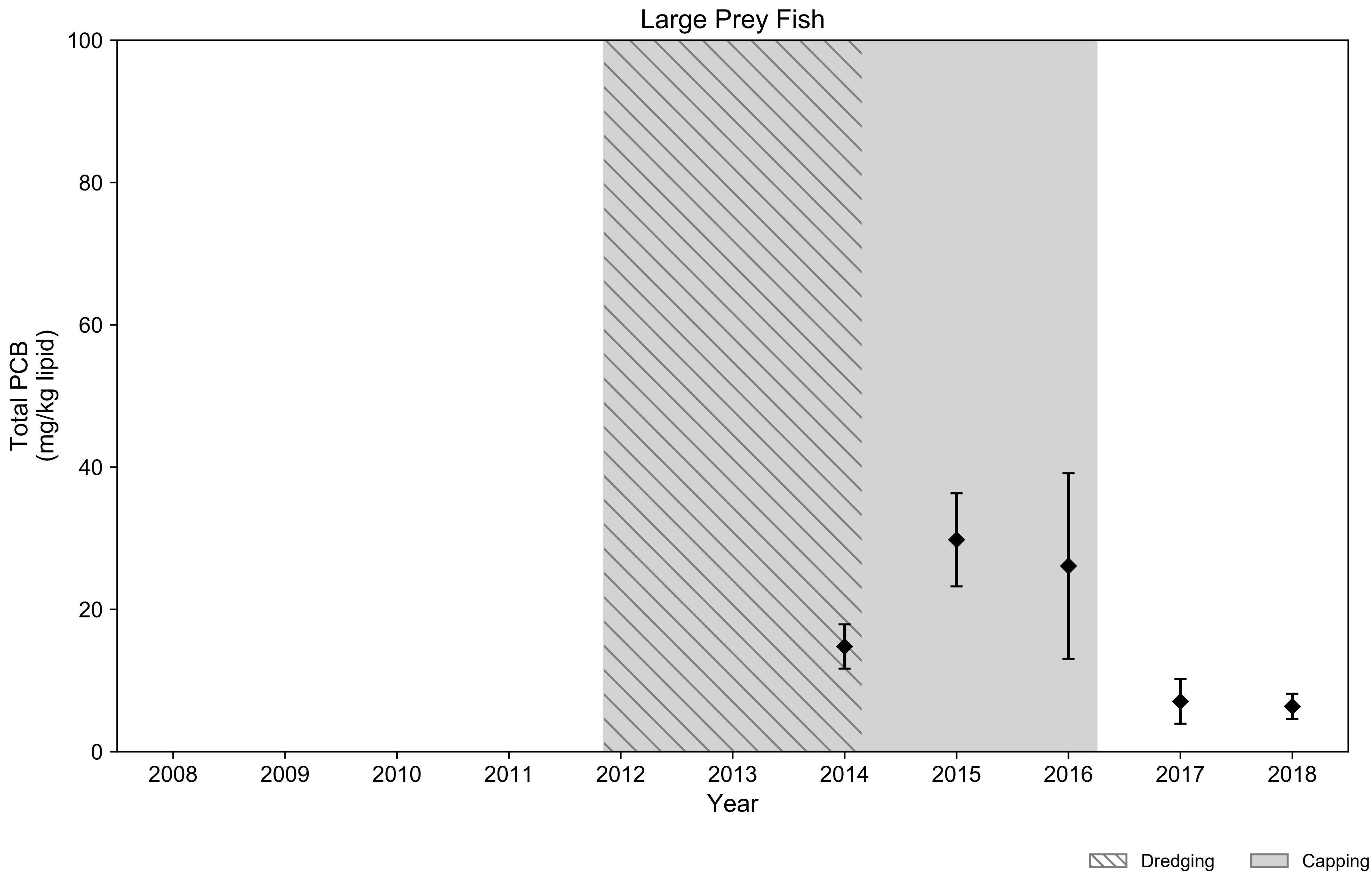
Lipid-Normalized Total PCB Concentrations in Common Carp and Pumpkinseed

ANCHOR QEA



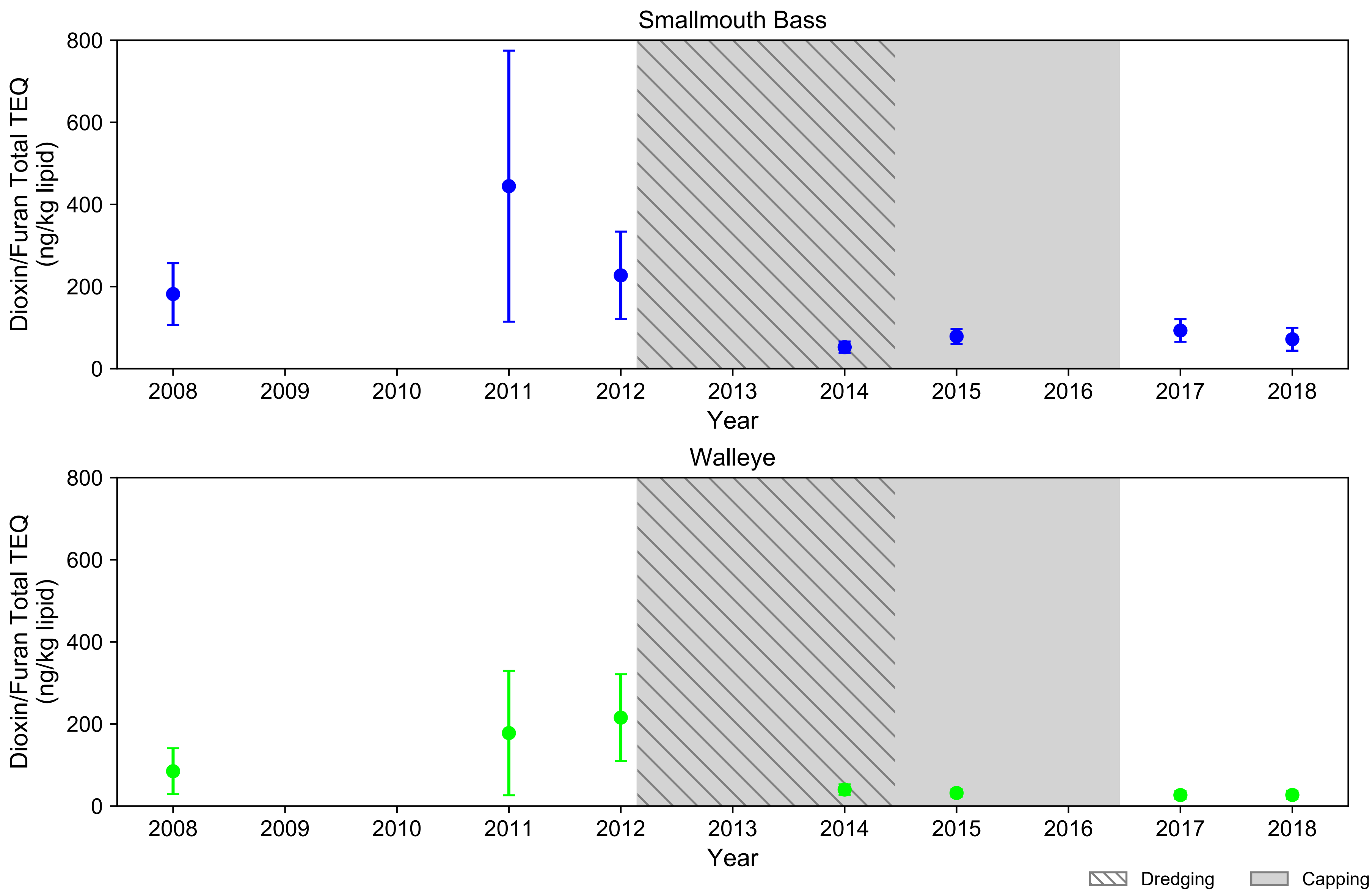
Set 4, Subset 1, Figure 5
Lipid-Normalized Total PCB Concentrations in Small Prey Fish (All SMUs)

ANCHOR QEA



Set 4, Subset 1, Figure 6

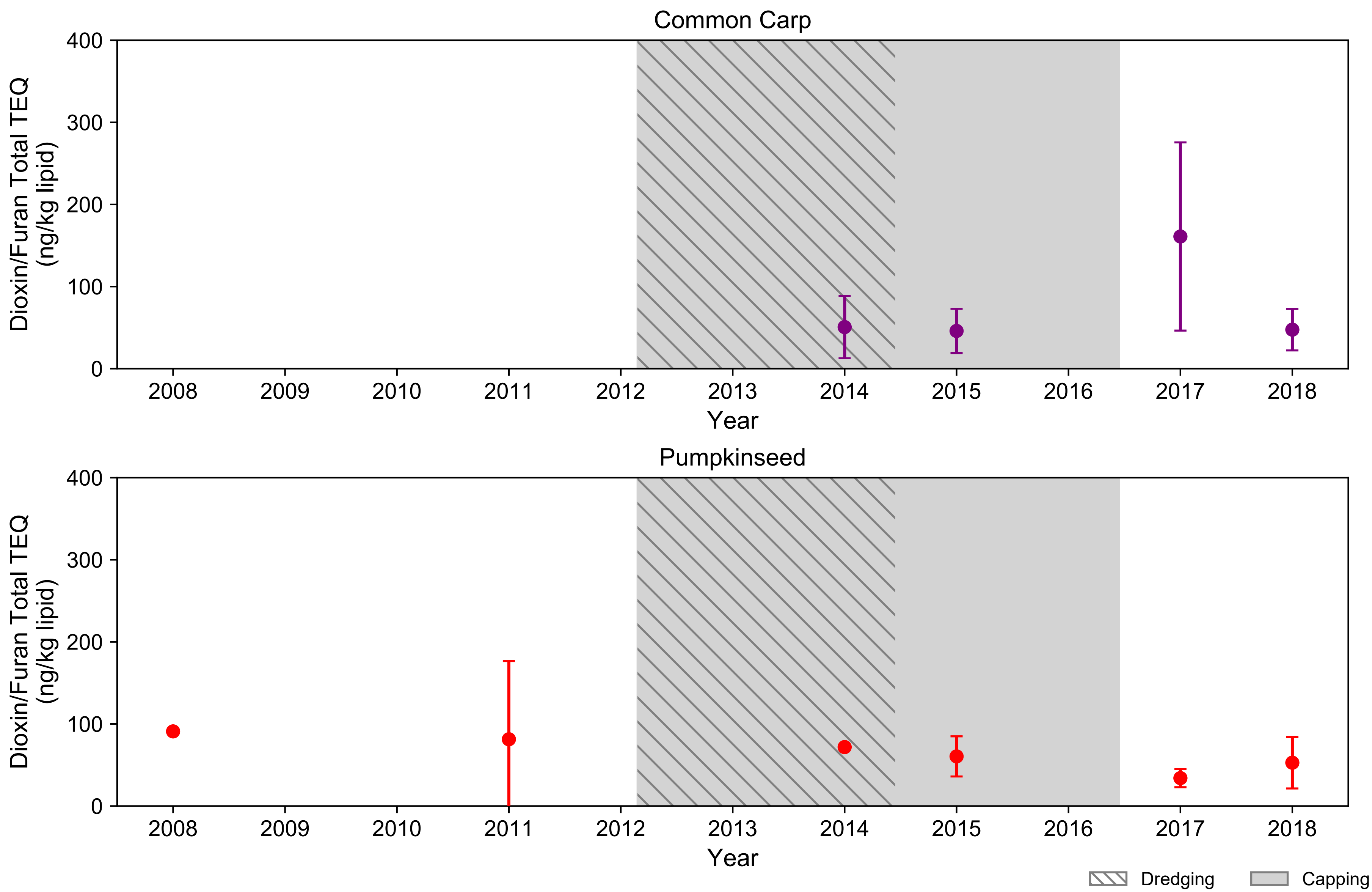
Lipid-Normalized Total PCB Concentrations in Large Prey Fish (All SMUs)



Set 4, Subset 1, Figure 7

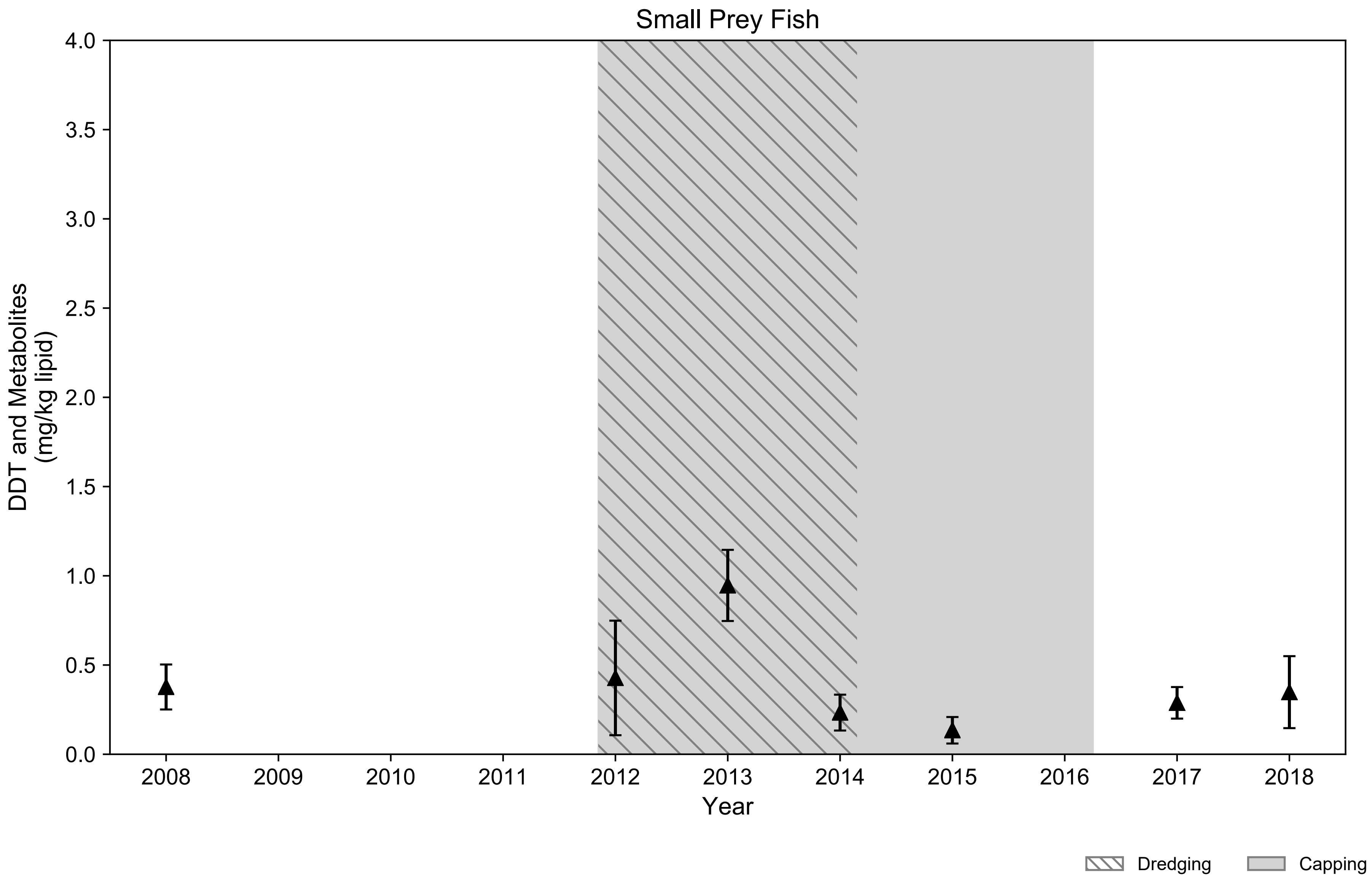
Lipid-Normalized Dioxin/Furan Total TEQ Concentrations in Smallmouth Bass and Walleye

SYR-SCOL - \\Helios\AQ\D_Drive\Projects\Honeywell\Onondaga_Lake_OLMMS_(E60287)\ANALYSIS\FISH\2018_OMM\Python\Feb_2020_Comments\temporal_sportfish_organics_LipidNorm.py 2/20/2020 14:15:0



Set 4, Subset 1, Figure 8

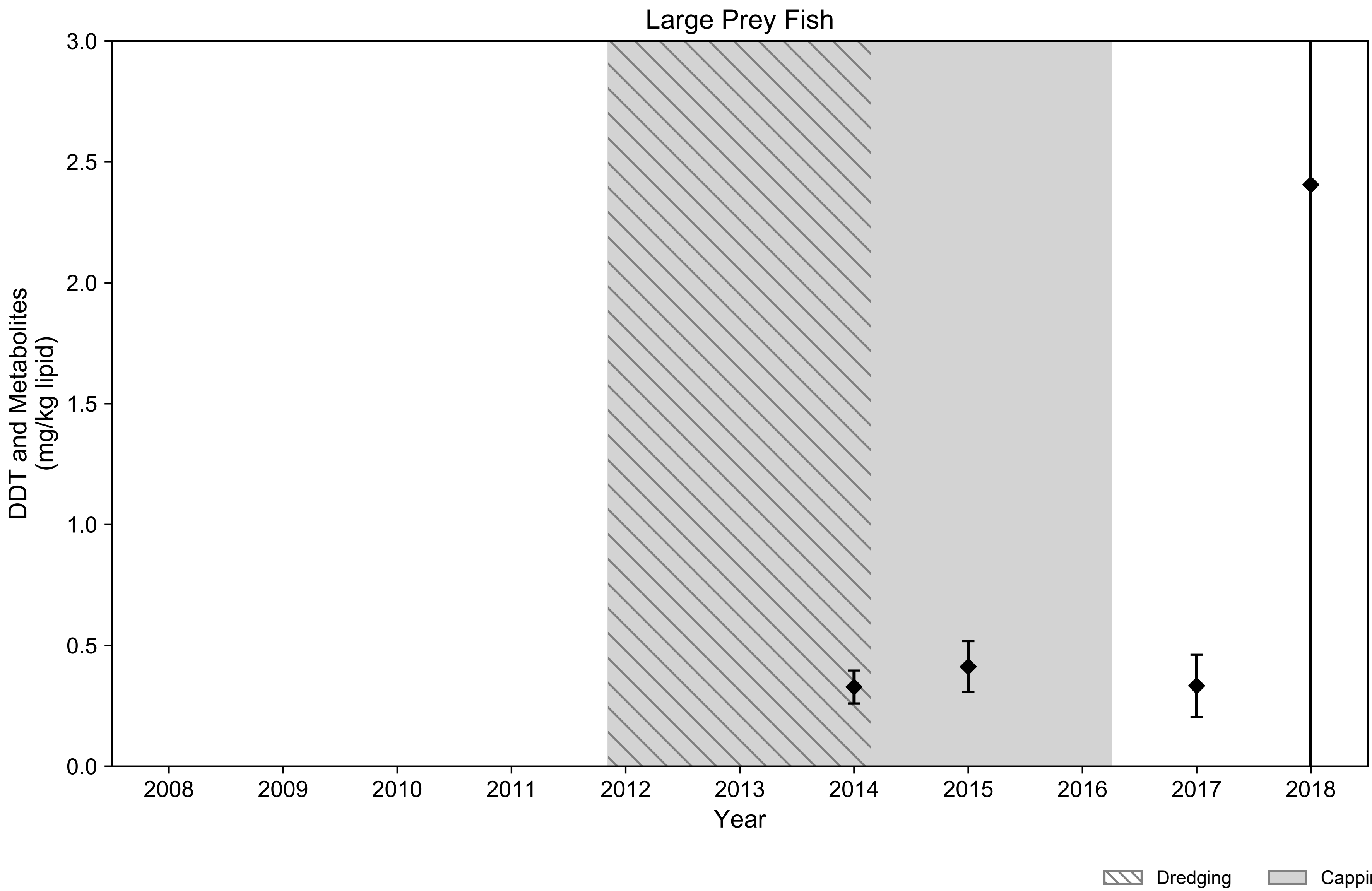
Lipid-Normalized Dioxin/Furan Total TEQ Concentrations in Common Carp and Pumpkinseed



Set 4, Subset 1, Figure 9

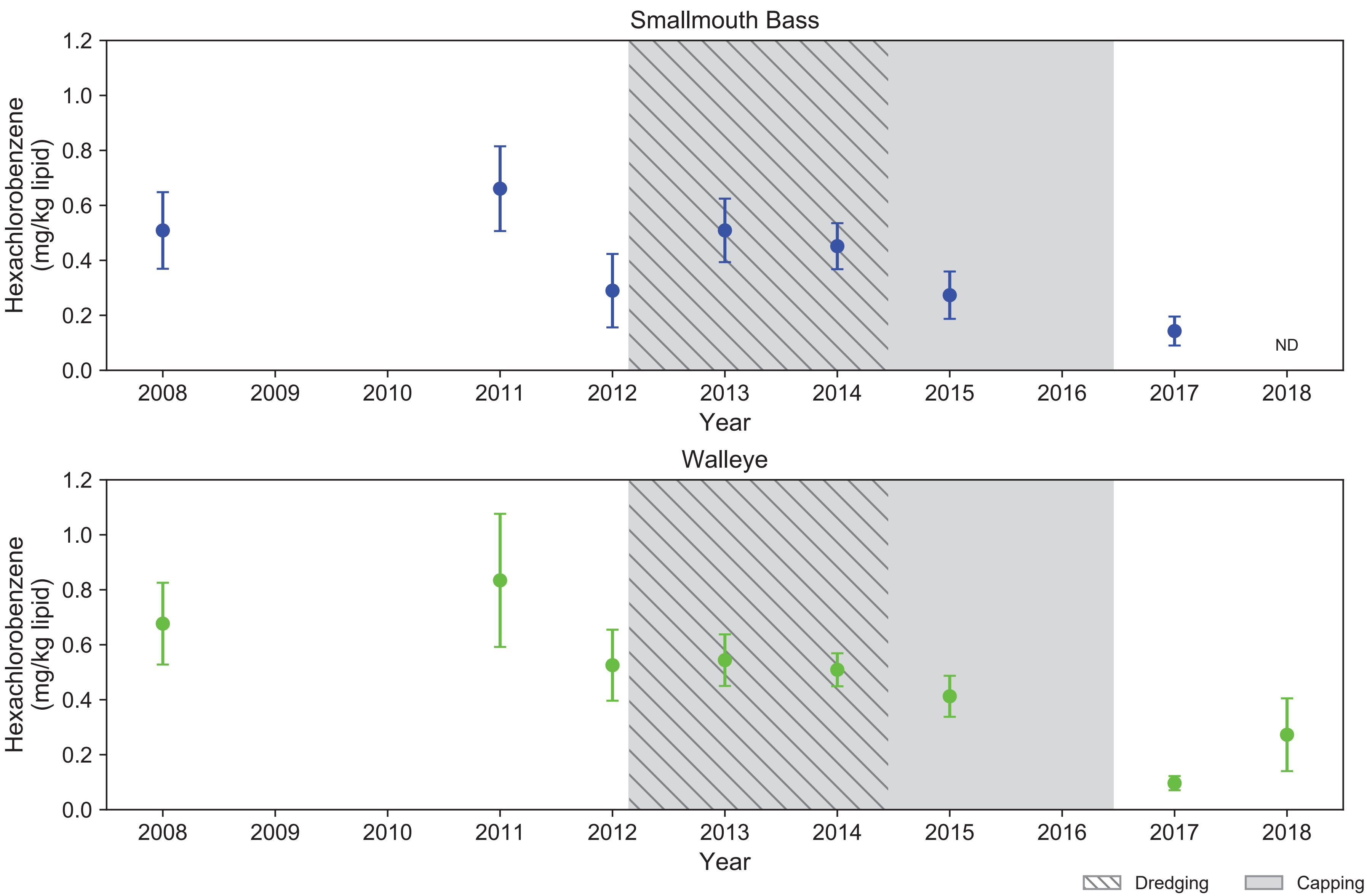
Lipid-Normalized DDT and Metabolites Concentrations in Small Prey Fish (All SMUs)

ANCHOR QEA



Set 4, Subset 1, Figure 10
Lipid-Normalized DDT and Metabolites Concentrations in Large Prey Fish (All SMUs)

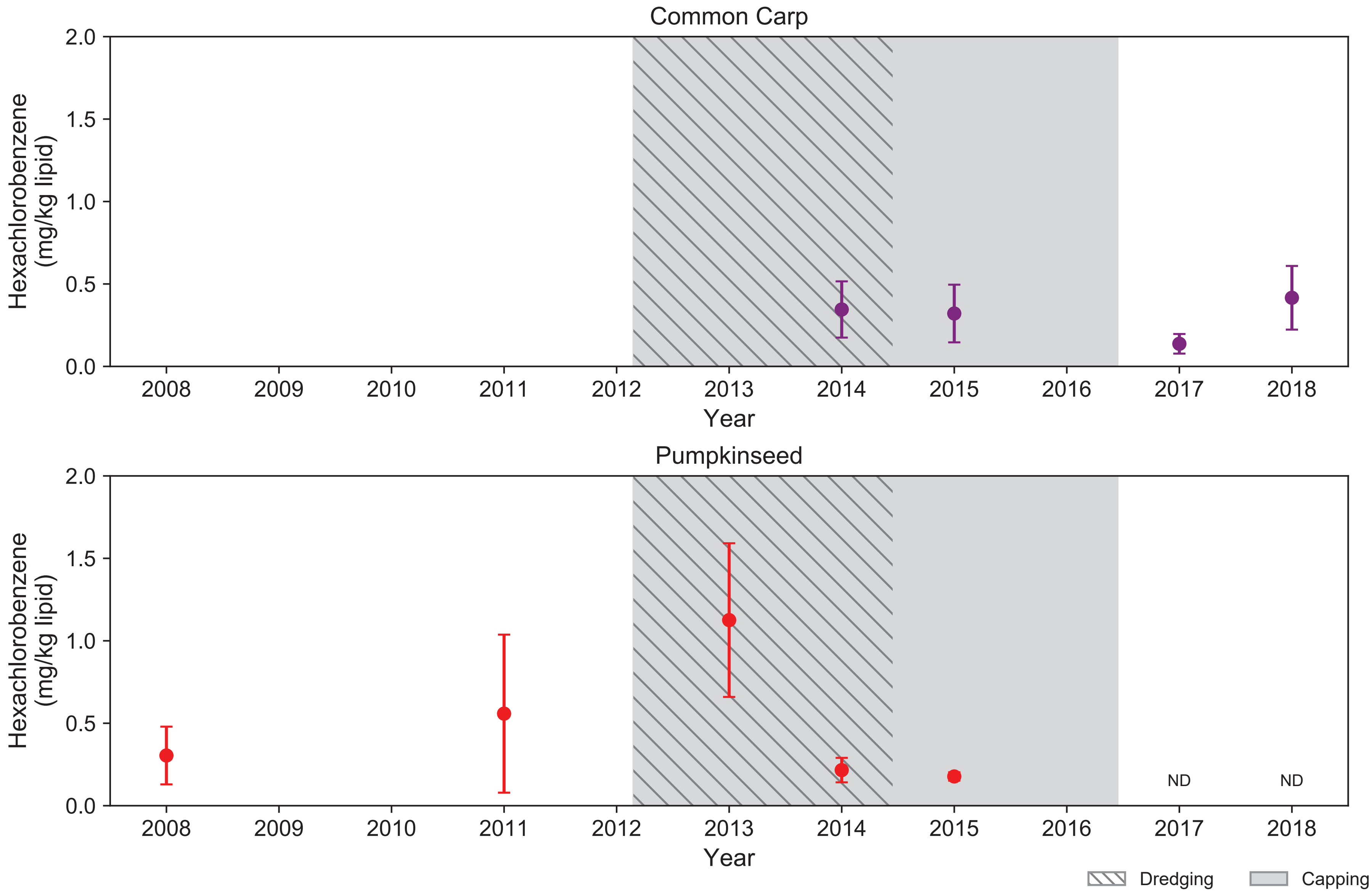
ANCHOR QEA



Set 4, Subset 1, Figure 11

Lipid-Normalized Hexachlorobenzene Concentrations in Smallmouth Bass and Walleye

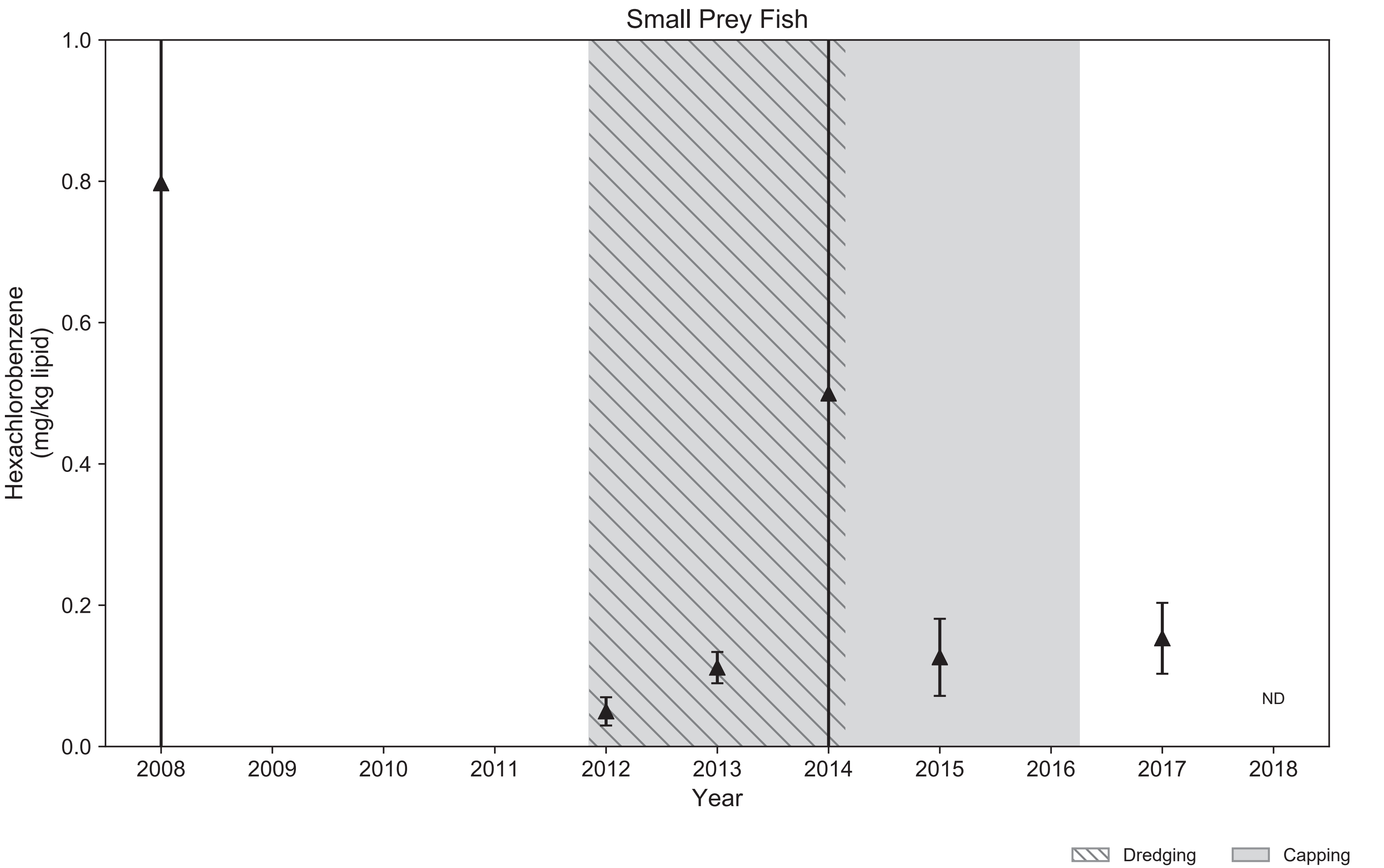
ANCHOR QEA



Set 4, Subset 1, Figure 12

Lipid-Normalized Hexachlorobenzene Concentrations in Common Carp and Pumpkinseed

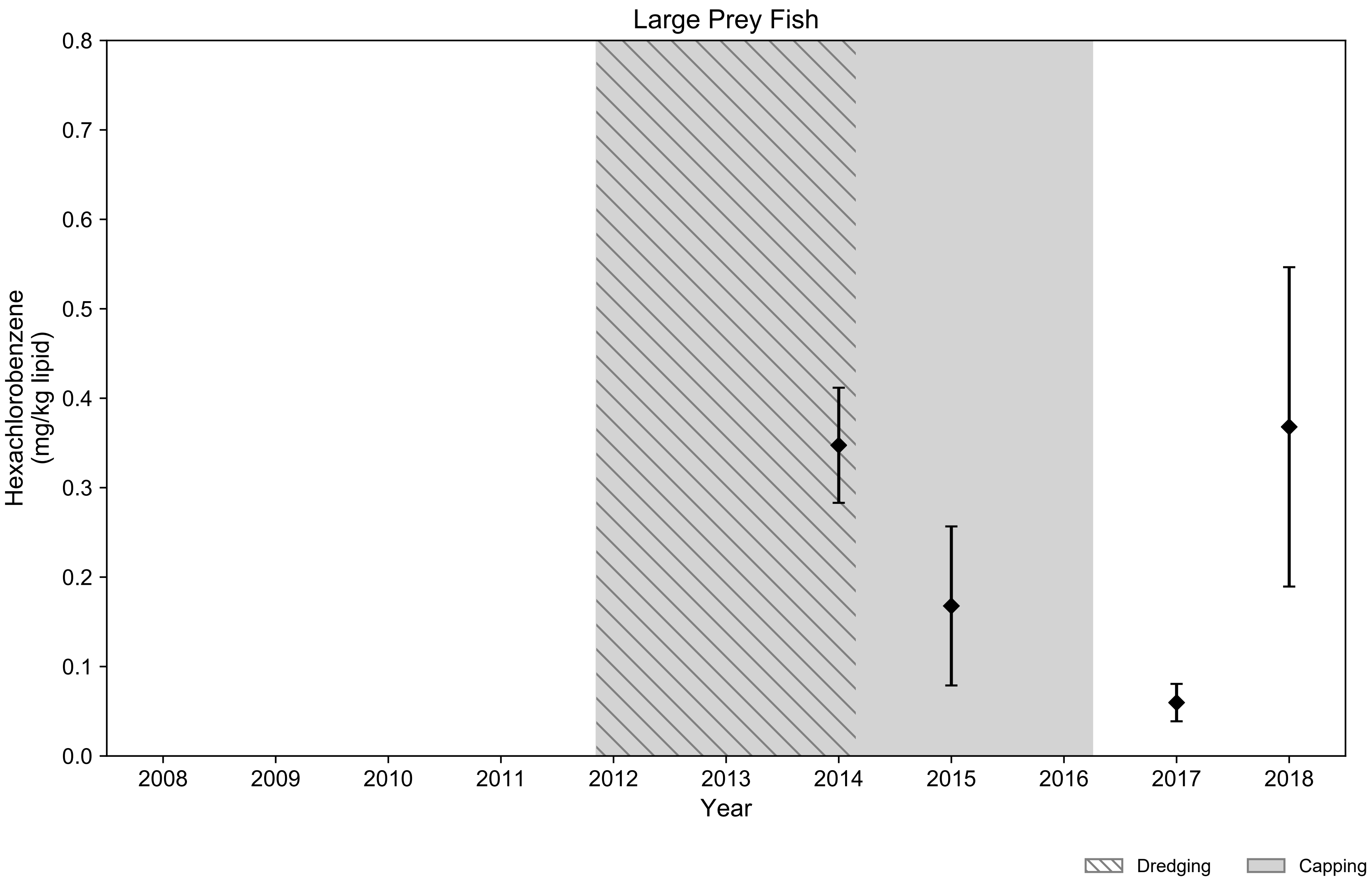
ANCHOR QEA



Set 4, Subset 1, Figure 13

Lipid-Normalized Hexachlorobenzene Concentrations in Small Prey Fish (All SMUs)

ANCHOR QEA

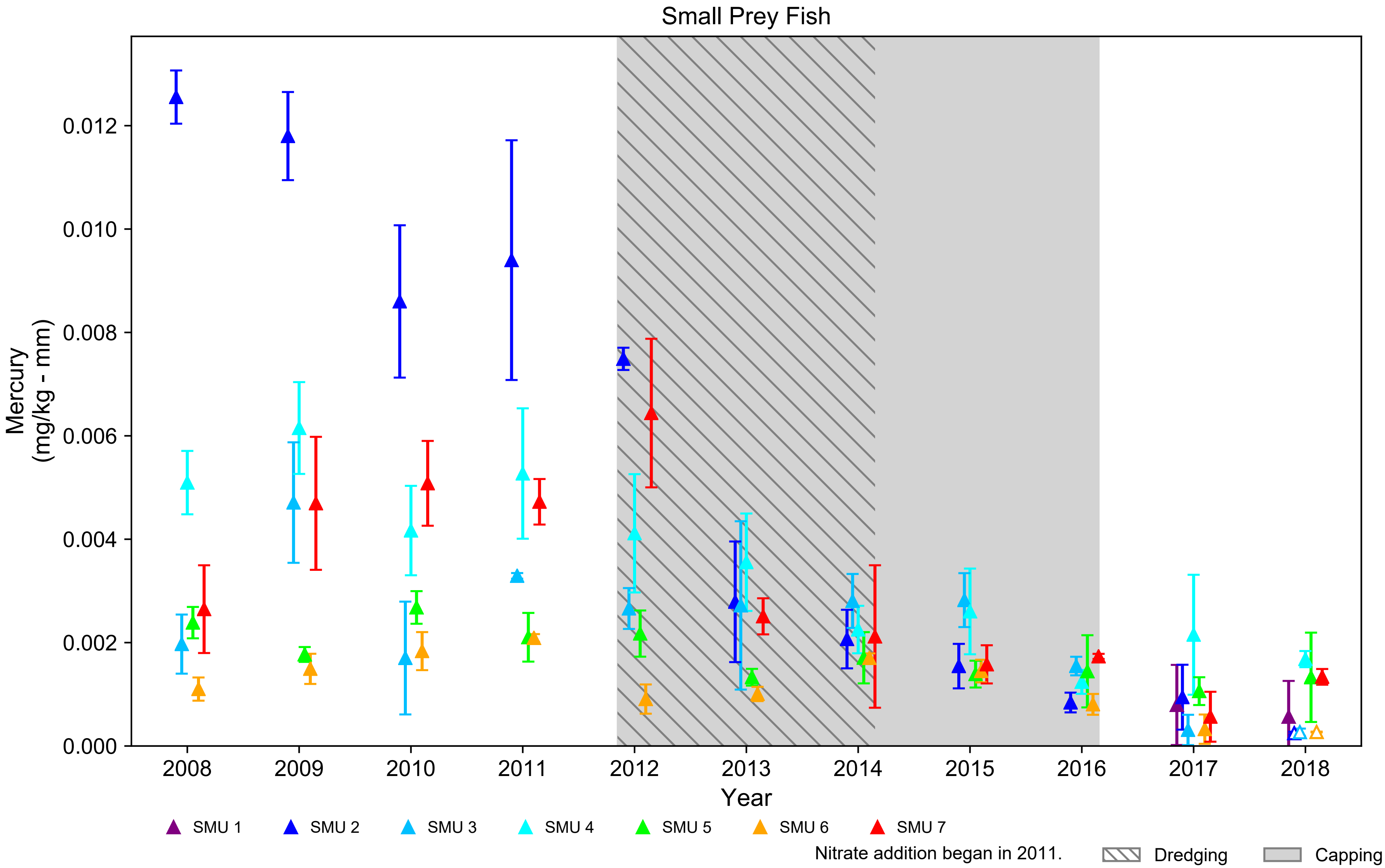


Set 4, Subset 1, Figure 14

Lipid-Normalized Hexachlorobenzene Concentrations in Large Prey Fish (All SMUs)

ANCHOR QEA

SYR-SCOL - \\Helios\AQ\D_Drive\Projects\Honeywell\Onondaga_Lake_OLMMS_(E60287)\ANALYSIS\FISH\2018_OMM\Python\Feb_2020_Comments\errbar_preyfish_lipid_ww_bySMU_allSMU.py 2/20/2020 14:27:29

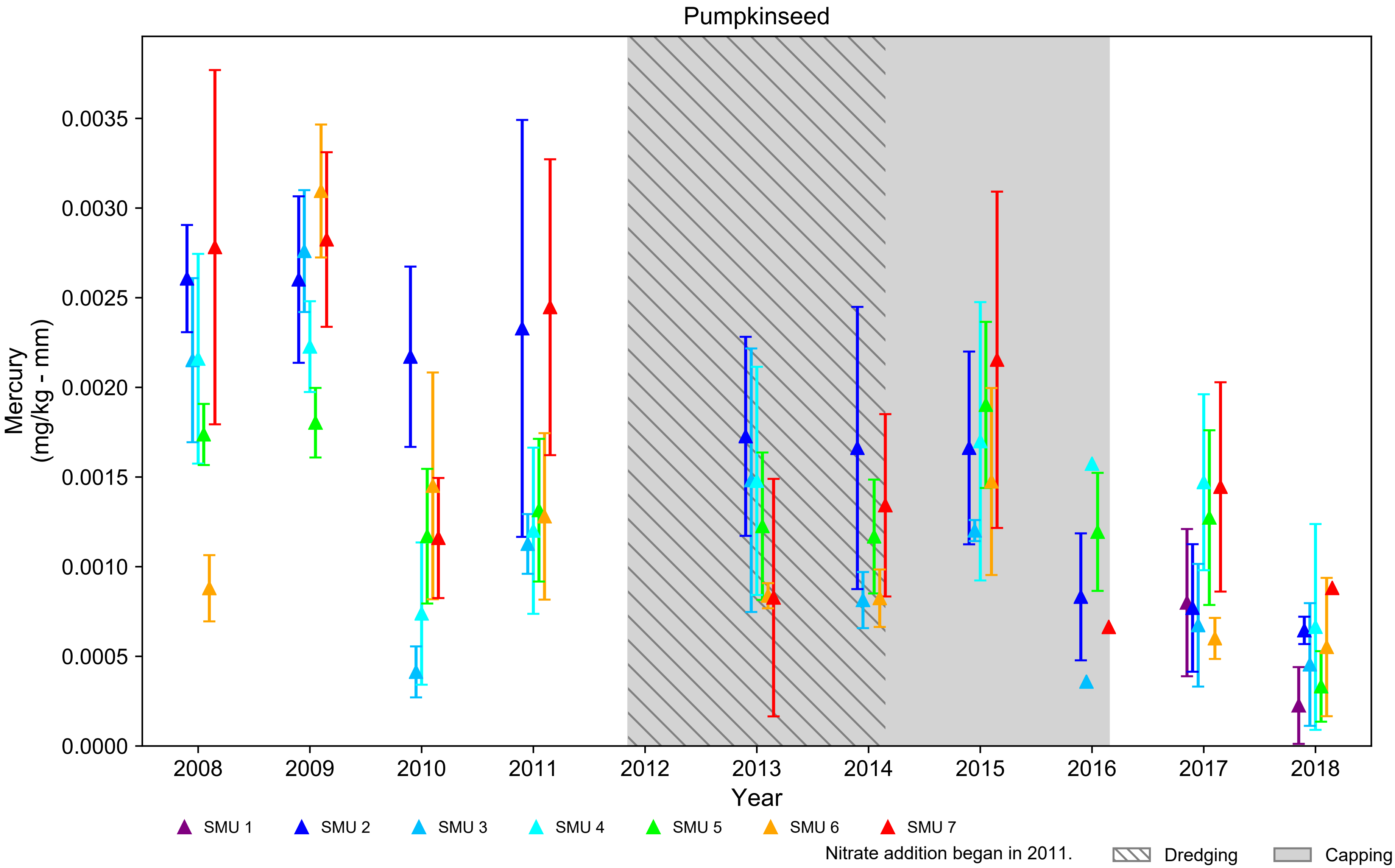


Set 4, Subset 2, Figure 1

Length-Normalized Mercury Concentrations in Small Prey Fish By SMU

ANCHOR QEA

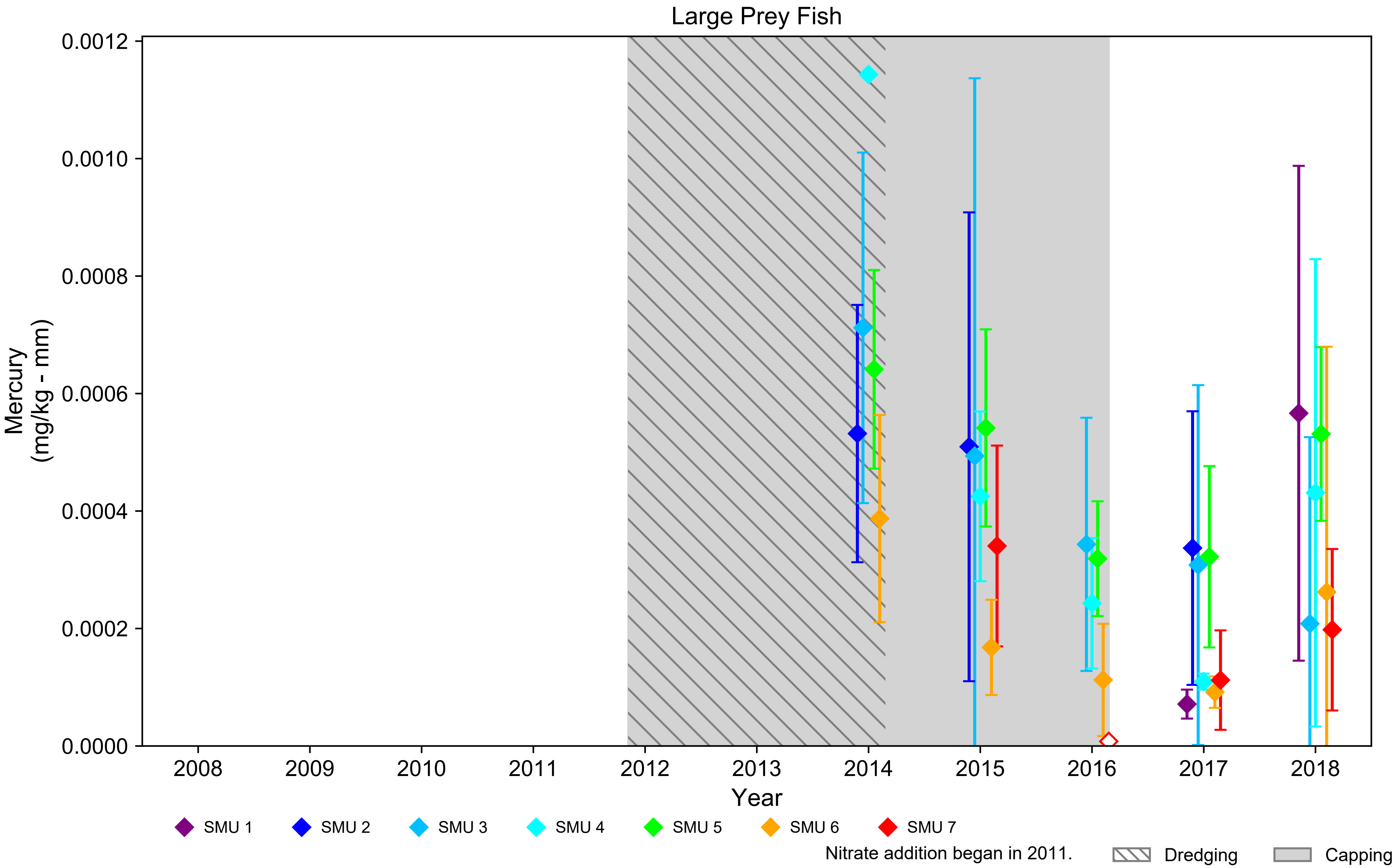
SYR-SCOL - \\Helios\AQ\D_Drive\Projects\Honeywell\Onondaga_Lake_OLMMS_(E60287)\ANALYSIS\FISH\2018_OMM\Python\Feb_2020_Comments\temporal_preyfish_bysmus_length_normalized_Hg.py 2/20/2020 16:8:58



Set 4, Subset 2, Figure 2

Length-Normalized Mercury Concentrations in Small Pumpkinseed By SMU

ANCHOR QEA

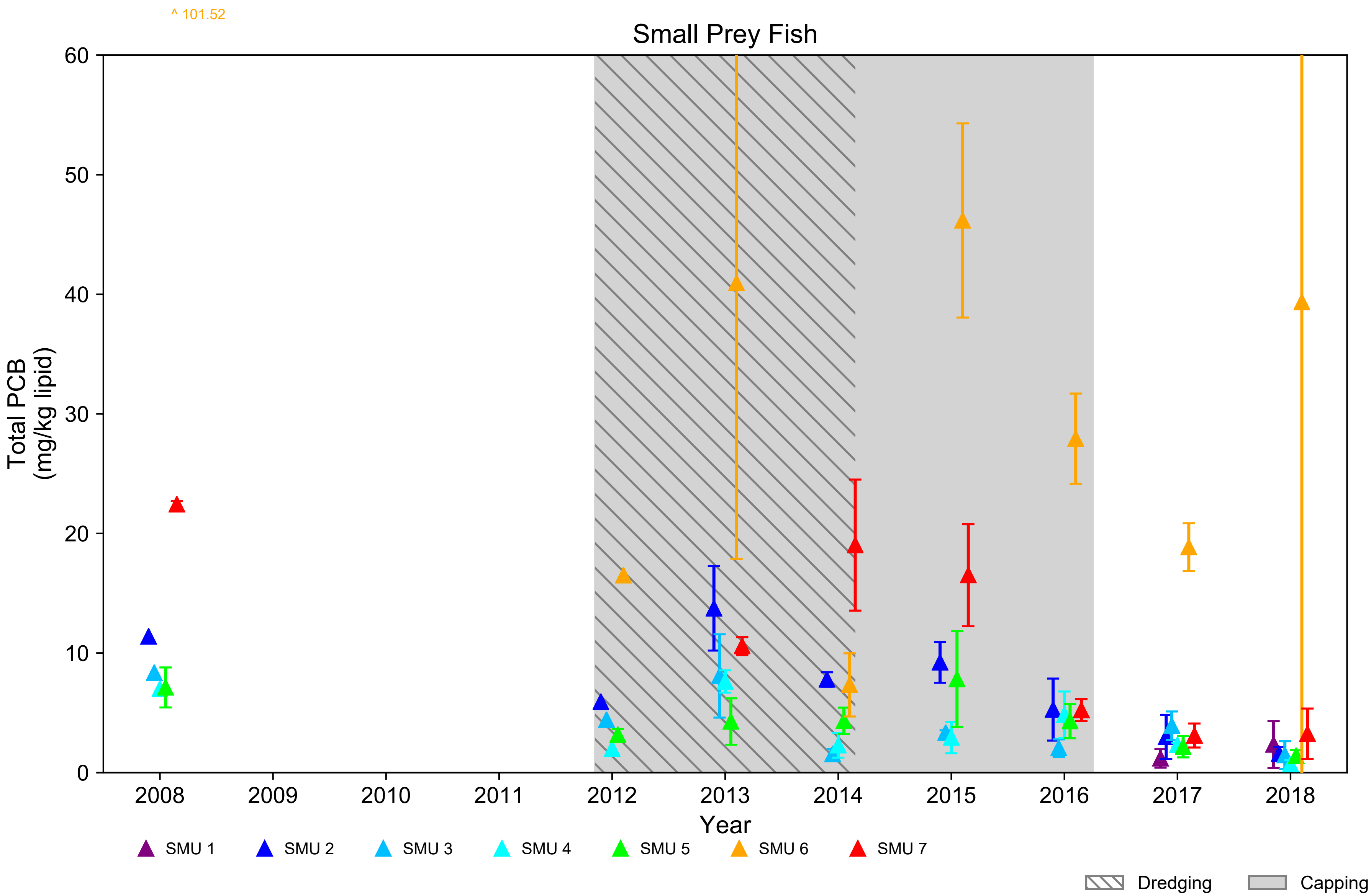


Set 4, Subset 2, Figure 3

Length-Normalized Mercury Concentrations in Large Prey Fish By SMU

ANCHOR QEA

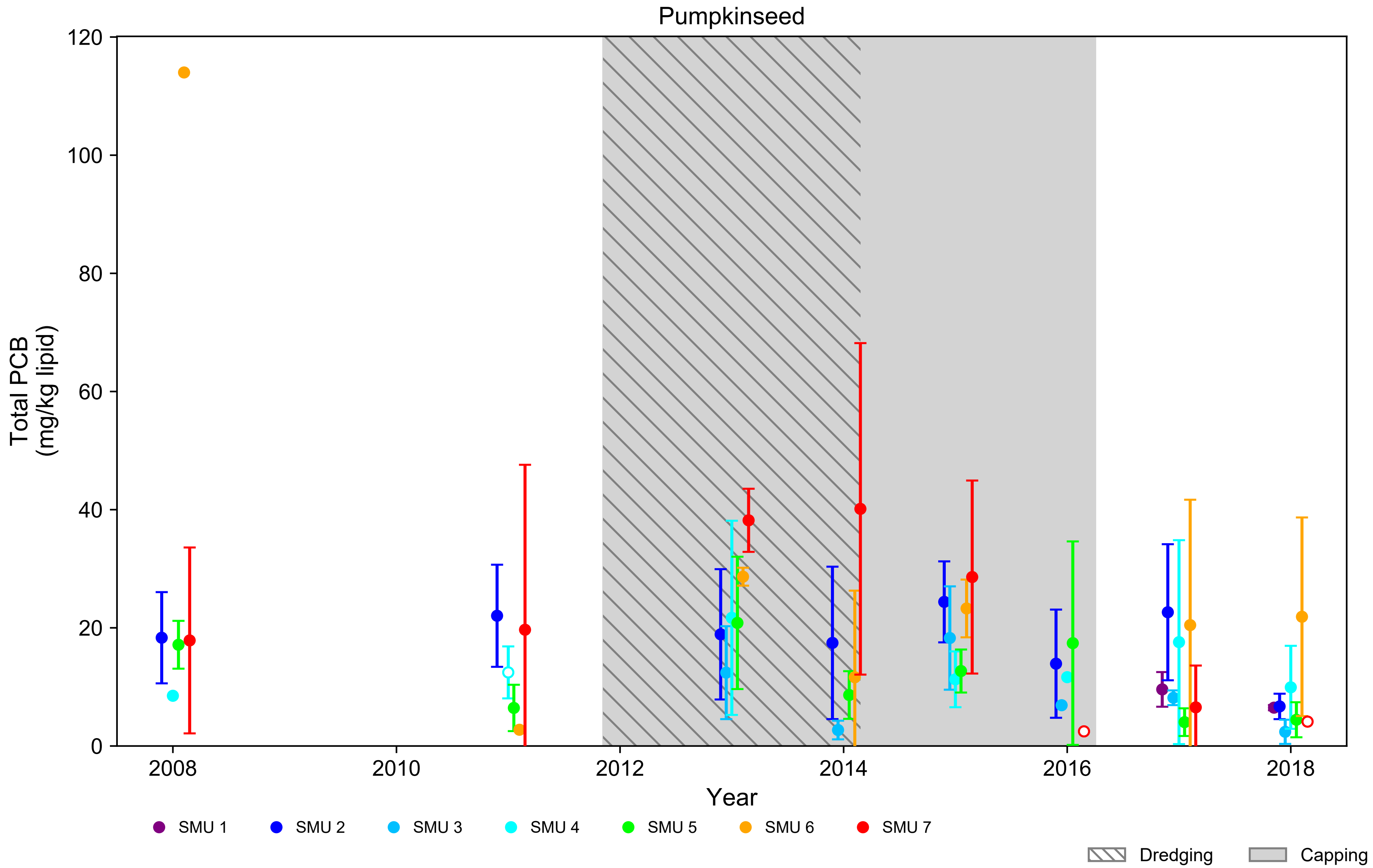
SYR-SCOL - \\Helios\AQ\D_Drive\Projects\Honeywell\Onondaga_Lake_OLMMS_(E60287)\ANALYSIS\FISH\2018_OMM\Python\Feb_2020_Comments\temporal_preyfish_bysmus_length_normalized_Hg.py 2/20/2020 16:8:59



Set 4, Subset 2, Figure 4

Lipid-Normalized Total PCB Concentrations in Small Prey Fish By SMU

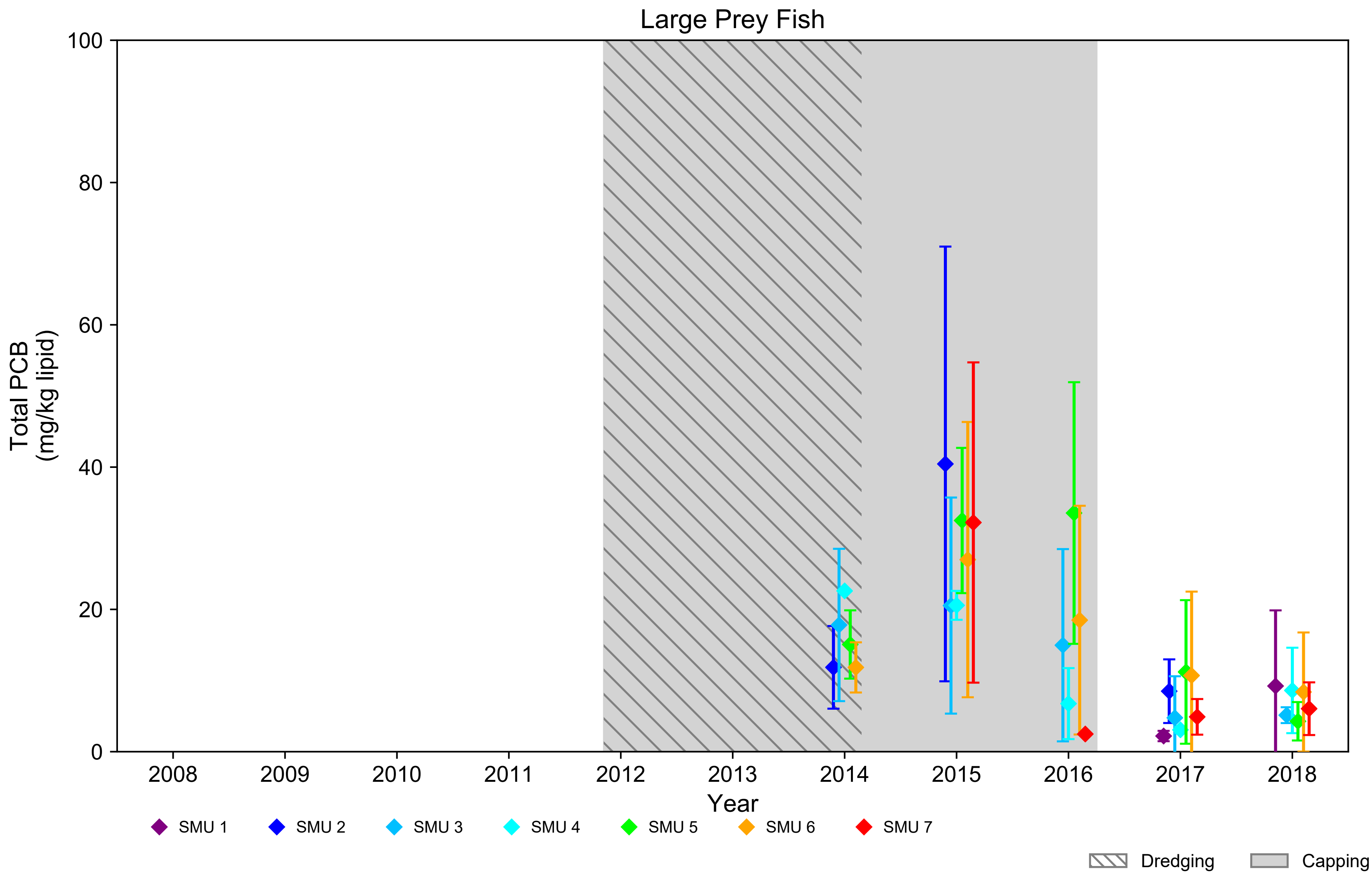
ANCHOR QEA



Set 4, Subset 2, Figure 5

Lipid-Normalized Total PCB Concentrations in Pumpkinseed By SMU

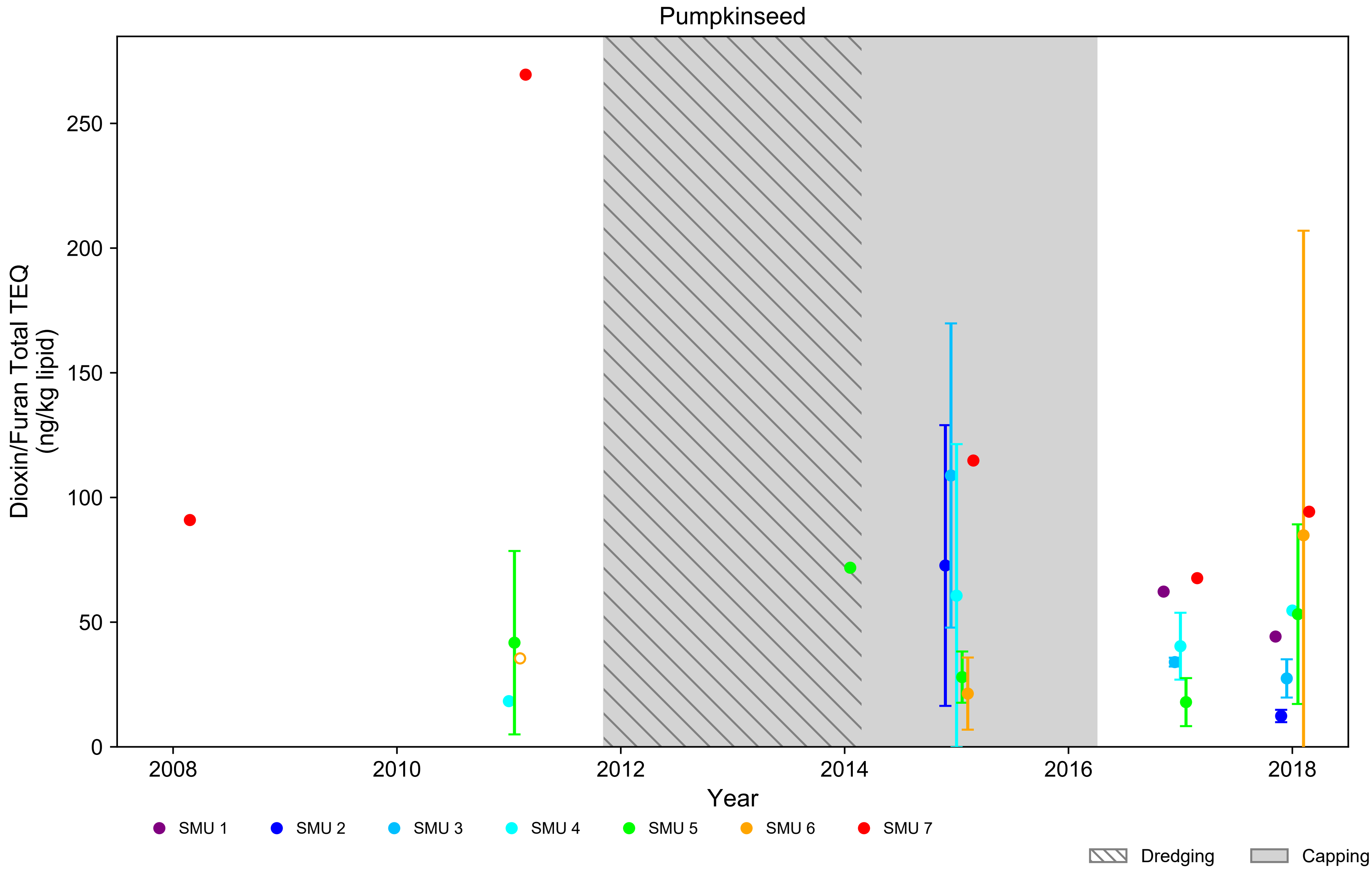
ANCHOR QEA



Set 4, Subset 2, Figure 6

Lipid-Normalized Total PCB Concentrations in Large Prey Fish By SMU

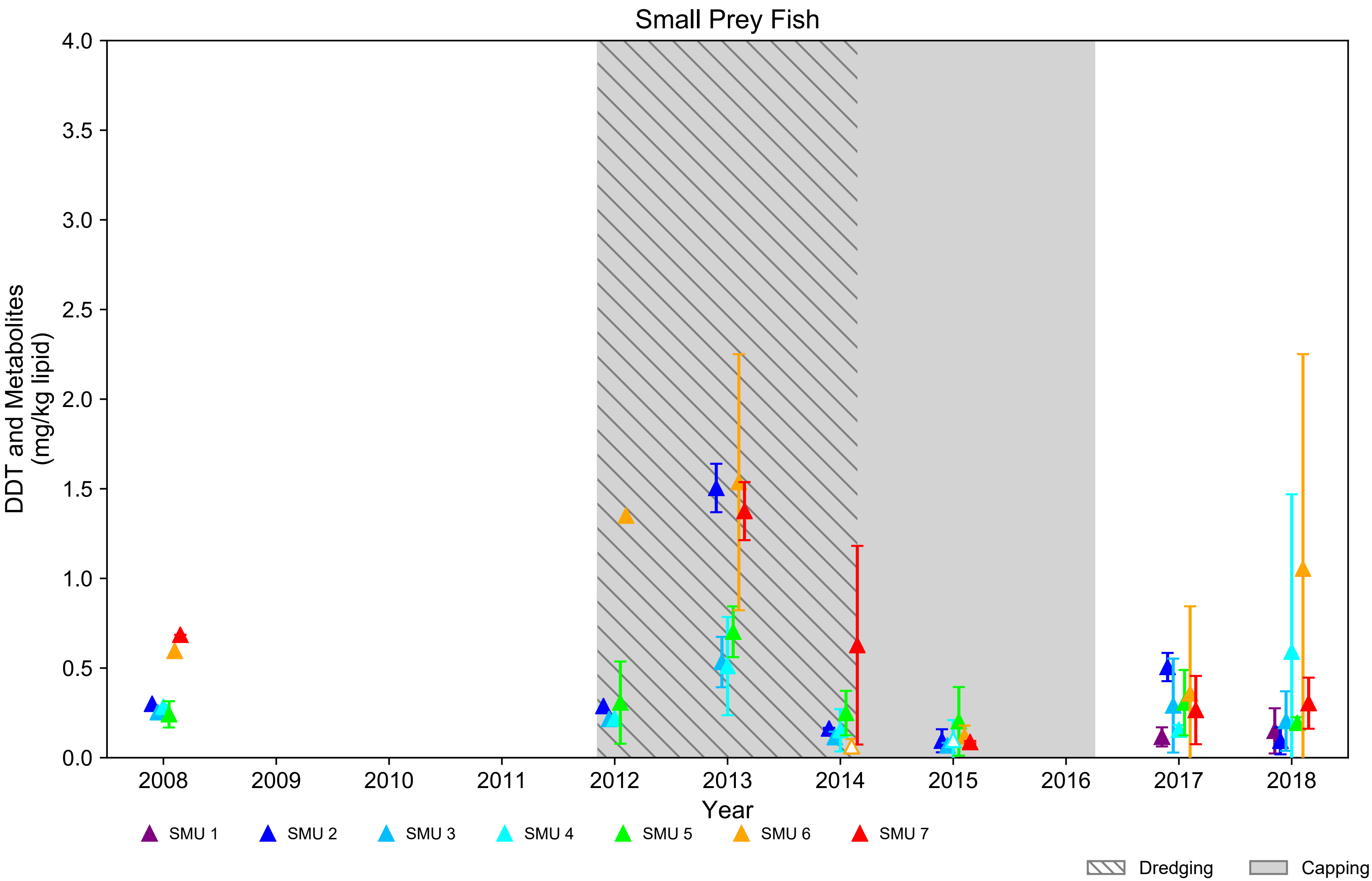
ANCHOR QEA



Set 4, Subset 2, Figure 7

Lipid-Normalized Dioxin/Furan Total TEQ Concentrations in Pumpkinseed By SMU

ANCHOR QEA

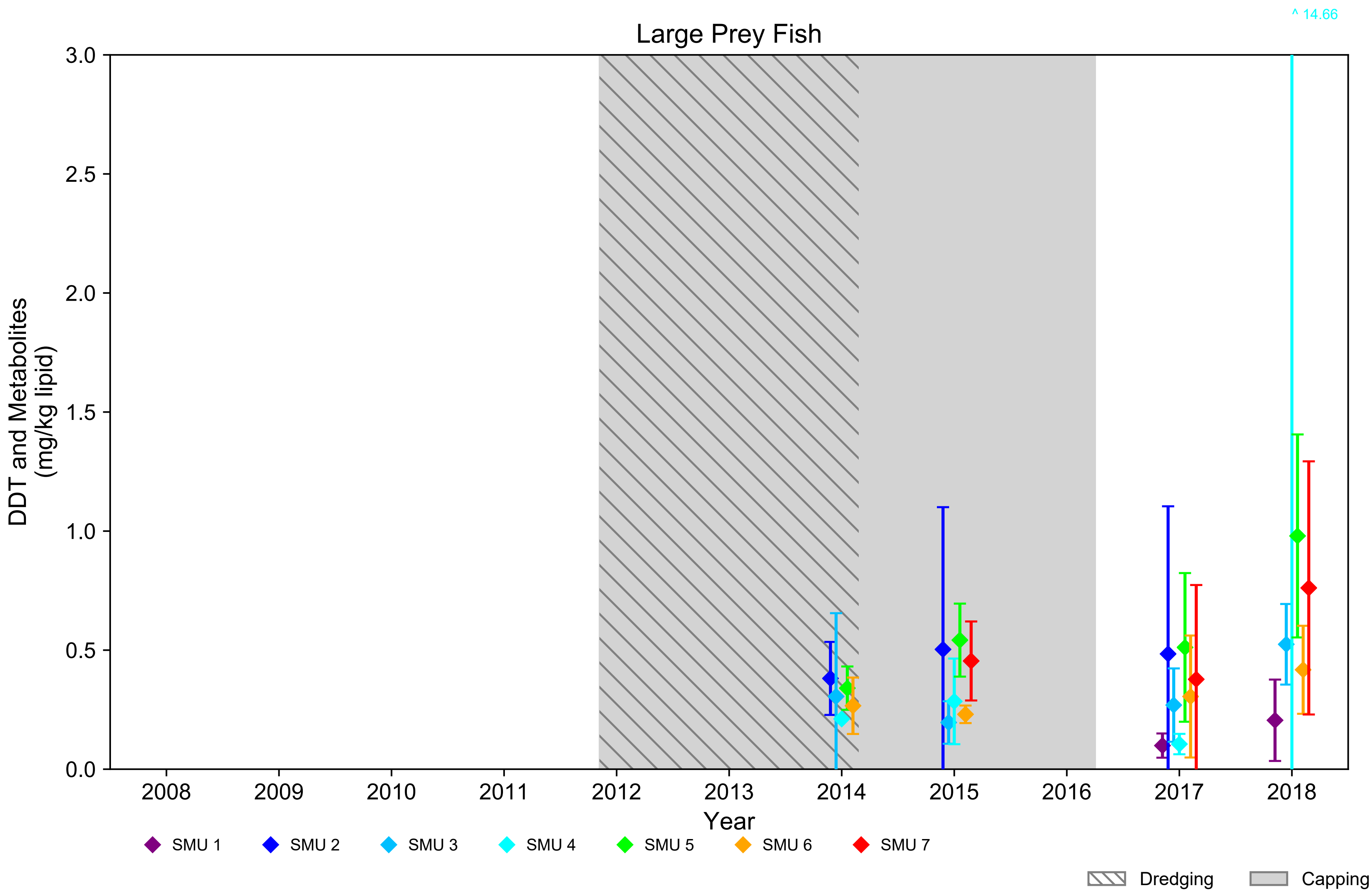


Set 4, Subset 2, Figure 8

Lipid-Normalized DDT and Metabolites Concentrations in Small Prey Fish By SMU

ANCHOR QEA

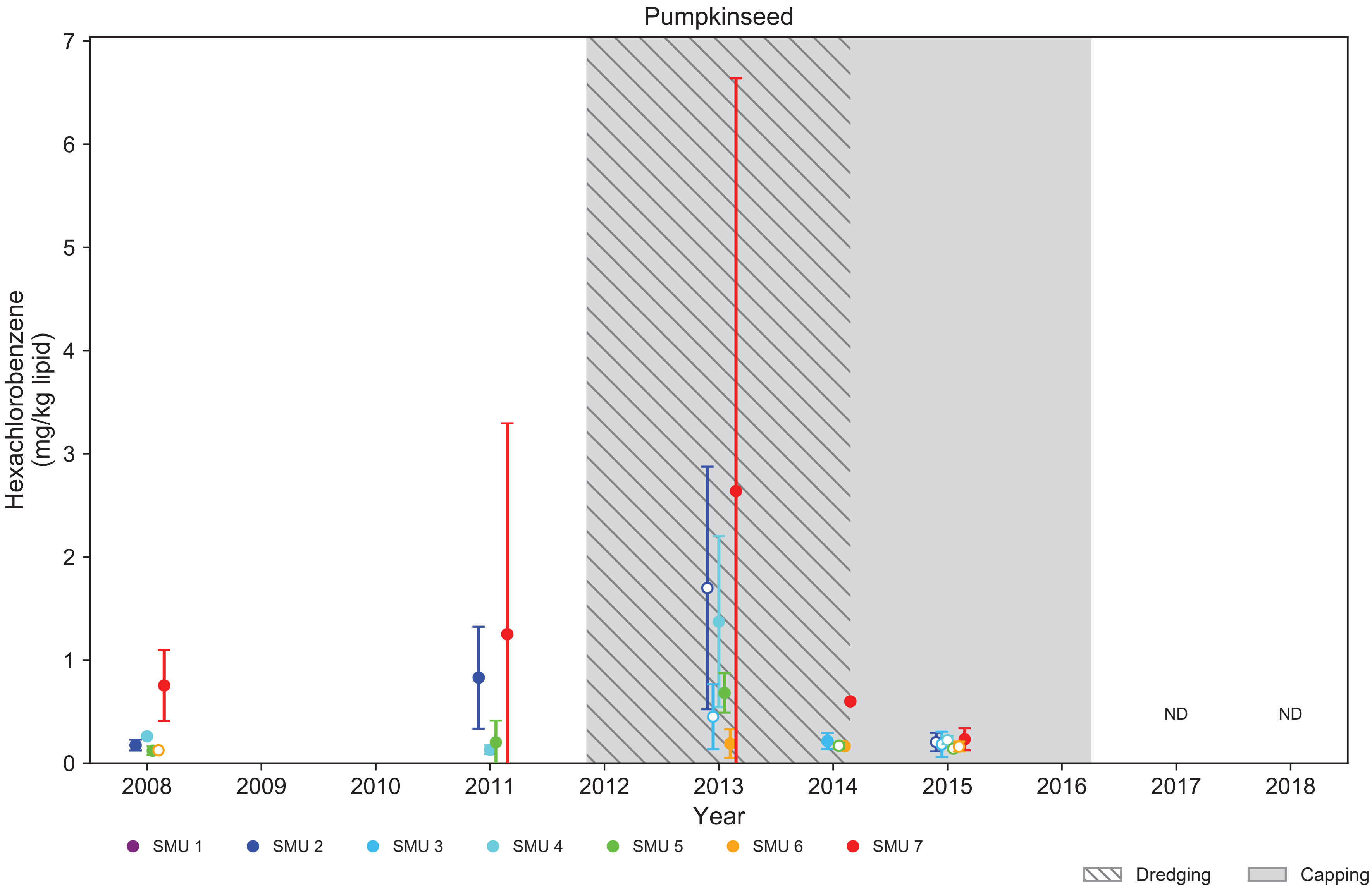
SYR-SCOL - \\Helios\AQ\D_Drive\Projects\Honeywell\Onondaga_Lake_OLMMS_(E60287)\ANALYSIS\FISH\2018_OMM\Python\Feb_2020_Comments\errbar_preyfish_lipid_ww_bySMU_allSMU.py 2/20/2020 14:27:39



Set 4, Subset 2, Figure 9

Lipid-Normalized DDT and Metabolites Concentrations in Large Prey Fish By SMU

ANCHOR QEA

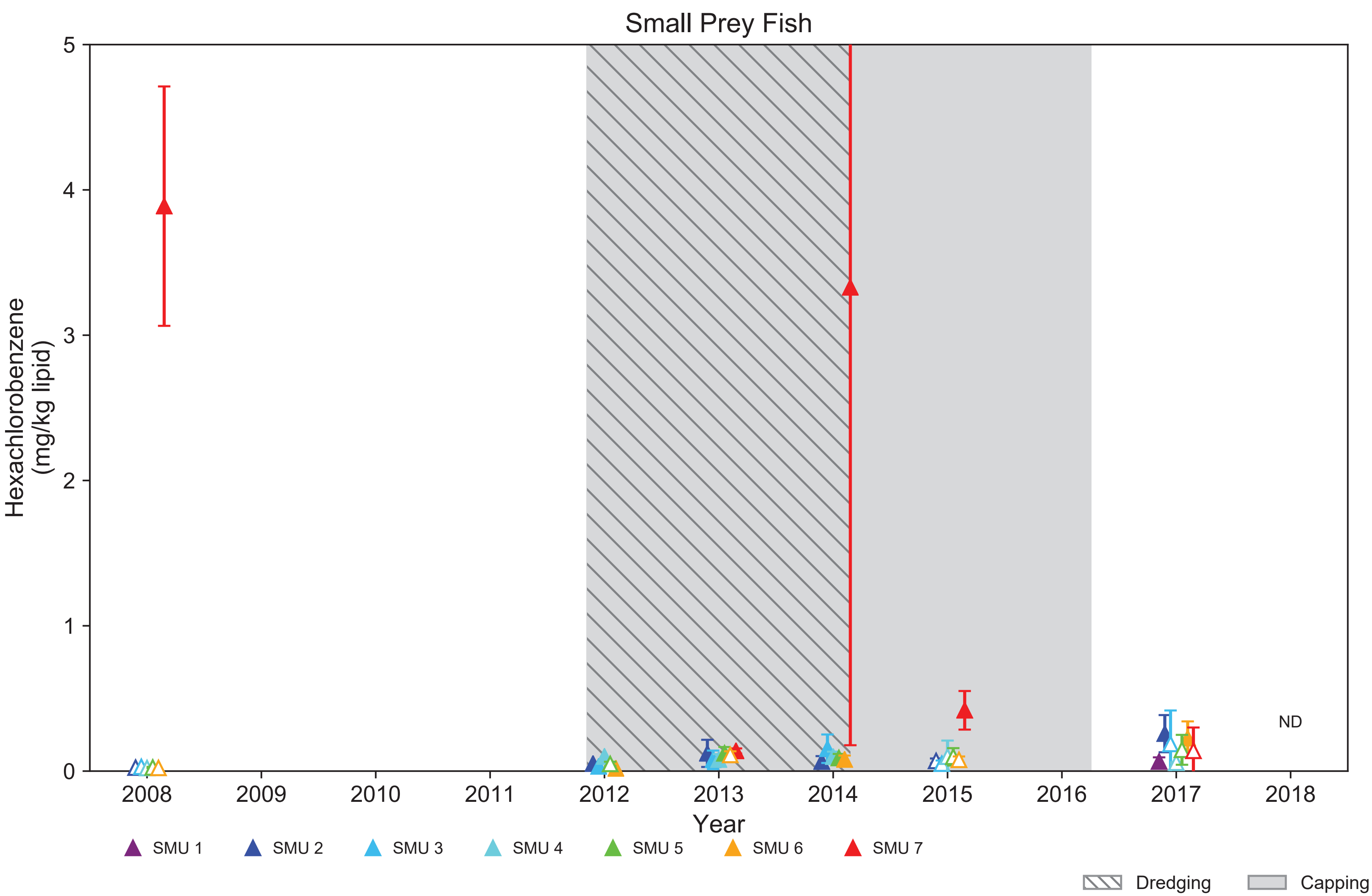


Set 4, Subset 2, Figure 10

Lipid-Normalized Hexachlorobenzene Concentrations in Pumpkinseed By SMU

Note: Open symbols indicate non-detects, reported at half the reporting limit.

ANCHOR QEA

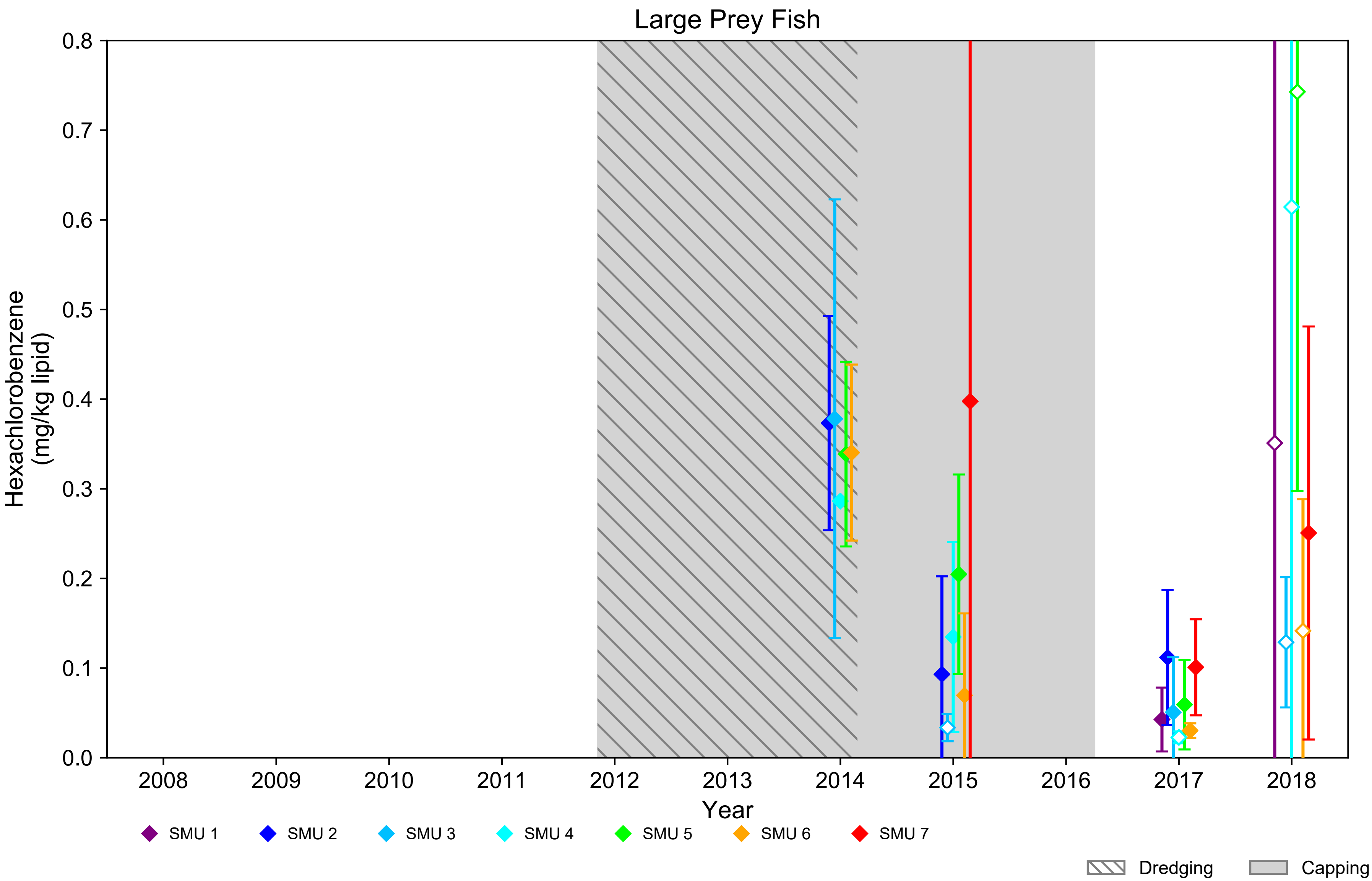


Set 4, Subset 2, Figure 11

Lipid-Normalized Hexachlorobenzene Concentrations in Small Prey Fish By SMU

Note: Open symbols indicate non-detects, reported at half the reporting limit.

ANCHOR QEA



Set 4, Subset 2, Figure 12

Lipid-Normalized Hexachlorobenzene Concentrations in Large Prey Fish By SMU

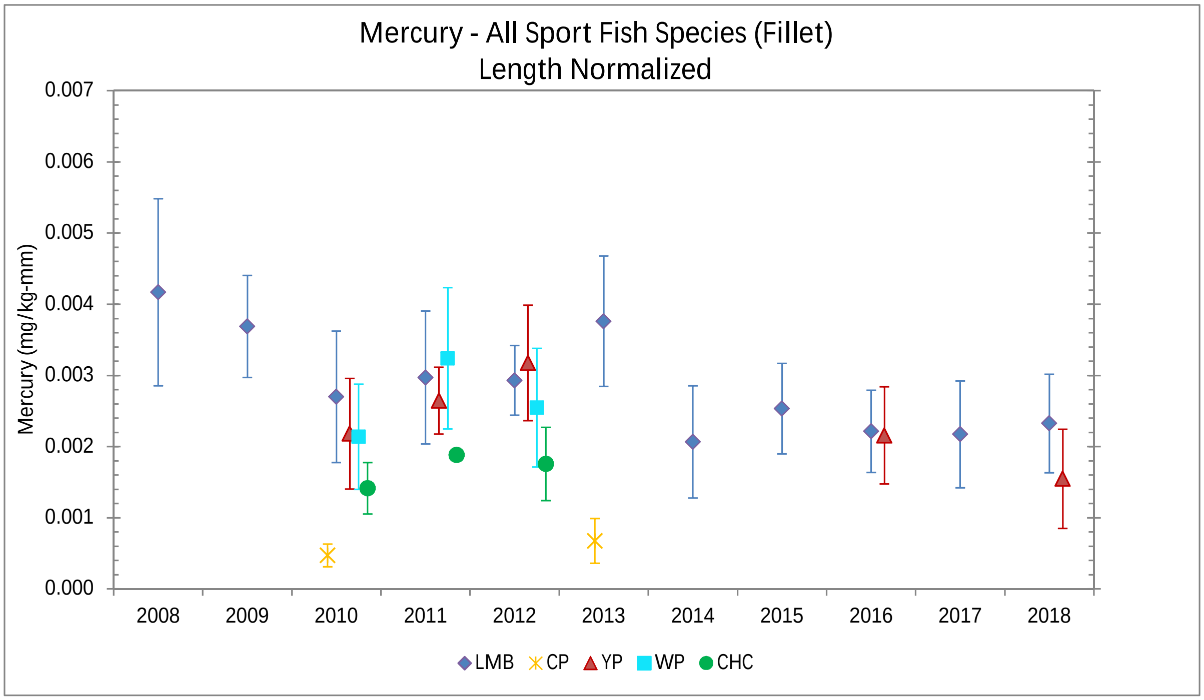
ANCHOR QEA

NYSDEC Set 4 Data (2008-2018)

September 2020

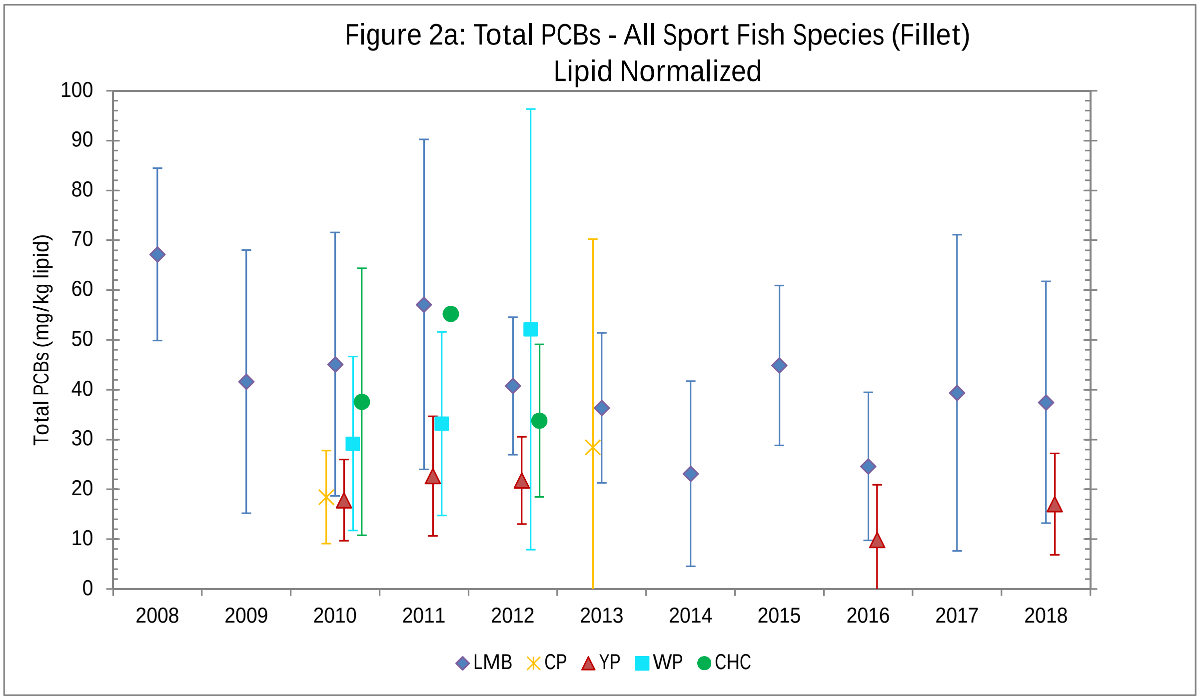
Set 4, Subset 1, DEC Figure 1

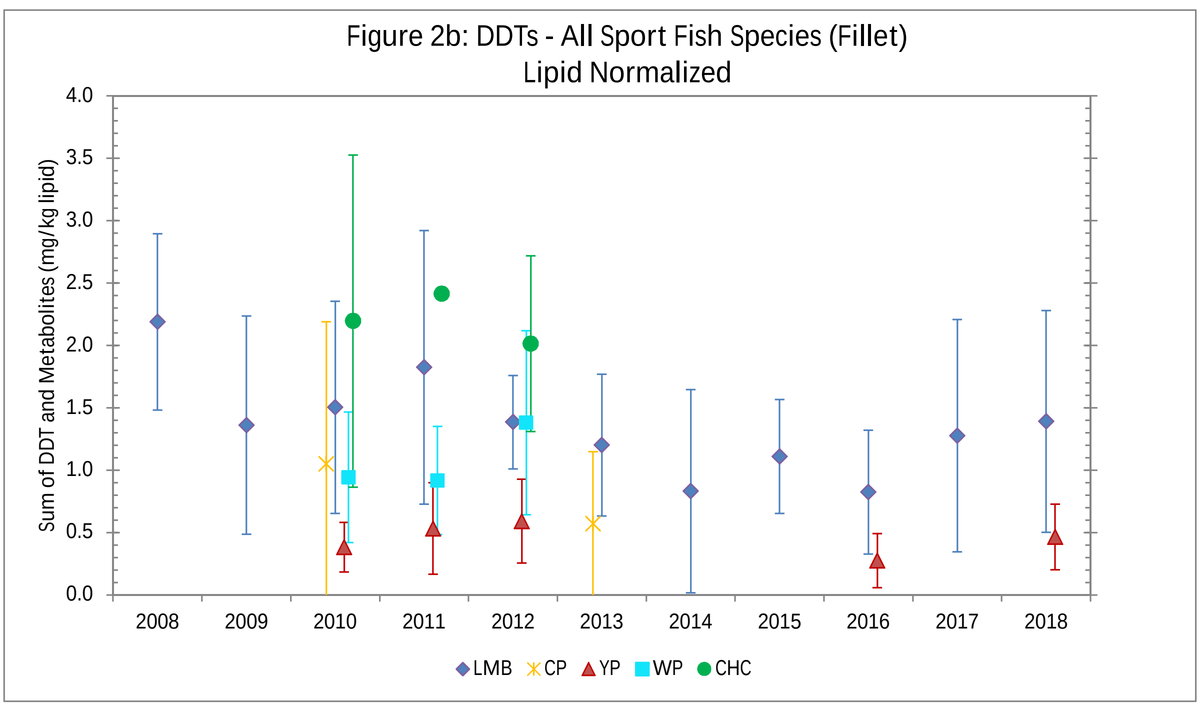
NYSDEC Length-Normalized Mercury Data



Set 4, Subset 1, DEC Figure 2

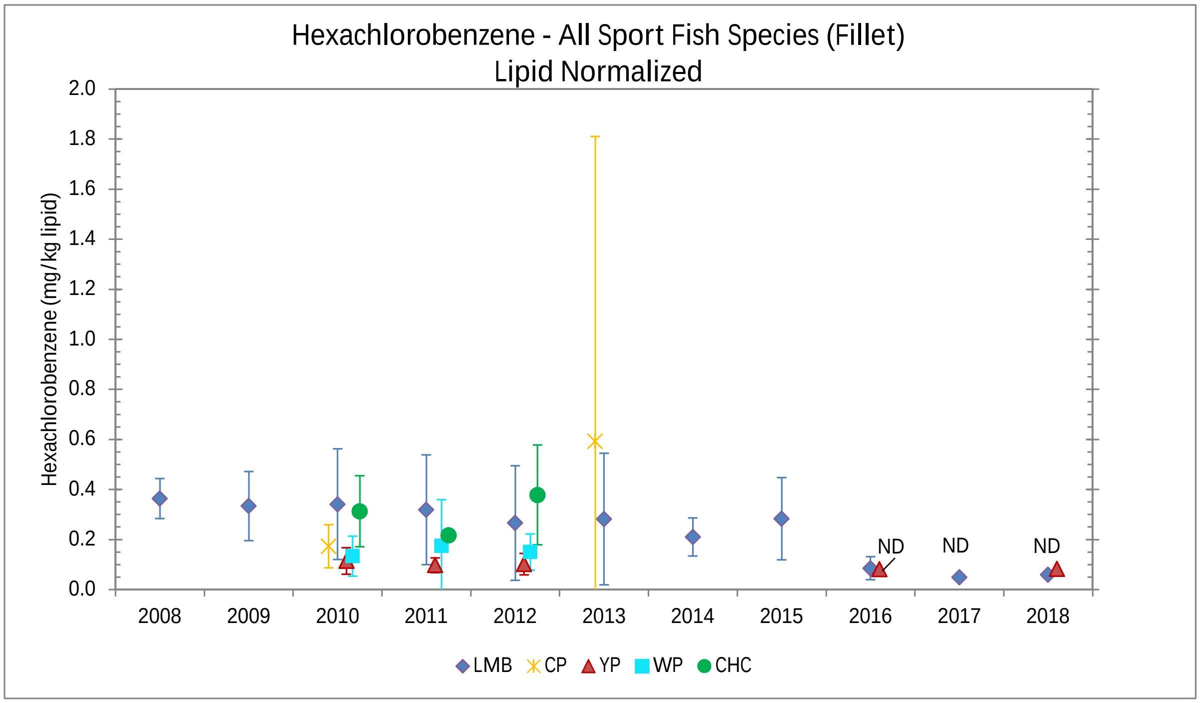
NYSDEC Lipid-Normalized Total PCBs and DDTs Data





Set 4, Subset 1, DEC Figure 3

NYSDEC Lipid-Normalized Hexachlorobenzene Data



Onondaga Lake Second Five Year Review

Attachment 4

Site Photographs

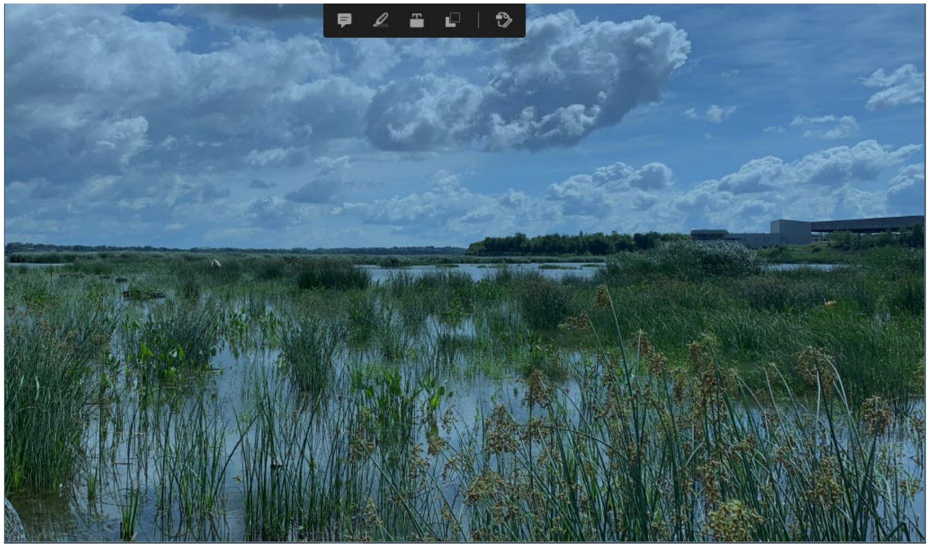
Harbor Brook


2020/07/15

2020/07/15

2020/07/15

Mouth of Ninemile Creek (East Spit and Wild Rice)



Mouth of Ninemile Creek (West Spit and Water Lily)

Wastebed B Outboard Area (Protective Berms)



Sediment Consolidation Area