Memo

Date:	Friday, July 08, 2022
Project:	LIS HWQMS Project
To:	Greg Wilkerson (DEP)
From:	Andy Thuman, Rich Isleib, Mikayla Reichard (HDR)
Subject:	Embayment Data

As part of the Long Island Sound Hydrodynamic and Water Quality Support (LIS HWQMS) Project, HDR is developing two stand-alone embayment models that can be linked to the new LIS open waters model grid, one in Connecticut and one in Long Island. HDR was asked to review available hydrodynamic and water quality data to aid in choice of the two embayments that will be modeled. The final decision for selecting the embayments for model development will be made by the New York State Department of Environmental Conservation (NYSDEC) and the Connecticut Department of Energy and Environmental Protection (CTDEEP).

In order to successfully develop and calibrate a model, there must be enough data to define the model inputs and for model calibration and validation. A description of the new open waters LIS model inputs has been included in Project Model Selection and Setup Report (HDR, 2021) and the model load development approach will be described in a separate memorandum in progress. This memorandum will discuss the hydrodynamic and water quality data that are available for embayment model calibration and validation.

The embayment models will use a finer resolution spatial model grid than the one developed for the open water LIS model grid. This is required to represent shoreline details, channels, bridge overpasses/culverts and embayment entrances. It is anticipated that the embayment models will have model grid sizes on the order of 10’s of meters and include up to ten vertical layers. An example higher spatial resolution model grid from a prior hydrodynamic model application in Port Jefferson Harbor as part of the Suffolk County Subwatersheds Wastewater Plan (SWP) is presented in Figure 1.

In addition to using a finer resolution spatial model grid for the embayment modeling, the offshore boundary conditions will be located out into LIS. For example, the boundary could be located as shown in Figure 1 or extended further out into LIS to provide boundary conditions that are minimally affected by loading sources and water quality concentrations from inside the embayment. These offshore boundary conditions for both the hydrodynamic and water quality models will be obtained from the calibrated and validated open waters LIS model.

An approximately one-year time period will be selected from the open waters LIS modeling time period of 2005-2014 to develop the embayment models, if sufficient data to develop the embayment models is available. In addition, the selected embayment model time period will be split into calibration and validation time periods of approximately 6-months duration.

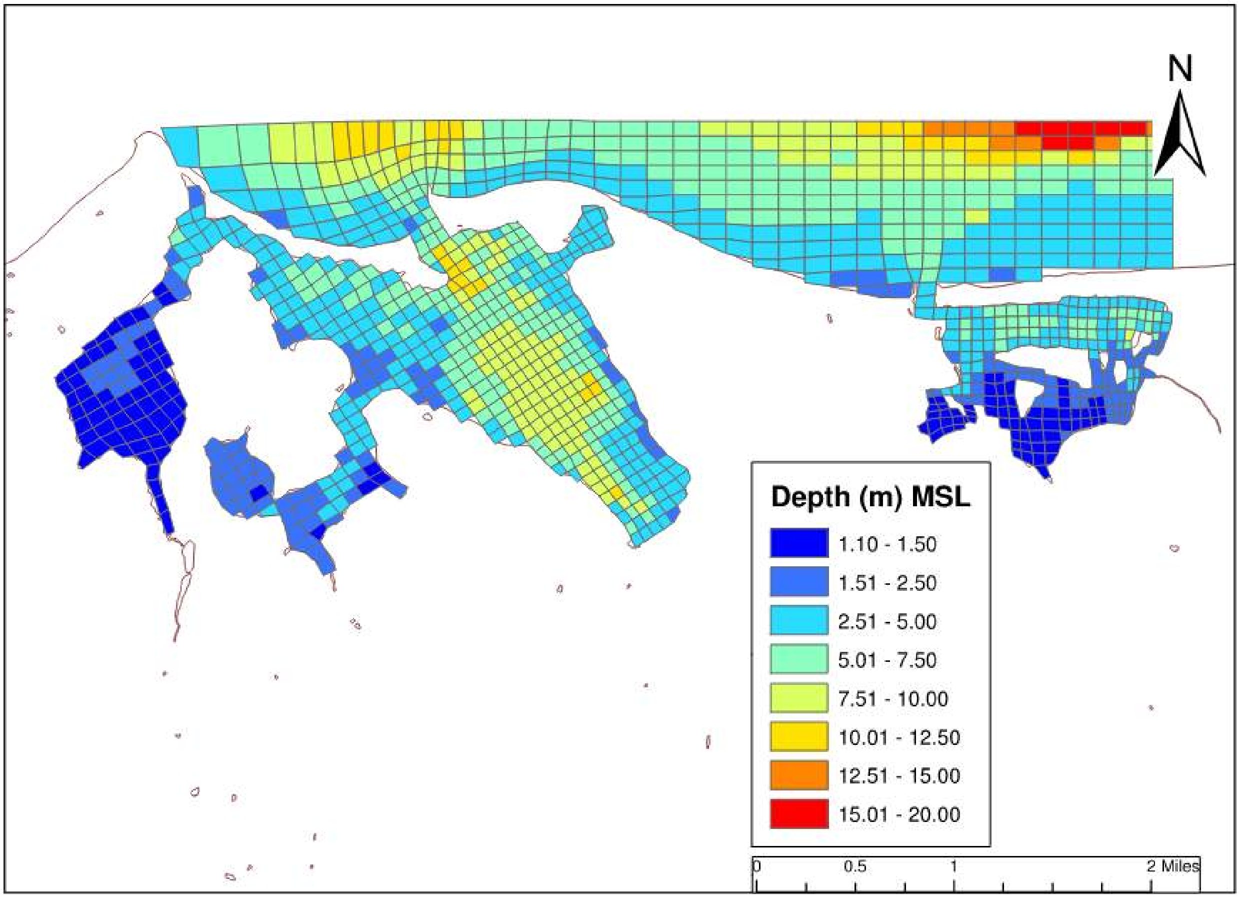


Figure 1. Port Jefferson Hydrodynamic Model Grid from Suffolk County SWP

Required Data

The data required for the hydrodynamic model calibration and validation should include, at a minimum, bathymetry, temperature and salinity with temporal coverage that includes at least monthly sampling for a full year. Spatial coverage should include the areas of importance within the waterbody as well as surface and bottom sampling. Water elevation and current measurements are other important data that can be used for model calibration and validation, but it is unlikely that most embayments will have these data types. For the water quality model, in this case a eutrophication model, the minimum requirements would include nitrogen and phosphorus speciation, chlorophyll-a, TSS, and dissolved oxygen (DO) with similar temporal and spatial coverage as the hydrodynamic sampling.

HDR reviewed available data to assess which embayments have the best data sets for potential use in model calibration and validation. The available data review was based on three primary sources: Establishing Nitrogen Endpoints for Three Long Island Sound Watershed Groupings, Subtask D. – Summary of Existing Water Quality Data (TetraTech, 2018); the Unified Water Study (UWS) (www.savethesound.org); and Eelgrass Success in Niantic River Estuary, CT (Data Synthesis) (Vaudrey et al., 2019).

Summaries of the TetraTech Subtask D and UWS embayment data are presented in Attachment 1. The data summaries include the sample count for each monitored parameter in each monitored embayment. The TetraTech Subtask D report that includes additional details on monitoring station locations and embayment specific data summaries is included as Attachment 2. Attachment 3 contains the UWS QAPP that includes additional details on monitoring station locations and parameters to be analyzed. Attachment 4 presents a map of the Niantic River Estuary and Bay available monitoring data. Attachment 5 contains monitoring station maps for embayment data from a number of different sources.

Available Data

The TetraTech report reviewed data from 24 embayments, 14 in Connecticut and 10 in New York. Data were collected for the period of 2000 through 2015, but the primary focus was on data collected between 2006 and 2015. The number of samples in each embayment were counted for total nitrogen (TN), total phosphorus (TP), chlorophyll-a, DO and Secchi depth, as well as other constituents.

The UWS project began in 2016 with a pilot using four monitoring groups. The inaugural season began in 2017 with 12 monitoring groups; and as of 2020, 23 monitoring groups sampled 38 embayments. Before 2019, monitoring did not include sampling for nutrients. By 2020, 13 embayments included nutrient sampling stations, referred to as Tier II sampling locations. Nutrients include TN, total dissolved nitrogen (TDN), ammonium (NH4), nitrite+nitrate (NO2+NO3), TP, and ortho-phosphate (PO4). Continuous DO is collected as well. Sampling in the UWS only includes the months of May through October.

TetraTech identifies eight embayments that have at least 100 TN samples during the period of data they reviewed. Four locations had at least 300 TN samples. These locations include: Pawcatuck River, Oyster Bay/Cold Spring Harbor Complex, Port Jefferson, and the Northport-Centerport Harbor Complex. The other four embayments include Mystic Harbor, Niantic Bay, Stony Brook Harbor, and Huntington Harbor.

There are some limitations with the data sets for these embayments. For the Oyster Bay/Cold Spring Harbor Complex, the vast majority of samples are for bottom TN and other important constituents are not collected. In Port Jefferson, the Northport-Centerpoint Harbor Complex, Stony Brook Harbor, and Huntington Harbor, the nutrient data are only surface measurements.

Reviewing the embayment data in terms of number of samples collected over a 10+ year period can dilute the apparent number of samples that can be used for modeling. In some cases, short duration sampling programs were conducted that may be adequate for modeling purposes. Vaudrey et al. 2016 conducted water quality surveys in 10 embayments during 2013-2014 to inform their nitrogen loading analysis. These embayments include the Mamaroneck River, Oyster Bay Harbor, Nissequoque River, Mt. Sinai Harbor and Mattituck Creek in New York; and Pawtucket River, Wequetequock Cove, Niantic River, Milford Harbor and Saugatuck River in Connecticut. The Wequetequock Cove, Milford Harbor, Nissequoque River and Mattituck River have surface areas of less than 1 km^2, so are likely less desirable for modeling purposes.

The embayments that include the Tier II nutrient sampling stations in the UWS include: Eastchester Bay, Little Neck Bay, Mamaroneck Harbor, Inner & Outer Norwalk Harbor, Huntington Northport Complex, Southport Harbor, and Niantic River.

The Niantic River Estuary and Bay data summarized in Vaudrey et al. (2019) provide almost all of the needed modeling data for this embayment. The available data include freshwater inflows and nutrient loads; meteorological data; and estuary/bay salinity, temperature, DO, light extinction, Secchi depth, nitrogen species, phosphorus species and chlorophyll-a data. These data span the years from 1999 through 2016. These datasets are extensive and would provide sufficient data for embayment model development.

HDR is also aware that USGS, in cooperation with CTDEEP, is performing two years of sampling in Mystic River and Norwalk Harbor to support development of hydrodynamic and water quality models.

These data sets are close to ideal for model development, but based on CTDEEP's ongoing efforts, modeling these two embayments as part of the LIS work may be redundant with CTDEEP plans.

Embayment Screening

Based on this first level screening, the following candidate waterbodies have been identified in Long Island and Connecticut:

- Long Island
  - Oyster Bay/Cold Spring Harbor Complex
  - Port Jefferson
  - Northport-Centerport Harbor Complex
  - Stony Brook Harbor
  - Mt. Sinai Harbor
  - Huntington Harbor

- Connecticut
  - Pawcatuck River
  - Niantic Bay/River
  - Saugatuck River
  - Southport Harbor

A portion of the Pawcatuck River watershed is in Rhode Island, so this embayment might not be ideal for CTDEEP purposes.

This preliminary screening of the available data provides insight into which embayments have data useful for the calibration and validation of stand-alone hydrodynamic and eutrophication models.

References

HDR, 2021. Hydrodynamic & Water Quality Model Selection and Setup. Developed for the New York City Department of Environmental Protection.

TetraTech, 2018. Establishing Nitrogen Thresholds and Allowable Loads for Three LIS Watershed Groupings: Embayments, Large Riverine Systems, and Western LIS Point Source Discharges to Open Water. Subtask D. Summary of Existing Water Quality Data. Prepared for the U.S. Environmental Protection Agency, Region 1.

Vaudrey, J.M.P, C. Yarish, J.K. Kim, C. Pickerell, L. Brousseau, J. Eddings, and M. Sautkulis. 2016. Connecticut Sea Grant Project Report: Comparative Analysis and Model Development for Determining the Susceptibility to Eutrophication of Long Island Sound Embayments. Project number R/CE-34-CTNY. 46p. Final report submitted to Connecticut Sea Grant, New York Sea Grant and Long Island Sound Study.

Vaudrey, J., J. Krumholz and C. Calabretta, 2019. Eelgrass Success in the Niantic River Estuary, CT: Quantifying Factors Influencing Interannual Variability of Eelgrass (*Zostera marina*) Using a 30-Year Dataset. UCONN Department of Marine Sciences. Prepared for the Niantic River Estuary Nitrogen Workgroup.

ATTACHMENT 1

TetraTech Subtask D & UWS Data Summaries

TetraTech Subtask D Data Summary

Embayment	BiSi_mgL	BOD_mgL	Chla_PheoFree_ugL	Chla_RFU	Chla_Sonde_PheoFree_ugL	Chla_ugL	DIN_mgL	DIP_mgL	DO_mgL	DO_pct	DOC_mgL	DON_mgL	Kd_invm	Light_pct	Macroalgae_gm2	Macrophyte_DW_gm2	NH3_mgL	NH4_mgL	NO2_mgL	NO23_mgL	NO3_mgL	PAR_0.5m	PAR_1m	PAR_AMB_umolm2s	PAR_uEsm2	PAR_UW_umolm2s	PARF_uEsm2	PC_mgL	pH
Bebee Cove, CT	0	0	21	0	0	0	0	8	21	0	0	0	0	0	0	0	8	0	0	8	0	0	0	0	0	0	0	0	8
Black Rock Harbor, CT	0	0	0	0	0	0	1	0	22	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Branford Harbor, CT	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clinton Harbor, CT	0	0	0	0	0	0	22	0	407	0	0	22	0	0	0	0	0	22	0	22	0	0	0	0	0	0	0	0	0
Connecticut River	2	0	83	0	0	0	2	4	25	23	2	0	0	0	0	0	83	0	0	81	0	0	0	0	0	0	0	2	23
Conscience Bay, NY	0	0	51	0	0	0	0	52	102	0	1	0	0	0	0	0	51	0	0	52	0	0	0	0	0	0	0	0	62
Eastchester Bay, NY	8	6	126	0	0	0	0	119	147	0	123	0	0	4	0	0	123	0	0	123	0	0	0	0	4	0	0	9	253
Five Mile River, CT	0	0	0	0	0	0	0	0	278	278	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greenwich Cove, CT	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hempstead Harbor, NY	8	6	60	0	0	0	0	9	602	0	9	0	0	0	0	0	9	0	0	9	0	0	0	0	0	0	0	9	530
Housatonic River	0	0	36	36	36	0	0	0	36	36	0	0	0	0	0	0	36	0	0	36	0	0	0	0	0	0	0	0	36
Huntington Bay, NY	0	0	73	0	0	0	0	79	154	0	2	0	0	0	0	0	79	0	0	79	0	0	0	0	0	0	0	0	100
Huntington Harbor, NY	0	0	180	0	0	0	0	150	330	0	3	0	0	0	0	0	150	0	0	150	0	0	0	0	0	0	0	0	200
Little Narragansett Bay, CT	0	0	165	0	0	0	0	83	219	48	0	0	6	0	10	10	109	0	0	110	0	0	0	0	0	0	0	0	111
Little Neck Bay, NY	8	6	702	0	0	0	0	642	867	0	638	0	0	231	0	0	650	0	0	651	0	0	0	0	269	0	216	9	1082
Lloyd Harbor, NY	0	0	40	0	0	0	1	39	78	0	1	0	1	0	0	0	40	0	1	40	1	0	0	2	0	2	0	0	52
Mamaroneck River, NY	0	0	15	0	0	0	0	0	56	56	0	0	4	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	32
Manhasset Bay, NY	8	6	90	0	0	0	0	9	889	0	9	0	0	0	0	0	9	0	0	9	0	0	0	0	0	0	0	9	784
Mattituck Creek, NY	0	0	135	0	0	0	0	135	304	35	0	0	0	0	4	4	131	0	0	135	0	0	0	0	0	0	0	0	275
Milford Harbor, CT	0	0	12	0	0	0	0	0	47	47	0	0	6	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	32
Mill Neck Creek, NY	0	0	0	0	0	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mt. Sinai Harbor, NY	0	0	117	0	0	3	0	81	226	28	0	0	0	0	5	5	77	0	0	81	0	0	0	0	0	0	0	0	152
Mumford Cove, CT	0	0	0	0	0	0	46	0	80	0	0	32	0	0	0	0	0	47	24	46	24	0	0	0	0	0	0	0	0
Mystic Harbor, CT	0	0	101	0	0	266	3	96	222	0	0	0	0	0	0	0	112	2	0	116	0	0	0	0	0	0	0	0	89
New Haven Harbor, CT	1	0	2	0	0	0	1	2	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0
Niantic Bay, CT	0	0	15	0	0	0	542	0	706	68	0	153	144	0	8	8	0	553	65	528	68	0	0	0	0	0	0	0	44
Nissequogue River, NY	0	0	64	0	0	0	0	69	165	33	3	0	0	0	3	3	66	0	0	69	0	0	0	0	0	0	0	0	108
Northport-Centerport Harbor Comple	0	0	356	0	0	0	0	338	713	0	7	0	0	0	0	0	338	0	0	338	0	0	0	0	0	0	0	0	451
Norwalk Harbor, CT	0	0	0	0	0	0	0	0	1368	1368	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oyster Bay / Cold Spring Harbor Comp	0	0	48	0	0	0	0	0	90	54	0	0	0	0	7	7	0	0	0	0	0	0	0	0	0	0	0	0	54
Pawcatuck River, CT & RI	0	0	539	0	0	0	67	248	890	60	0	17	73	0	4	4	313	78	13	379	6	0	0	0	0	0	0	0	307
Pequonnock River, CT	0	0	1	0	0	0	1	1	2	0	0	0	1	0	0	0	1	0	1	1	0	0	0	2	0	2	0	0	2
Port Jefferson Harbor, NY	0	0	500	0	0	0	0	495	1008	0	11	0	0	0	0	0	484	0	0	495	0	0	0	0	0	0	0	0	622
Saugatuck Estuary, CT	0	0	11	0	0	0	0	0	537	537	0	0	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	34
Stonington Harbor, CT	0	0	73	0	0	0	0	41	138	12	0	0	0	0	0	0	70	0	0	71	0	0	0	0	0	0	0	0	71
Stony Brook Harbor, NY	0	0	184	0	0	0	0	205	395	0	5	0	0	0	0	0	206	0	11	207	5	0	0	0	0	0	0	0	253
Thames River	1	0	3	0	0	0	2	3	2	0	1	0	1	0	0	0	3	0	1	2	1	0	0	2	0	2	0	1	2
Williams Cove, CT	0	0	68	0	0	0	0	102	140	0	0	0	0	0	0	0	108	0	0	108	0	0	0	0	0	0	0	0	72

Embayment	PN_mgL	PO4_mgL	PP_mgL	Salinity_ppt	Seagrass_gm2	Secchi_m	Si_mgL	SiO2_mgL	SiO3_mgL	SpecCond_uScm	TDN_mgL	TDP_mgL	Temp_C	TKN_mgL	TN_mgL	TOC_mgL	TP_mgL	TSS_mgL	Turbidity_NTU	Min Date	Max Date	Years of data	Number of Individual Sites	S	B
Bebee Cove, CT	0	0	0	17	0	0	0	0	0	0	0	0	21	0	8	0	8	0	0	6/10/2012	10/3/2015	3.31	2	128	0
Black Rock Harbor, CT	0	0	0	22	0	11	0	0	0	0	0	0	22	0	0	0	0	1	0	8/17/2000	8/26/2003	3.02	11	55	27
Branford Harbor, CT	0	0	0	20	0	10	0	0	0	0	0	0	20	0	0	0	0	0	0	8/26/2003	8/26/2003	0.00	10	67	3
Clinton Harbor, CT	0	0	0	570	0	275	0	0	0	0	22	0	569	0	0	0	0	0	0	6/16/2000	7/23/2009	9.10	18	1779	174
Connecticut River	2	56	2	25	0	76	2	0	0	23	2	2	25	0	83	0	83	82	0	9/14/2006	10/3/2018	12.05	11	703	90
Conscience Bay, NY	0	0	0	102	0	51	0	0	0	0	52	52	104	0	52	1	52	0	0	1/24/2006	12/3/2015	9.86	2	661	176
Eastchester Bay, NY	9	0	9	147	0	66	9	114	0	4	9	9	149	114	123	0	123	126	69	6/28/2010	12/16/2015	5.47	6	2113	12
Five Mile River, CT	0	0	0	278	0	0	0	0	0	0	0	0	278	0	0	0	0	0	0	6/28/2009	9/25/2015	6.24	5	1008	104
Greenwich Cove, CT	0	0	0	18	0	9	0	0	0	0	0	0	18	0	0	0	0	0	0	8/25/2003	8/25/2003	0.00	9	48	15
Hempstead Harbor, NY	9	0	9	602	0	216	9	0	0	0	9	9	604	0	9	0	9	24	0	6/26/2006	9/14/2015	9.22	2	2123	637
Housatonic River	0	0	0	36	0	0	0	0	0	36	0	0	36	0	36	0	36	36	0	5/23/2019	10/18/2019	0.41	6	504	0
Huntington Bay, NY	0	0	0	154	0	79	0	0	0	0	77	77	154	0	77	2	77	12	0	1/9/2006	11/5/2015	9.82	2	1009	266
Huntington Harbor, NY	0	0	0	294	0	186	0	0	0	0	147	147	310	0	147	3	147	12	0	1/9/2006	8/29/2016	10.64	5	2040	516
Little Narragansett Bay, CT	23	27	0	184	10	73	0	0	0	0	23	0	220	0	132	0	109	14	0	6/12/2008	10/14/2015	7.34	13	1601	85
Little Neck Bay, NY	9	0	9	854	0	564	9	642	0	320	9	9	862	641	650	0	651	674	275	6/26/2006	12/16/2015	9.47	7	12042	107
Lloyd Harbor, NY	0	0	0	78	0	40	0	0	0	0	38	38	78	0	39	1	39	0	0	1/9/2006	11/5/2015	9.82	2	517	132
Mamaroneck River, NY	35	40	0	56	2	4	0	0	0	0	36	0	56	0	35	0	0	15	0	7/11/2013	10/30/2014	1.30	8	330	116
Manhasset Bay, NY	9	0	9	887	0	334	9	0	0	0	9	9	891	0	9	0	9	36	0	6/26/2006	9/14/2015	9.22	3	3615	418
Mattituck Creek, NY	24	30	0	304	4	131	0	0	0	0	159	134	304	0	159	0	135	20	0	1/27/2006	12/8/2015	9.86	14	1945	617
Milford Harbor, CT	27	34	0	47	5	5	0	0	0	0	28	0	47	0	24	0	0	17	0	7/3/2013	10/29/2014	1.32	7	280	108
Mill Neck Creek, NY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0	8/11/2008	10/6/2014	6.15	10	173	27
Mt. Sinai Harbor, NY	16	22	0	190	5	116	0	0	0	0	97	81	206	0	97	0	81	12	0	1/27/2006	8/29/2016	10.59	10	1240	455
Mumford Cove, CT	0	0	0	80	0	0	0	0	0	0	32	0	80	0	0	0	0	0	0	6/11/2002	7/15/2004	2.09	12	544	0
Mystic Harbor, CT	0	0	0	170	0	2	0	0	0	0	0	0	231	0	114	0	112	3	0	9/5/2000	10/3/2015	15.07	6	1376	0
New Haven Harbor, CT	1	0	1	1	0	0	1	0	0	0	1	1	1	0	2	0	2	2	0	9/19/2006	9/19/2006	0.00	2	24	0
Niantic Bay, CT	26	38	0	1057	8	259	0	0	0	0	93	0	1052	0	112	0	0	17	0	6/19/2000	10/29/2014	14.36	65	5391	439
Nissequogue River, NY	20	27	0	165	3	66	0	0	0	0	88	69	165	0	88	3	69	15	0	1/25/2006	10/22/2015	9.74	11	1055	306
Northport-Centerport Harbor Comple	0	0	0	677	0	376	0	0	0	0	333	333	694	0	332	7	332	24	0	1/9/2006	8/29/2016	10.64	11	4473	1176
Norwalk Harbor, CT	0	0	0	1368	0	541	0	0	0	0	0	0	1368	0	0	0	0	0	0	6/17/2006	10/1/2015	9.29	10	5209	804
Oyster Bay / Cold Spring Harbor Comp	20	32	0	54	7	36	0	0	0	0	20	0	71	0	432	0	0	12	0	7/7/2008	8/29/2016	8.15	24	611	333
Pawcatuck River, CT & RI	22	32	0	866	4	309	0	0	0	0	39	0	940	0	334	0	312	11	0	5/5/2000	10/14/2015	15.44	52	5856	114
Pequonnock River, CT	0	0	0	2	0	1	0	0	0	0	0	0	2	0	1	0	1	0	0	7/14/2010	7/14/2010	0.00	1	22	0
Port Jefferson Harbor, NY	0	0	0	973	0	522	0	0	0	0	495	495	1012	0	495	11	495	32	0	1/24/2006	8/29/2016	10.60	15	6387	1758
Saugatuck Estuary, CT	21	29	0	537	1	3	0	0	0	0	21	0	537	0	21	0	0	11	0	7/1/2006	9/27/2015	9.24	14	2140	166
Stonington Harbor, CT	6	7	0	58	0	0	0	0	0	0	6	0	137	0	77	0	71	3	0	7/3/2008	9/2/2015	7.16	5	821	20
Stony Brook Harbor, NY	0	0	0	359	0	190	0	0	0	32	212	212	376	0	212	5	212	13	0	1/25/2006	8/29/2016	10.59	10	2734	560
Thames River	1	0	1	2	0	1	1	0	0	0	1	1	2	0	3	0	3	2	0	9/18/2006	9/29/2010	4.03	3	45	0
Williams Cove, CT	0	0	0	149	0	0	0	0	0	0	0	0	157	0	108	0	108	0	0	5/13/2009	10/1/2015	6.38	5	1120	0

UWS Data Summary

Embayment	Surface Temperature (°C)	Surface Salinity (ppt)	Surface Dissolved Oxygen (%)	Surface Dissolved Oxygen (mg/L)	Surface Turbidity (NTU)	Surface Chlorophyll-a (ug/L)	Bottom Sample Depth (m)	Bottom Temperature (°C)	Bottom Salinity (ppt)	Bottom Dissolved Oxygen (%)	Bottom Dissolved Oxygen (mg/L)	Bottom Turbidity (NTU)	Bottom Chlorophyll-a (ug/L)	Mid Sample Depth (m)	Mid Temperature (°C)	Mid Salinity (ppt)	Mid Dissolved Oxygen (%)	Mid Dissolved Oxygen (mg/L)	Mid Turbidity (NTU)	Mid Chlorophyll-a (ug/L)	Min date	Max date	# of Years covered	# indiv stations
Alewife Cove	0	0	0	0	0	0	0	0	0	0	0	0	0	61	61	61	61	61	42	61	5/29/2018	9/26/2019	1.33	4
Cove Harbor	79	77	79	79	69	79	79	79	78	79	79	69	79	17	17	17	17	17	15	17	5/12/2018	10/19/2019	1.44	4
Connecticut River	208	118	208	208	182	208	208	208	119	208	208	181	208	2	2	0	2	2	2	2	5/9/2018	11/1/2019	1.48	8
Darien River (Harbor)	84	83	84	84	79	84	84	84	83	84	84	79	84	12	12	12	12	12	10	12	5/12/2018	10/19/2019	1.44	4
Eastchester Bay	196	196	196	196	184	196	196	196	196	196	196	185	196	11	11	11	11	11	11	11	5/18/2018	10/18/2019	1.42	9
Farm River	96	96	96	96	83	89	96	96	96	96	96	83	89	20	20	20	20	20	15	20	6/7/2018	10/27/2019	1.39	7
Goldsmith's Inlet	19	18	19	19	17	19	19	19	18	19	19	18	19	57	57	54	57	57	50	57	5/24/2018	10/30/2019	1.43	4
Hempstead Harbor	132	132	132	132	124	132	132	132	132	132	132	129	131	14	14	14	14	14	12	14	6/12/2018	10/15/2019	1.34	6
Hunter Island Bay	76	76	76	76	72	76	76	76	76	76	76	74	75	0	0	0	0	0	0	0	5/11/2018	10/25/2019	1.46	4
Centerport Harbor	72	72	72	72	56	72	72	72	72	72	72	27	30	21	21	21	21	21	13	17	5/11/2018	10/25/2019	1.46	3
Huntington Bay	72	72	72	72	56	72	72	72	72	72	72	23	30	26	26	26	26	26	14	24	5/10/2018	10/22/2019	1.45	3
Huntington Harbor	117	117	117	117	105	118	117	117	117	117	117	45	50	37	37	37	37	37	33	36	5/10/2018	10/22/2019	1.45	5
Lloyd Harbor	94	94	94	94	85	96	94	94	94	94	94	35	40	9	9	9	9	9	7	7	5/10/2018	10/22/2019	1.45	4
Northport Bay	165	165	165	165	131	165	165	165	165	165	165	64	74	48	48	48	48	48	32	38	5/11/2018	10/25/2019	1.46	7
Northport Harbor	71	71	71	71	65	71	71	71	71	71	71	31	31	10	10	10	10	10	10	10	5/11/2018	10/25/2019	1.46	3
Holly Pond	13	13	13	13	13	13	13	13	13	13	13	13	13	89	89	89	89	89	84	89	5/7/2018	10/29/2019	1.48	4
Housatonic River	110	110	110	110	93	110	110	110	110	110	110	96	110	0	0	0	0	0	0	0	5/16/2018	10/24/2019	1.44	5
Little Neck Bay	220	220	218	219	184	199	220	220	220	220	219	189	199	10	10	10	10	10	10	10	5/8/2018	10/22/2019	1.46	10
Mamaroneck River (Harbor)	44	43	40	40	32	44	44	44	44	40	40	33	44	0	0	0	0	0	0	0	5/9/2018	10/30/2018	0.48	4
Manhasset Bay	223	223	223	223	189	214	223	223	223	223	223	192	214	11	11	11	11	11	11	11	5/9/2018	10/22/2019	1.45	11
Mattituck Creek	105	99	105	105	102	104	105	105	99	105	105	101	104	15	15	15	15	15	15	15	5/23/2018	10/30/2019	1.44	6
Mill River (Southport Harbor)	68	68	68	68	50	56	68	68	68	68	68	62	65	27	27	27	27	27	18	26	5/15/2018	10/30/2019	1.46	4
Niantic River	133	133	133	133	116	133	133	133	133	133	133	126	133	35	35	35	35	35	34	35	5/19/2018	10/19/2019	1.42	8
Nissequogue River	87	87	87	87	71	87	87	87	87	87	87	69	87	87	87	87	87	87	74	87	6/12/2018	10/23/2019	1.36	7
New Rochelle Harbor	76	76	76	76	68	76	76	76	76	76	76	70	76	0	0	0	0	0	0	0	5/11/2018	10/25/2019	1.46	4
Norwalk Harbor	118	118	118	118	105	118	118	118	118	118	118	109	118	0	0	0	0	0	0	0	5/1/2018	10/23/2018	0.48	12
Cold Spring Harbor	147	147	147	147	130	147	147	147	147	147	147	67	75	0	0	0	0	0	0	0	5/9/2018	10/30/2019	1.48	7
Mill Neck Creek	64	64	64	64	64	64	64	64	64	64	64	31	32	2	2	2	2	2	1	1	5/9/2018	10/30/2019	1.48	3
Oyster Bay	85	85	85	85	84	86	85	85	85	85	85	44	44	24	24	24	24	24	10	11	5/9/2018	10/30/2019	1.48	4
Port Jefferson Harbor	232	231	232	232	174	230	232	232	232	232	232	182	231	16	16	16	16	16	13	16	5/13/2018	10/19/2019	1.43	10
Stamford Harbor	162	162	162	162	136	162	162	162	162	162	162	156	162	0	0	0	0	0	0	0	5/8/2018	10/31/2019	1.48	7
Stonington Harbor	106	106	106	106	30	106	106	106	106	106	106	60	106	54	54	54	54	54	24	53	5/14/2018	10/4/2019	1.39	8
Black Rock Harbor	72	72	72	72	52	72	72	72	72	72	72	54	72	0	0	0	0	0	0	0	5/10/2019	10/18/2019	0.44	0
Bronx River	54	54	54	54	33	54	54	54	54	54	54	26	54	0	0	0	0	0	0	0	6/26/2019	10/25/2019	0.33	0
Mamaroneck Harbor	48	48	48	48	36	48	48	48	48	48	48	35	48	0	0	0	0	0	0	0	5/8/2019	10/24/2019	0.46	0
Mystic Harbor	39	39	39	39	35	39	39	39	39	39	39	37	39	6	6	6	6	6	6	6	5/11/2019	10/19/2019	0.44	0
Norwalk Harbor	125	125	125	125	120	125	125	125	125	125	125	120	125	0	0	0	0	0	0	0	5/29/2019	10/16/2019	0.38	0
Scotts Cove	48	48	48	48	48	48	48	48	48	48	48	48	48	0	0	0	0	0	0	0	5/4/2019	10/19/2019	0.46	0

ATTACHMENT 2

TetraTech Subtask D Report

Establishing Nitrogen Endpoints for Three Long Island Sound Watershed Groupings:

Embayments, Large Riverine Systems, and Western Long Island Sound Open Water

Subtask D. Summary of Existing Water Quality Data

Submitted to:

U.S. Environmental Protection Agency
Region 1 and Long Island Sound Office

Submitted by:

Tetra Tech, Inc.

March 27, 2018

This Tetra Tech technical study was commissioned by the United States Environmental Protection Agency (EPA) to synthesize and analyze water quality data to assess nitrogen-related water quality conditions in Long Island Sound and its embayments, based on the best scientific information reasonably available. This study is neither a proposed TMDL, nor proposed water quality criteria, nor recommended criteria. The study is not a regulation, and is not guidance, and cannot impose legally binding requirements on EPA, States, Tribes, or the regulated community, and might not apply to a particular situation or circumstance. Rather, it is intended as a source of relevant information to be used by water quality managers, at their discretion, in developing nitrogen reduction strategies.

Subtask D. Summary of Existing Water Quality Data

Contents

Introduction and Methods Overview

Tetra Tech contacted EPA-recommended water quality monitoring organizations, local monitoring organizations with established Quality Assurance Project Plans (QAPPs) (according to Vaudrey et al. 2013), and other water quality monitoring organizations recommended by local stakeholders to gather water quality data for Long Island Sound (LIS) and its embayments. Tetra Tech also queried the Water Quality Portal for additional water quality data.[1] Tetra Tech reviewed water quality monitoring datasets that met its EPA-approved QAPP requirements and organized those datasets in an Excel spreadsheet (Tetra Tech 2017). Datasets that did not meet Tetra Tech's EPA-approved QAPP requirements were not considered further for this project.

Table D-1 provides a list of organizations considered as data sources for water quality data and a brief description of the source of each organization's dataset. The organizations are listed first by the 14 organizations with data that will be potentially useful for stressor-response analysis to support development of recommended nitrogen endpoints, and second by organizations with datasets considered but not selected (including the reasons why).

Table D-1. Monitoring Organizations Considered

Organization	Source
Data Sources Selected	
Connecticut Department of Energy and Environment (CT DEEP)	Provided by CT DEEP (Chris Bellucci) in December 2016.
EPA National Coastal Condition Assessment (EPA NCCA)	2006 data accessed from the Water Quality Portal in January 2017; 2010 data accessed from EPA's website[a] in January 2017.
EPA Region 1	Provided by EPA Region 1 (Dan Arsenault) in January 2018.
EPA Office of Research and Development (EPA ORD)[b]	Provided by EPA ORD (Jim Latimer) in January 2017.
Friends of the Bay	Provided by Friends of the Bay (Paul DeOrsay) in December 2016.
Harbor Watch Water Quality Monitoring Program of Earthplace (Harbor Watch)	Provided by Harbor Watch (Sarah Crosby) in January 2017.
Interstate Environmental Commission (IEC)	Provided by IEC (Robin Jazxhi) in December 2016.
National Oceanic and Atmospheric Administration Federal Research at Hunts Point (NOAA Hunts Point)	Provided by NOAA (Judy Yaqin Li) in March 2017.
New York City Department of Environmental Protection (NYC DEP)	Provided by NYC DEP (Beau Ranheim) in January 2017.[c]
Stony Brook University–Dr. Gobler's Laboratory	Provided by Stony Brook University (Christopher Gobler) in April 2017.
Suffolk County, NY	Provided by Suffolk County (Nancy Pierson) in January 2017.
University of Connecticut Embayment Research	Provided by Dr. Vaudrey in March 2017.
University of Connecticut Research Data	Provided by Dr. Yarish in March 2017.
University of Rhode Island Watershed Watch (URIWW) Compiled Data[d]	Provided by URIWW (Elizabeth Herron) and Clean Up Sound and Harbors (Fran Pijar) in January 2017.

[1] https://www.waterqualitydata.us/.

Organization	Source
Data Sources Considered but Not Selected	
Maritime Aquarium at Norwalk	Provided by Maritime Aquarium at Norwalk (Tom Naiman) in March 2017. Data were from cruises and did not include nutrient data.
University of Connecticut Researcher Datasets	Data downloaded from the University of Connecticut website.[e] Data are either included in the EPA ORD dataset or are out of the targeted temporal scope of this project.
Cedar Island Marina Research Laboratory	Data requested but not received. Some data from this organization were already included in the EPA ORD dataset.
Coalition to Save Hempstead Harbor	Limited data of interest.
Long Island Sound Integrated Coastal Observing System	Data requested but not received.
CT DEEP (Kelly Streich)	Data requested but not received.
Millstone Environmental Lab	No data available in a readily accessible format. An annual summary report was provided by Millstone Environmental Lab as a PDF.
Rocking the Boat	Data for one station were available within the geographic scope. However, data do not meet QAPP requirements. Data were unremarked, and nondetect results were not included with these data.
Bridgeport Regional Aquaculture Science and Technology Center	Data are stored with Maritime Aquarium at Norwalk, according to staff at Bridgeport Regional Aquaculture Science and Technology Center.
Northport Harbor Water Quality Protection Committee	No data of interest.
Oyster Bay/Cold Spring Harbor Protection Committee	Data are stored with Friends of the Bay, according to staff at Oyster Bay/Cold Spring Harbor Protection Committee.
Setauket Harbor Taskforce	No data of interest.
Manhasset Bay Protection Committee	No data of interest, and data were not collected under a QAPP.
The Yale School of Forestry and Environmental Studies (FES) and University of New Haven	Yale FES was included in the Vaudrey et al. (2013) community survey as not operating under an approved QAPP and not collecting nutrient data (only dissolved oxygen [DO] and physical). Data source not pursued further.
Town of Greenwich, Westchester County, and IEC	Reported by EPA as possible data sources for Byram River. Upon contact, no data of interest available.

[a] https://www.epa.gov/national-aquatic-resource-surveys/data-national-aquatic-resource-surveys.
[b] EPA ORD dataset includes compiled data from EPA, University of Connecticut researchers, and Cedar Island Marina Research Laboratory.
[c] NYC DEP dataset includes data that provide only a result. Results below the detection limit are not included. Tetra Tech will consider in subsequent analysis steps.
[d] URIWW dataset includes compiled data from Clean Up Sound and Harbors, Save the Bay, and Watch Hill Conservancy.
[e] http://www.lisrc.uconn.edu/eelgrass/index.html.

Tetra Tech and EPA worked collaboratively to determine which data sources to include in the analysis, based on applicability (whether the data are potentially useful for stressor-response analyses in estuarine waters), availability (whether the data have been provided and are in an accessible format), and quality (whether the data are of known and documented quality). Table D-2 outlines the overarching rationale for selection of water quality datasets.

Table D-2. Rationale for Selecting Water Quality Data

Applicability of Analysis	
Geographic Scope	Limited to embayments selected by EPA and delineated by Vaudrey et al. (2016) and the open water LIS.
Data Collection Period of Interest	The primary data collection period selected: 2006–2015. This period was chosen as the most recent 10-year period with complete annual water quality data to allow for interannual variability in the characterization of current water quality data loads and concentrations. In some cases, data are included in the final dataset that are outside the data collection period because they might prove useful for embayments with little to no data available for 2006–2015. For some of the stressor-response relationships, data outside the selected data collection period might prove useful for establishing relationships between nutrients and the response variables.
Parameters of Interest	Included the following parameters: nitrogen species, phosphorus species, chlorophyll *a* (chl *a*) (corrected and uncorrected), dissolved oxygen (DO), Secchi depth (SD), and other standard physical (e.g., temperature, pH, salinity, TSS) and biological parameters (e.g., light, algae, benthos, fish species), as available.
Selected Waters	Focus was on data for selected embayments, western LIS embayments, and the Connecticut, Housatonic, and Thames rivers. However, gathering as much water quality data as possible for nitrogen and potential response variables was important to inform empirical stressor-response modeling in estuarine waters. As resources allowed, water quality data were also collected for other embayments and open water areas of LIS to provide a gradient in conditions to inform empirical stressor-response modeling.
Data Availability	
Data Provided	Data provided to Tetra Tech in time for this summary.
Format	Data provided in a readily accessible format for analysis (e.g., a consistently formatted spreadsheet or database).
Data Quality	
Data Collected Under a QAPP	Data collected under a documented quality program.
Tetra Tech QAPP	Data met Tetra Tech's EPA-approved QAPP requirements (Tetra Tech 2017).
Metadata	Data accompanied by appropriate detailed metadata. Tetra Tech referred any questions of data interpretation to the data providers.

Tetra Tech received water quality data in formats ranging from a single spreadsheet to multiple spreadsheets and databases with highly variable organization. Within the project files, Tetra Tech preserved the original data in the form provided by each monitoring organization. To determine whether a dataset should be included, Tetra Tech reviewed each data source using the rationale described in Table D-2. Next Tetra Tech processed and organized the data in a standard format. Tetra Tech created one master file including all processed and organized data from 14 selected data sources (*Appendix D: LIS Water Quality Data*). In addition, Tetra Tech maintained processed files for each dataset separate from the master file. The master file contains an overall stations table, a sample-level data table in wide format (individual columns for each parameter), and a sample-level data table version in long format (all parameters in one column). The overall stations table includes a unique station name, station location coordinates, the selected embayments, monitoring organization, and a summary of key nutrient and response data availability for each monitoring station.

Tetra Tech did not include profile data or additional biological data (e.g., on algae, benthos, fish species) in the overall spreadsheet *Appendix D: LIS Water Quality Data*. These data remain in individual processed spreadsheets for each organization. Complete documentation for each dataset is available upon request, including (1) individual original datasets provided by monitoring organizations; (2) individual processed datasets for each monitoring organization; and (3) detailed processing notes for each dataset. An overview of processing methods is provided in below.

To process the original data received, Tetra Tech extracted data from the original databases and spreadsheets and organized the data in a consistent format. Tetra Tech automated all data transformations (e.g., combining data from multiple tabs or spreadsheets) when possible and performed quality assurance (QA) checks to confirm accuracy of all processing steps. Tetra Tech organized the data from each data source into a standardized format of one worksheet for stations with a unique station identifier, location description, and latitude and longitude; and a second worksheet for the source's water quality data. Organizing data in a standardized format allows for easier comparisons during analysis. For example, in some cases, data were provided in a series of small separate tables by year or by station, which does not allow for easy comparison. Tetra Tech applied the following standardization rules to each dataset:

- Standardized site locations and names to include the monitoring organization and station name to ensure that each station name was unique when combining multiple datasets. Plotted station locations and confirmed missing coordinates or coordinates not matching the station description with the data provider. Standardized coordinates to decimal degrees.
- Embayment assignments were reviewed and modified when they were found to be erroneous based on where data points were located when plotted.
- Excluded blank fields and fields not of interest for this analysis from the processed and organized tables (e.g., parameters not of interest for this analysis, sample or lab notations, fields not populated).
- Standardized field names to a consistent naming format among different datasets to allow for combining fields among datasets (e.g., adjusting date and time combined in one column to two separate columns).
- Standardized formatting of provided data (e.g., changed mm-dd-yy to mm-dd-yyyy).
- Standardized parameter names to a master list of parameter names and included standard units in the name for each parameter (e.g., TN_mg/L). If the original units provided were not in standard units, units were converted (e.g., depth converted from feet to meters, nutrient concentrations converted from µmols to mg/L). Inconsistencies in parameter naming or interpretation were resolved with the data provider.
- Added a numeric sample ID that is unique among all datasets.
- Generated both long and wide formats of the processed and organized data for ease of further analysis. Some data were originally formatted in long formats and others in wide formats.

Depth codes were often available from the original source data and were maintained along with sample depth (when provided). Depth code values include S (surface), M (mid-water), NB (near-bottom), and B (bottom). In cases in which depth codes were not provided, Tetra Tech assigned water chemistry and chl *a* results from 1 m and shallower as surface samples and results deeper than 1 m as bottom samples. A simple surface or bottom designation is sufficient for cases in which depth was not originally provided because those sites are primarily located within embayments, where typically only two water chemistry or chlorophyll samples are available. When datasets included depth profile data for physical parameters (e.g., pH, salinity, temperature, and dissolved oxygen [DO]), those physical parameter values were paired with water chemistry and chl *a* values based on depth. Missing depths and sample times were filled in from neighboring values in the dataset when possible and recommended by the data provider.

In some cases, the parameter name included the depth code, so that information could be added to the depth code field.

Tetra Tech reset results reported as not detected or less than a reported value to one-half of the provided detection limit. Additionally, Tetra Tech added a qualifier column to track which samples included results that are less than the detection limit. Tetra Tech reviewed and interpreted QA comments associated with each sample, when included, to screen sample data from the processed and organized tables (e.g., holding time exceeded, blank contaminated). We did not include non-ambient monitoring data (wastewater effluent) or data not within open water embayments or the LIS (tributaries) in the data selected for analysis. Additionally, Tetra Tech performed a quick screening for erroneous values, nonnumeric results, and missing value codes (e.g., -99) and removed those values from the dataset. While some erroneous values were associated with QA comments questioning the data and would be removed based on the QA comments, Tetra Tech also identified some additional results that were not reasonable. For example, ambient water temperatures greater than 100 °C and pH in excess of 14 were removed from the dataset. As Tetra Tech further analyzed the data to make nitrogen target recommendations, we conducted a more detailed outlier analysis where needed (e.g., looking at reasonable ranges of DO in specific areas).

When nitrogen species, but not TN, were included in a dataset, Tetra Tech calculated TN by summing component N species data. When Photosynthetically Active Radiation (PAR) data were available, Tetra Tech used regression to calculate light attenuation (K_d) using data from 1 to 5 meters in depth. This depth range was used to limit the surface and bottom data discrepancies typical with these data. Tetra Tech matched values for K_d and Secchi depth (SD) with surface water chemistry and chlorophyll data.

As mentioned previously, Tetra Tech performed QA checks when processing and standardizing each dataset. Additionally, Tetra Tech coordinated with the original data provider, when necessary, to clarify and correct any inconsistencies observed.

Results

As described above, water quality monitoring data from 14 organizations were included in the analysis based on data applicability, availability, and quality. These data correspond to 588 monitoring stations within LIS, as shown in Figure D-1, in relation to the selected watershed groupings, open water, and other embayments. Maps included in this subtask illustrate watershed boundaries as delineated by Vaudrey, for which there are associated data. Portions of the maps that are not highlighted indicate that no loading data are available for a given area (e.g., the small portion of land between the Eastern and Western Narrows in Figure D-1). Table D-3 provides a summary, by monitoring organization, of the number of stations, data collection period, and number of samples available for key nutrient and response parameters (TN, TP, chl *a*, DO, and SD). Over 24,000 nutrient parameter samples (TN and TP) and 65,000 response parameter samples (chl *a*, DO, and SD) were processed. A sample for this summary is defined as one station, parameter, day, and depth combination. Nearly 90 percent of these samples were obtained from Connecticut Department of Energy and Environment (CT DEEP), Interstate Environmental Commission (IEC), New York City Department of Environmental Protection (NYC DEP), Suffolk County, and University of Rhode Island Watershed Watch (URIWW). CT DEEP and IEC data are largely from open water areas, while NYC DEP, Suffolk County, and URIWW sampling was targeted more to embayments.

Complete compiled results for these parameters as well as other physical and nutrient parameters (e.g., temperature, salinity, nitrate, ammonia) are included in the spreadsheet *Appendix D: LIS Water Quality*

Data. Profile data and additional biological data (e.g., on algae, benthos, fish species) are included in processed spreadsheets for each organization.

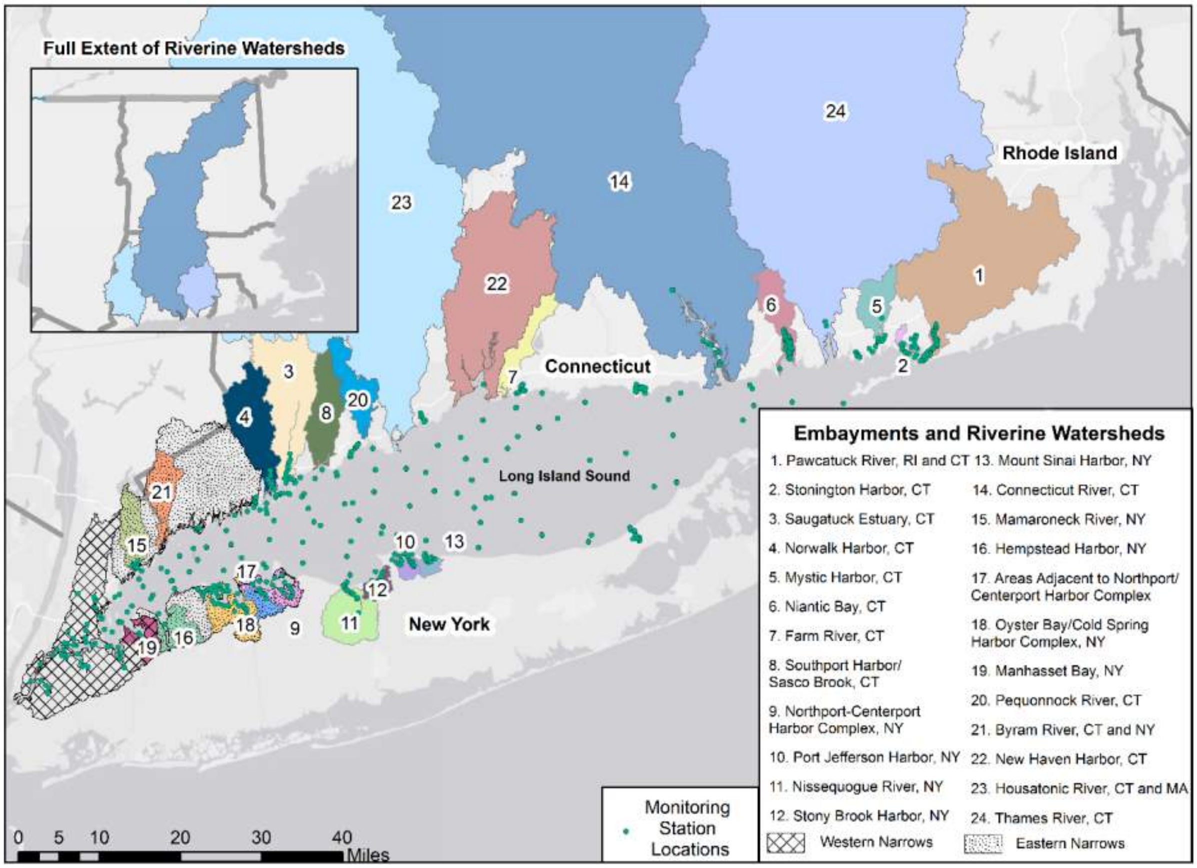


Figure D-1. Monitoring Stations within Watersheds Delineated by Dr. Jamie Vaudrey (University of Connecticut). Portions of the Maps that are Not Highlighted as Part of a Selected Watershed Indicate that No Loading Data are Available for a Given Area (e.g., the Small Portion of Land between the Eastern and Western Narrows).

Table D-3. Monitoring Organization Counts of Stations and Key Nutrient and Response Parameter Samples

Monitoring Organization	Number of Stations	Data Collection Period	Number of Nutrient Samples		Number of Response Samples		
			TN	TP	Chl *a*	DO	SD
CT DEEP	60	2006–2015	4,068	3,956	3,876	8,204	2,295
EPA NCCA	56	2006–2010	54	53	54	72	23
EPA Region 1	7	2017	23	23	23	23	21
EPA ORD	152	2000–2009	88	0	448	1,320	580
Friends of the Bay	22	2008–2014	612	0	0	0	0
Harbor Watch	36	2006–2015	0	0	0	2,343	639
IEC	22	2006–2015	99	99	641	7,574	2,367
NOAA (Hunts Point)	1	2012	26	0	112	143	0
NYC DEP	45	2006–2015	5,179	5,185	5,191	7,828	7,973
Stony Brook University–Dr. Gobler	6	2014–2016	0	0	216	216	210

Monitoring Organization	Number of Stations	Data Collection Period	Number of Nutrient Samples		Number of Response Samples		
			TN	TP	Chl *a*	DO	SD
Suffolk County	57	2006–2015	1,697	1,697	1,547	3,311	1,639
University of Connecticut (Vaudrey)	96	2013–2014[a]	269	0	140	530	19
University of Connecticut (Yarish)	3	2011–2016	0	0	0	0	33
URIWW	25	2007–2015	725	724	942	1,379	365
Total	**588**		**12,840**	**11,737**	**13,190**	**32,943**	**16,164**

[a] Data collected in 2011–2012 were not collected under an established QAPP and did not include indication of nondetect results. These data were not included in the analysis.

Table D-4 summarizes by embayment (selected and other), open water, and western LIS the number of stations and samples for nutrient and response parameter samples (TN, TP, chl *a*, DO, and SD). Of the 588 water quality monitoring stations processed for inclusion in the analysis, 72 percent were located within embayments and 28 percent were located in open water areas of LIS. More than 35 percent of the embayment stations were found within the 23 selected embayments. The western LIS, including open water and embayment areas, has data from 168 stations and 12 monitoring organizations.

Table D-4. Watershed Category Counts of Stations and Key Nutrient and Response Parameter Samples

Watershed Category	Number of Stations	Number of Nutrient Samples		Number of Response Samples		
		TN	TP	Chl *a*	DO	SD
Embayments	421	6,905	5,974	7,018	15,742	9,074
EPA-selected	*274*	*2,665*	*1,997*	*2,870*	*8,595*	*3,301*
Other	*147*	*4,240*	*3,977*	*4,148*	*7,147*	*5,773*
Open Water	167	5,935	5,763	6,172	17,201	7,090
Total	**588**	**12,840**	**11,737**	**13,190**	**32,943**	**16,164**
Western LIS	168	7,867	7,122	7,957	20,284	11,877
Eastern Narrows	*110*	*2,624*	*1,899*	*2,400*	*9,378*	*2,934*
Western Narrows	*58*	*5,243*	*5,223*	*5,557*	*10,906*	*8,943*

Table D-5 includes counts of stations and samples. Also provided in the table are the depths codes and data collection periods for which data were available. Depth codes were added to the data corresponding to surface (S), mid-water (M), near-bottom (NB), and B (bottom). Overall, we found a significant amount of data; however, it varies across the watershed groupings and open water. Of the 23 embayments, 9 embayments have at least 100 TN samples from 2006–2015. Pawcatuck River, RI; Oyster Bay/Cold Spring Harbor Complex, NY; Port Jefferson Harbor, NY; and the Northport-Centerport Harbor Complex, NY, all have more than 300 TN samples and associated response data largely provided by URIWW and Suffolk County. Monitoring data were available for Niantic Bay from EPA ORD and the University of Connecticut (Vaudrey), but largely prior to the primary temporal period of 2006–2015. Nutrient monitoring data were not available from Norwalk Harbor, CT, and no monitoring data of interest were available from the Byram River, CT/NY; Pequonnock River, CT; Farm River, CT; and Southport Harbor/Sasco Brook, CT embayments. The Eastern and Western Narrows had significant water quality monitoring data available. The Connecticut River, CT embayment had limited data available from 11 monitoring stations in 2006 and 2017. The Thames River, CT embayment also had limited data from three monitoring stations from 2006–2010. The Housatonic River, MA/CT embayment had no monitoring data of interest available.

For the stressor-response model, described in Subtasks F/G, Tetra Tech used a hierarchical modeling approach to estimate relationships between nutrients and response endpoints. In hierarchical models, the parameters of the model are assumed to come from a distribution of similar models. For example, the slope and intercept of the simple linear relationship between nitrogen and chlorophyll in any one embayment can be seen as taken from a population of slopes and intercepts that relate nitrogen to chlorophyll for embayments in general. Embayments that are heavily sampled weight this global relationship more than less sampled ones, but they still both reflect an underlying general or global relationship represented by the average slope and intercept across all embayments. Using a hierarchical model, one starts with the global relationship and then weights it using local data, which adjusts the model for that embayment. The best estimate of the model for an unsampled embayment is the global model. Using this approach, Tetra Tech was able to provide models for less sampled or even unsampled embayments. Having data from as many embayments around LIS as possible, however, provides the most accurate results. To estimate endpoints, Tetra Tech used a multiple-lines-of-evidence approach that includes values from the stressor-response modeling, along with values derived from scientific literature and distribution-based approaches.

Table D-5. Counts of Stations and Key Nutrient and Response Parameter Samples

Watershed	Depth Code[a]	Number of Stations	Data Collection Period	Number of Nutrient Samples		Number of Response Samples		
				TN	TP	Chl *a*	DO	SD
Pawcatuck River, RI and CT	S, M, B	52	2000–2015	334	312	642	890	309
Stonington Harbor, CT	S, M, B	5	2008–2015	77	71	73	138	0
Saugatuck Estuary, CT[b]	S, M, B	14	2006–2015	21	0	11	537	3
Norwalk Harbor, CT	S, B	10	2006–2015	0	0	0	1,368	541
Mystic Harbor, CT	S, M, B	6	2000–2015	114	112	104	222	2
Niantic Bay, CT[b]	S, M, B	65	2000–2014	112	0	281	706	259
Farm River, CT	N/A	0	N/A	0	0	0	0	0
Southport Harbor/Sasco Brook, CT[b]	N/A	0	N/A	0	0	0	0	0
Northport-Centerport Harbor Complex, NY[b]	S, B	11	2006–2016	332	332	320	677	340
Port Jefferson Harbor, NY	S, B	15	2006–2016	495	495	464	972	487
Nissequogue River, NY	S, M, B	11	2006–2015	88	69	64	165	66
Stony Brook Harbor, NY	S, B	10	2006–2016	212	212	148	359	158
Mt. Sinai Harbor, NY	S, M, B	10	2006–2016	97	81	117	226	116
Eastern Narrows, CT and NY	S, M, NB, B	110	2003–2016	2,624	1,899	2,400	9,378	2,934
Western Narrows, NY	S, M, B	58	2006–2015	5,243	5,223	5,557	10,906	8,943
Eastern and Western Narrows (Combined), CT and NY	S, M, NB, B	168	2003–2016	7,897	7,122	7,957	20,284	11,877
Connecticut River, CT	S, M, B	11	2006–2017	27	27	27	25	21
Other Embayments	S, M, B	147	2000–2015	4,240	3,977	4,148	7,147	5,773
Open Water	S, M, NB, B	167	2006–2016	5,935	5,763	6,172	17,201	7,090
Mamaroneck River, NY	S, M, B	8	2013–2014	35	0	15	56	4

Watershed	Depth Code[a]	Number of Stations	Data Collection Period	Number of Nutrient Samples		Number of Response Samples		
				TN	TP	Chl *a*	DO	SD
Hempstead Harbor, NY	S, M, B	2	2006–2015	9	9	60	602	216
Huntington Bay, NY	S, B	2	2006–2015	77	77	73	154	79
Huntington Harbor, NY	S, B	5	2006–2016	147	147	180	330	186
Lloyd Harbor, NY	S, B	2	2006–2015	39	39	40	78	40
Oyster Bay/Cold Spring Harbor Complex, NY[b]	S, M, B	27	2008–2016	435	0	48	90	36
Manhasset Bay, NY	S, M, B	3	2006–2015	9	9	90	889	334
Pequonnock River, CT	N/A	0	N/A	0	0	0	0	0
Byram River, CT and NY	N/A	0	N/A	0	0	0	0	0
New Haven Harbor, CT	S, M	2	2006	2	2	2	1	0
Housatonic River, MA and CT	N/A	0	N/A	0	0	0	0	0
Thames River, CT	S, M, B	3	2006–2010	3	3	3	2	1

[a] Depth code values include S (surface), M (mid-water), NB (near-bottom), B (bottom), and N/A (not available).
[b] Includes multiple Vaudrey et al. (2016) embayments. See detailed description sections below.

The following summaries provide an overview of water quality data availability for each selected watershed grouping as well as for other water quality data used for analysis (open water and other embayments).

D.1 Pawcatuck River, RI and CT

Water quality monitoring data were available for the Pawcatuck River embayment from 3 monitoring organizations corresponding to 52 monitoring stations and 5,970 samples from 2000–2015. Data were provided by URIWW from 2007–2015 (4,583 samples), from EPA ORD from 2000–2004 (969 samples), and from University of Connecticut (Vaudrey) from the period 2013–2014 (418 samples).

Figure D-2 shows all monitoring station locations within and around the Pawcatuck River embayment. Table D-6 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-6 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-6, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

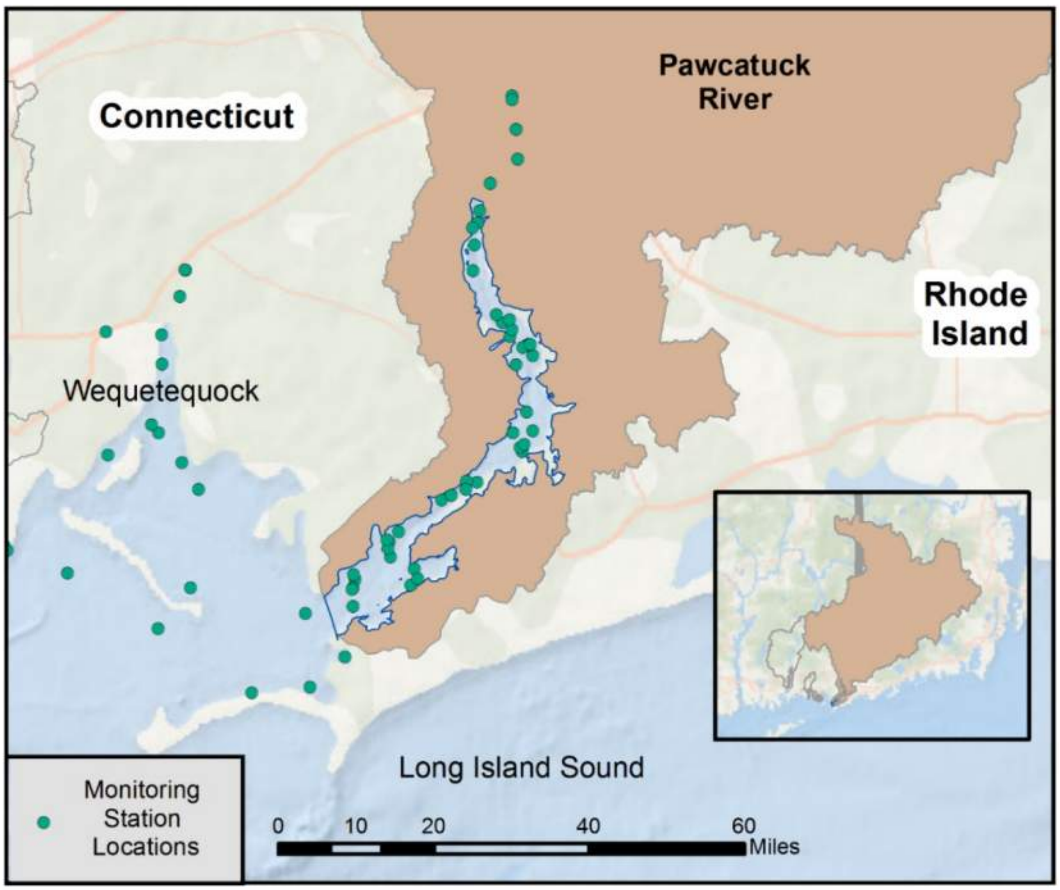


Figure D-2. Pawcatuck River, RI and CT Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-6. Parameter Counts of Stations and Samples for Pawcatuck River, RI and CT Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2000–2003	14	67	42	0	25	0.00	0.24	0.06
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2007–2015	6	248	55	0	193	0.01	0.03	0.02
DON_mgL	Dissolved organic nitrogen [mg/L]	2002–2003	5	17	11	0	6	0.15	0.34	0.26
NH3_mgL	Ammonia–nitrogen [mg/L]	2007–2015	6	313	74	0	239	0.01	0.12	0.05
NH4_mgL	Ammonium [mg/L]	2000–2003	14	78	47	0	31	0.00	0.09	0.01
NO2_mgL	Nitrite [mg/L]	2000–2003	8	13	5	0	8	0.00	0.76	0.30
NO23_mgL	Nitrate + nitrite [mg/L]	2000–2015	20	379	117	0	262	0.01	0.44	0.03
NO3_mgL	Nitrate [mg/L]	2003	3	6	5	0	1	0.02	0.27	0.09
PN_mgL	Particulate nitrogen [mg/L]	2013–2014	5	22	3	0	19	0.02	0.32	0.09
PO4_mgL	Phosphate–P [mg/L]	2013–2014	10	32	3	0	29	0.01	0.04	0.01
TDN_mgL	Total dissolved nitrogen [mg/L]	2002–2014	10	39	14	0	25	0.19	0.79	0.33
TN_mgL	Total nitrogen [mg/L]	2007–2015	11	334	76	0	258	0.29	0.92	0.47
TP_mgL	Total phosphorus [mg/L]	2007–2015	6	312	73	0	239	0.03	0.06	0.04
Response Parameters										
CHLA_µgL [a]	Chl *a* [µg/L]	2000–2004	18	103	66	0	37	1.91	27.30	6.80
CHLAC_µgL [a]	Chl *a*, corrected [µg/L]	2007–2015	11	539	3	0	536	1.20	22.31	5.70
do_mgL	Dissolved oxygen [mg/L]	2000–2015	48	890	302	20	568	5.20	8.80	7.00
do_perc	Dissolved oxygen [% saturation]	2013–2014	10	60	20	20	20	44.91	127.27	91.55
Kd	Kd [m–1], computed from 1–5 m photosynthetically active radiation data	2000–2014	20	73	69	0	4	0.82	2.20	1.26
Macroalgae_gm2	Total macrophyte dry weight [g m–2]	2013–2014	3	4	0	0	4	4.50	1,172.99	329.09
Macrophyte_DW_gm2	Total macroalgae [g m–2]	2013–2014	3	4	0	0	4	4.50	1,172.99	329.09
Seagrass_gm2	Seagrass [g m–2]	2013–2014	3	4	0	0	4	0.00	0.00	0.00
secchi_m	Secchi depth [m]	2003–2014	10	309	15	0	294	0.88	2.50	1.30
Physical Parameters										
pH	pH	2007–2015	16	307	78	13	216	7.18	8.10	8.00
salinity_ppt	Salinity [ppt]	2000–2015	52	866	251	20	595	6.50	33.13	26.73
temp_C	Temperature [deg C]	2000–2015	52	940	298	20	622	14.00	23.50	20.40
TSS_mgL	Total suspended solids [mg/L]	2013–2014	5	11	3	0	8	1.91	9.09	3.96
Total		**2000–2015**	**52**	**5,970**	**1,630**	**93**	**4,247**			

[a] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.2 Stonington Harbor, CT

Water quality monitoring data were available for the Stonington Harbor embayment from 2 monitoring organizations corresponding to 5 monitoring stations and 841 samples from 2008–2015. Data were provided by URIWW from 2008–2015 (749 samples) and from University of Connecticut (Vaudrey) from 2013–2014 (92 samples).

Figure D-3 shows all monitoring station locations within and around the Stonington Harbor embayment. Table D-7 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-7 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-7, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

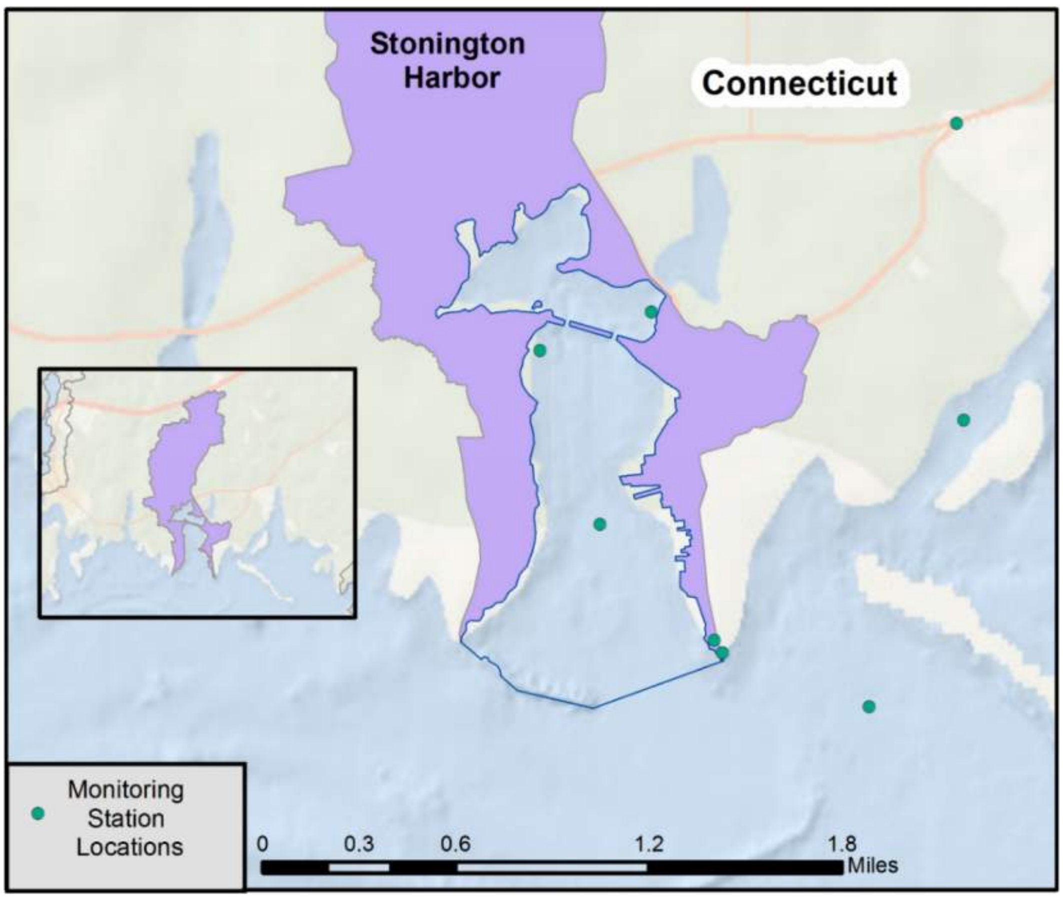


Figure D-3. Stonington Harbor, CT Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-7. Parameter Counts of Stations and Samples for Stonington Harbor, CT Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10^{th} Percentile	90^{th} Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2010–2015	2	41	19	0	22	0.01	0.04	0.03
NH3_mgL	Ammonia–nitrogen [mg/L]	2008–2015	3	70	28	0	42	0.01	0.09	0.05
NO23_mgL	Nitrate + nitrite [mg/L]	2008–2015	3	71	28	0	43	0.01	0.03	0.02
PN_mgL	Particulate nitrogen [mg/L]	2013–2014	2	6	0	0	6	0.03	0.26	0.11
PO4_mgL	Phosphate–P [mg/L]	2013–2014	2	7	0	0	7	0.02	0.06	0.04
TDN_mgL	Total dissolved nitrogen [mg/L]	2013–2014	2	6	0	0	6	0.12	0.16	0.14
TN_mgL	Total nitrogen [mg/L]	2008–2015	5	77	28	0	49	0.23	0.45	0.33
TP_mgL	Total phosphorus [mg/L]	2008–2015	3	71	28	0	43	0.03	0.06	0.04
Response Parameters										
CHLAC_µgL	Chl *a*, corrected [µg/L]	2008–2015	5	73	4	0	69	1.82	6.22	3.70
do_mgL	Dissolved oxygen [mg/L]	2008–2015	5	138	44	4	90	5.50	8.03	6.80
do_perc	Dissolved oxygen [% saturation]	2013–2014	2	12	4	4	4	87.49	100.06	97.40
Physical Parameters										
pH	pH	2008–2015	5	71	26	4	41	7.80	8.00	7.95
salinity_ppt	Salinity [ppt]	2009–2015	4	58	21	4	33	22.78	33.50	32.00
temp_C	Temperature [deg C]	2008–2015	5	137	45	4	88	15.00	23.08	19.70
TSS_mgL	Total suspended solids [mg/L]	2013–2014	2	3	0	0	3	2.28	3.03	2.77
Total		**2008–2015**	**5**	**841**	**275**	**20**	**546**			

D.3 Saugatuck Estuary, CT[2]

Water quality monitoring data were available for the Saugatuck Estuary embayment from 2 monitoring organizations corresponding to 14 monitoring stations and 2,306 samples from 2006–2015. Data were provided by Harbor Watch from 2006–2015 (1,940 samples) for DO, salinity, and temperature (no nutrient data) and from University of Connecticut (Vaudrey) from 2013–2014 (366 samples).

Figure D-4 shows all monitoring station locations within and around the Saugatuck Estuary embayment. Table D-8 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-8 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-8, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

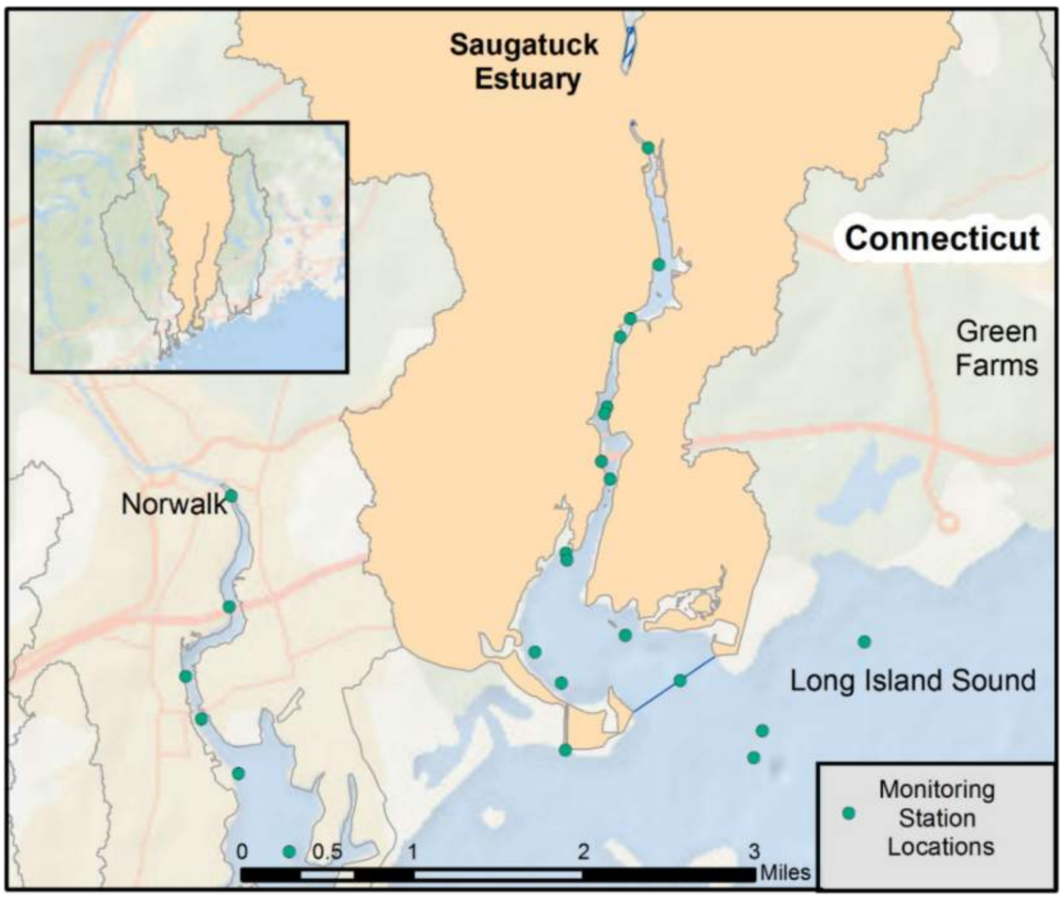


Figure D-4. Saugatuck Estuary, CT Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

[2] Includes two Vaudrey et al. (2016) embayments: Saugatuck River, CT and Saugatuck River, North, CT (freshwater).

Table D-8. Parameter Counts of Stations and Samples for Saugatuck Estuary, CT Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
PN_mgL	Particulate nitrogen [mg/L]	2013–2014	4	21	3	0	18	0.07	0.37	0.21
PO4_mgL	Phosphate–P [mg/L]	2013–2014	8	29	3	0	26	0.02	0.10	0.06
TDN_mgL	Total dissolved nitrogen [mg/L]	2013–2014	4	21	3	0	18	0.19	0.72	0.26
TN_mgL	Total nitrogen [mg/L]	2013–2014	4	21	3	0	18	0.39	0.83	0.57
Response Parameters										
CHLAC_µgL	Chl *a*, corrected [µg/L]	2013–2014	4	11	3	0	8	7.83	13.92	10.78
do_mgL	Dissolved oxygen [mg/L]	2006–2015	14	537	259	16	262	4.25	7.02	5.65
do_perc	Dissolved oxygen [% saturation]	2006–2015	14	537	259	16	262	56.87	96.14	76.27
Kd	Kd [m–1], computed from 1–5m photosynthetically active radiation data	2013–2014	2	4	0	0	4	0.74	1.11	0.86
Macroalgae_gm2	Total macrophyte dry weight [g m–2]	2014	1	1	0	0	1	4.59	4.59	4.59
Macrophyte_DW_gm2	Total macroalgae [g m–2]	2014	1	1	0	0	1	4.59	4.59	4.59
Seagrass_gm2	Seagrass [g m–2]	2014	1	1	0	0	1	0.00	0.00	0.00
secchi_m	Secchi depth [m]	2013–2014	2	3	0	0	3	1.31	1.86	1.54
Physical Parameters										
pH	pH	2013–2014	8	34	12	10	12	7.33	7.74	7.58
salinity_ppt	Salinity [ppt]	2006–2015	14	537	259	16	262	18.86	26.40	23.80
temp_C	Temperature [deg C]	2006–2015	14	537	259	16	262	20.60	24.80	22.70
TSS_mgL	Total suspended solids [mg/L]	2013–2014	4	11	3	0	8	4.32	14.72	5.51
Total		**2006–2015**	**14**	**2,306**	**1,066**	**74**	**1,166**			

D.4 Norwalk Harbor, CT

Water quality monitoring data were available for the Norwalk Harbor embayment from 1 monitoring organization corresponding to 10 monitoring stations and 6,013 samples from 2006–2015. Data were provided by Harbor Watch (no nutrient data).

Figure D-5 shows all monitoring station locations within and around the Norwalk Harbor embayment. Table D-9 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-9 is organized by all available parameters (response and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-9, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

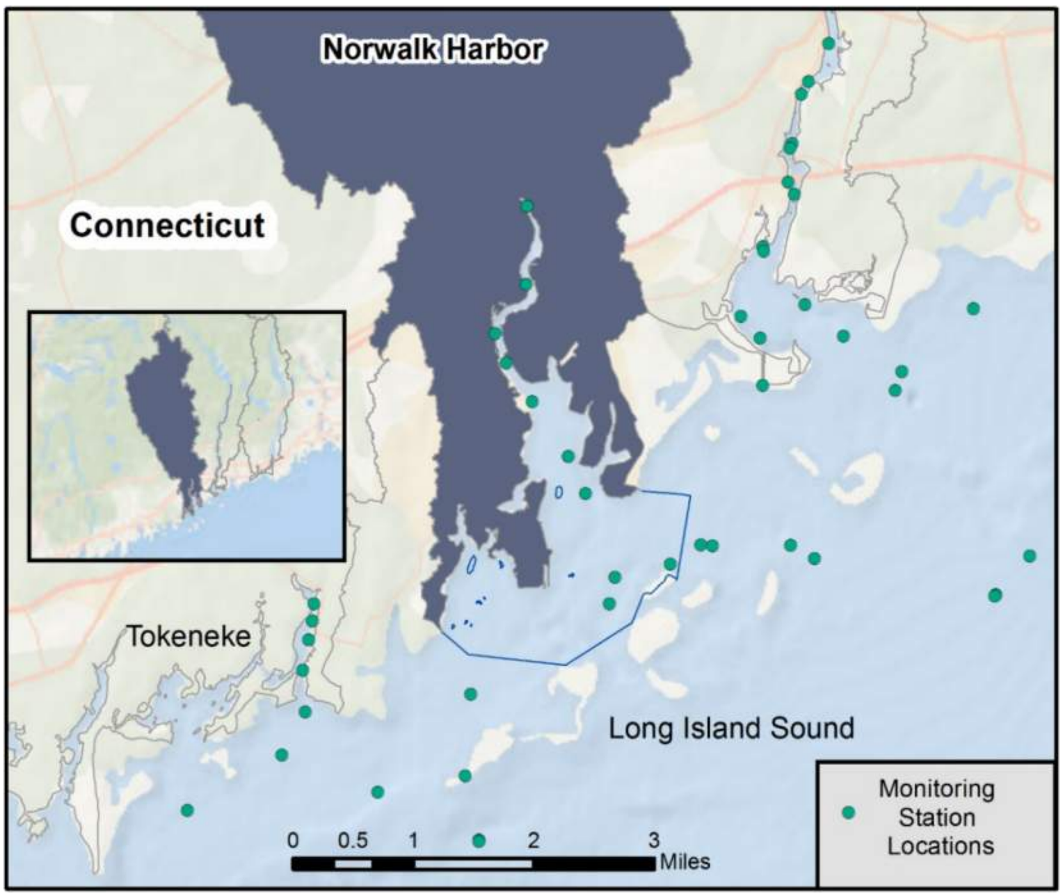


Figure D-5. Norwalk Harbor, CT Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-9. Parameter Counts of Stations and Samples for Norwalk Harbor, CT Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Response Parameters										
do_mgL	Dissolved oxygen [mg/L]	2006–2015	10	1,368	682	0	686	2.24	7.48	5.26
do_perc	Dissolved oxygen [% saturation]	2006–2015	10	1,368	682	0	686	30.72	95.42	72.33
secchi_m	Secchi depth [m]	2006–2015	10	541	0	0	541	0.90	1.70	1.20
Physical Parameters										
salinity_ppt	Salinity [ppt]	2006–2015	10	1,368	682	0	686	22.40	27.10	25.00
temp_C	Temperature [deg C]	2006–2015	10	1,368	682	0	686	17.70	25.10	22.90
Total		**2006–2015**	**10**	**6,013**	**2,728**	**0**	**3,285**			

D.5 Mystic Harbor, CT

Water quality monitoring data were available for the Mystic Harbor embayment from 2 monitoring organizations corresponding to 6 monitoring stations and 1,376 samples from 2000–2015. Data were provided by URIWW from 2009–2015 (1,347 samples) and from EPA ORD from 2000–2004 (29 samples).

Figure D-6 shows all monitoring station locations within and around the Mystic Harbor embayment. Table D-10 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-10 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-10, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

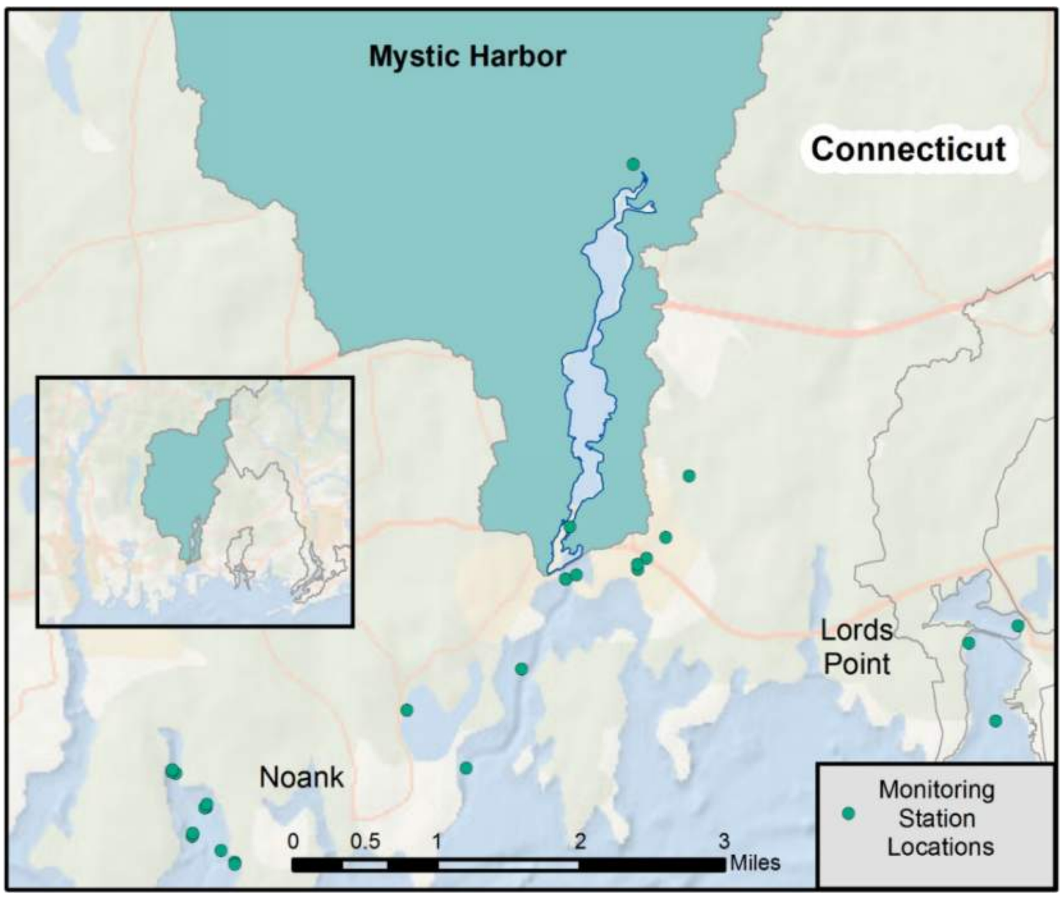


Figure D-6. Mystic Harbor, CT Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-10. Parameter Counts of Stations and Samples for Mystic Harbor, CT Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2000–2004	3	3	0	0	3	0.03	0.09	0.06
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2010–2015	3	96	38	0	58	0.01	0.05	0.02
NH3_mgL	Ammonia–nitrogen [mg/L]	2009–2015	3	112	45	0	67	0.03	0.15	0.09
NH4_mgL	Ammonium [mg/L]	2000–2004	2	2	0	2	0	0.04	0.06	0.05
NO23_mgL	Nitrate + nitrite [mg/L]	2000–2015	6	116	44	2	70	0.01	0.07	0.02
TN_mgL	Total nitrogen [mg/L]	2004–2015	4	114	44	1	69	0.39	0.75	0.53
TP_mgL	Total phosphorus [mg/L]	2009–2015	3	112	44	0	68	0.03	0.08	0.05
Response Parameters										
CHLA_µgL[a]	Chl *a* [µg/L]	2000–2004	3	3	0	2	1	2.62	10.94	9.88
CHLAC_µgL[a]	Chl *a*, corrected [µg/L]	2010–2015	2	101	0	0	101	2.90	17.00	8.50
do_mgL	Dissolved oxygen [mg/L]	2000–2015	5	222	82	0	140	5.10	7.95	6.60
secchi_m	Secchi depth [m]	2000–2001	2	2	0	2	0	1.02	1.18	1.10
Physical Parameters										
pH	pH	2009–2015	3	89	32	0	57	7.70	8.00	7.90
salinity_ppt	Salinity [ppt]	2000–2015	5	170	58	0	112	22.60	32.00	30.00
temp_C	Temperature [deg C]	2000–2015	5	231	80	0	151	15.40	25.00	20.00
TSS_mgL	Total suspended solids [mg/L]	2000–2004	3	3	0	2	1	5.20	17.20	6.00
Total		**2000–2015**	**6**	**1,376**	**467**	**11**	**898**			

[a] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.6 Niantic Bay, CT[3]

Water quality monitoring data were available for the Niantic Bay embayment from 2 monitoring organizations corresponding to 65 monitoring stations and 5,830 samples from 2000–2014. Data were provided by EPA ORD from 2000–2004 (5,337 samples) and from University of Connecticut (Vaudrey) from 2013–2014 (493 samples).

Figure D-7 shows all monitoring station locations within and around the Niantic Bay embayment. Table D-11 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-11 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-11, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

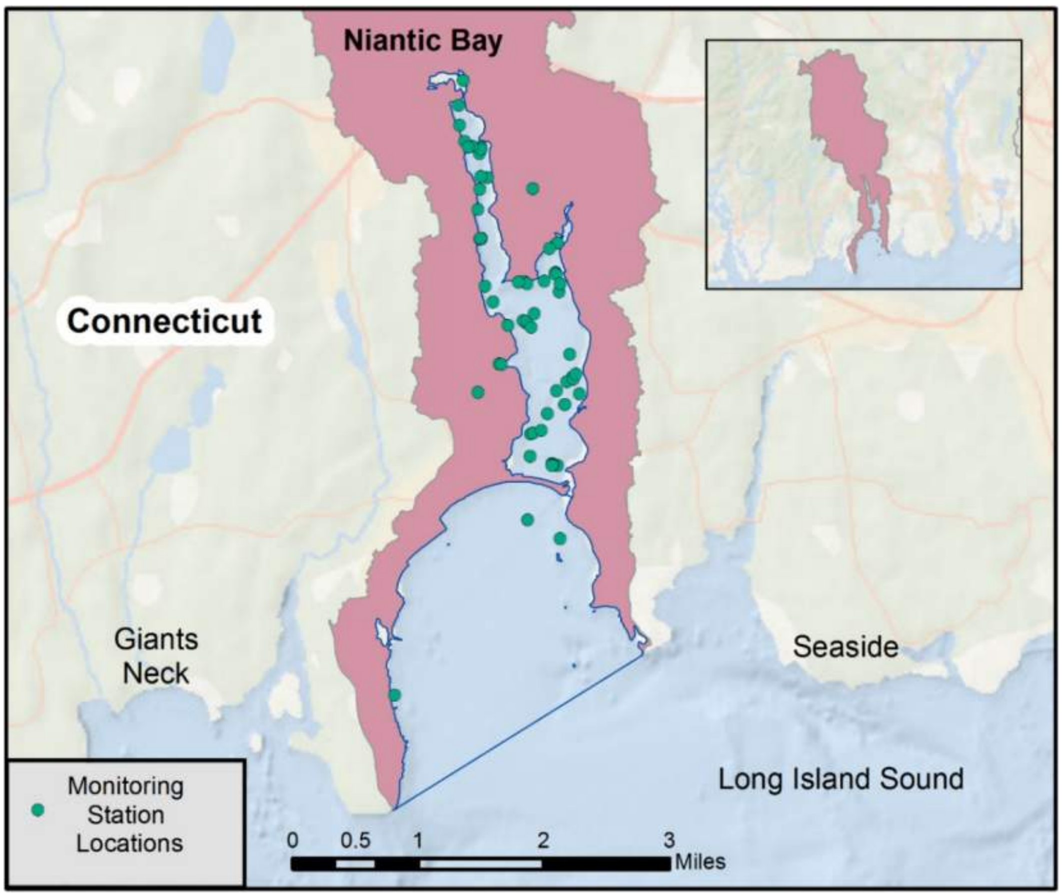


Figure D-7. Niantic Bay, CT Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

[3] Includes two Vaudrey et al. (2016) embayments: Niantic River, CT and Niantic Bay, CT.

Table D-11. Parameter Counts of Stations and Samples for Niantic Bay, CT Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2000–2004	39	542	101	0	441	0.00	0.13	0.03
DON_mgL	Dissolved organic nitrogen [mg/L]	2002–2003	20	153	34	0	119	0.14	0.24	0.18
NH4_mgL	Ammonium [mg/L]	2000–2004	38	553	113	1	439	0.00	0.06	0.01
NO2_mgL	Nitrite [mg/L]	2003	7	65	34	0	31	0.00	0.01	0.00
NO23_mgL	Nitrate + nitrite [mg/L]	2000–2004	39	528	96	2	430	0.00	0.08	0.01
NO3_mgL	Nitrate [mg/L]	2003	7	68	35	0	33	0.00	0.05	0.00
PN_mgL	Particulate nitrogen [mg/L]	2013–2014	7	26	4	0	22	0.05	0.24	0.12
PO4_mgL	Phosphate–P [mg/L]	2013–2014	12	38	4	0	34	0.01	0.04	0.02
TDN_mgL	Total dissolved nitrogen [mg/L]	2002–2014	17	93	38	0	55	0.15	0.29	0.20
TN_mgL	Total nitrogen [mg/L]	2002–2014	18	112	4	1	107	0.17	0.38	0.26
Response Parameters										
CHLA_µgL[a]	Chl *a* [µg/L]	2000–2004	33	266	126	2	138	1.67	14.06	5.43
CHLAC_µgL[a]	Chl *a*, corrected [µg/L]	2013–2014	7	15	4	0	11	1.80	6.99	3.37
do_mgL	Dissolved oxygen [mg/L]	2000–2014	64	706	508	21	177	4.18	9.30	7.23
do_perc	Dissolved oxygen [% saturation]	2013–2014	12	68	24	21	23	70.11	128.94	99.28
Kd	Kd [m–1], computed from 1–5m photosynthetically active radiation data	2000–2014	34	144	138	0	6	0.46	0.94	0.65
Macroalgae_gm2	Total macrophyte dry weight [g m–2]	2013–2014	7	8	0	0	8	4.36	106.11	6.72
Macrophyte_DW_gm2	Total macroalgae [g m–2]	2013–2014	7	8	0	0	8	4.36	206.36	19.35
Seagrass_gm2	Seagrass [g m–2]	2013–2014	7	8	0	0	8	0.00	92.36	0.00
secchi_m	Secchi depth [m]	2002–2013	30	259	248	10	1	1.20	2.50	1.75
Physical Parameters										
pH	pH	2013–2014	12	44	16	13	15	4.27	8.01	6.33
salinity_ppt	Salinity [ppt]	2000–2014	64	1,057	532	21	504	24.70	31.70	29.70
temp_C	Temperature [deg C]	2000–2014	64	1,052	532	21	499	6.19	24.28	20.30
TSS_mgL	Total suspended solids [mg/L]	2000–2014	9	17	4	2	11	1.81	6.12	2.61
Total		**2000–2014**	**65**	**5,830**	**2,595**	**115**	**3,120**			

[a] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.7 Farm River, CT

No water quality data were available for the Farm River embayment. Figure D-8 shows the Farm River embayment. To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used data from other embayments and open water. Refer to Subtasks F and G for additional information.

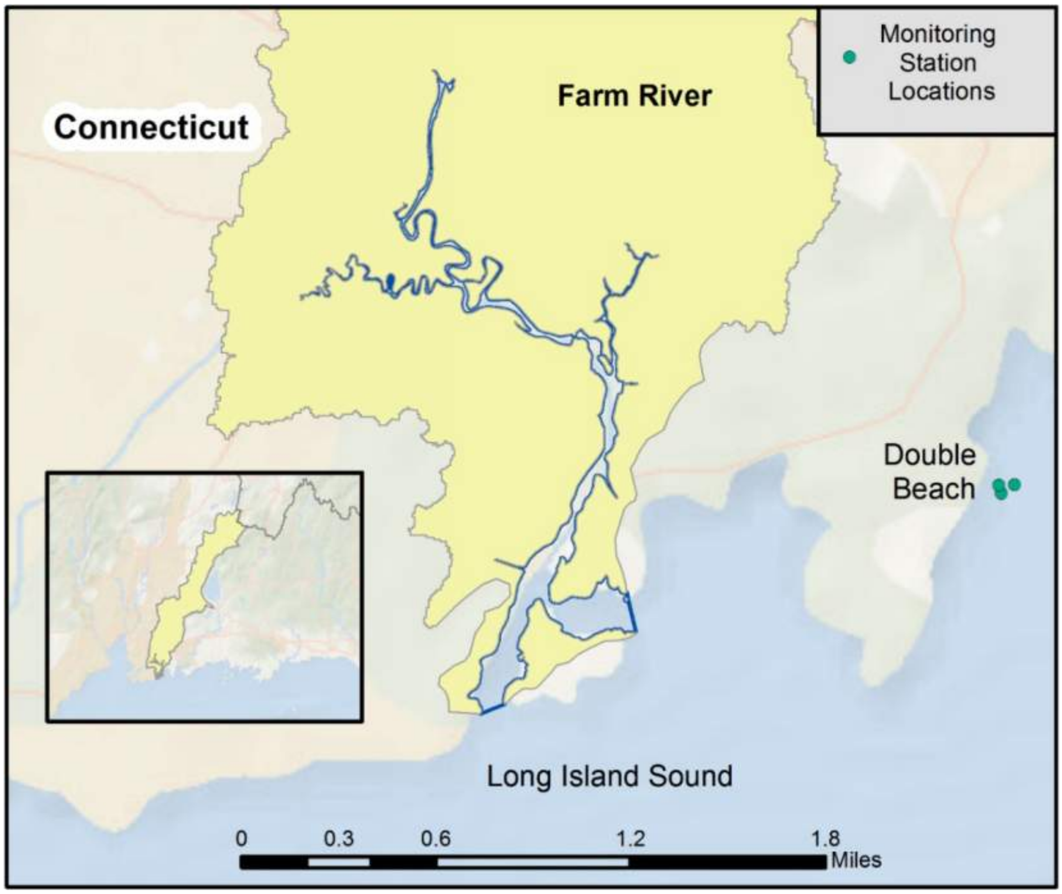


Figure D-8. Farm River, CT Embayment and Nearby Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

D.8 Southport Harbor/Sasco Brook, CT[4]

No water quality data were available for the Southport Harbor/Sasco Brook embayment. Figure D-9 shows the Southport Harbor/Sasco Brook embayment. To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used data from other embayments and open water. Refer to Subtasks F and G for additional information.

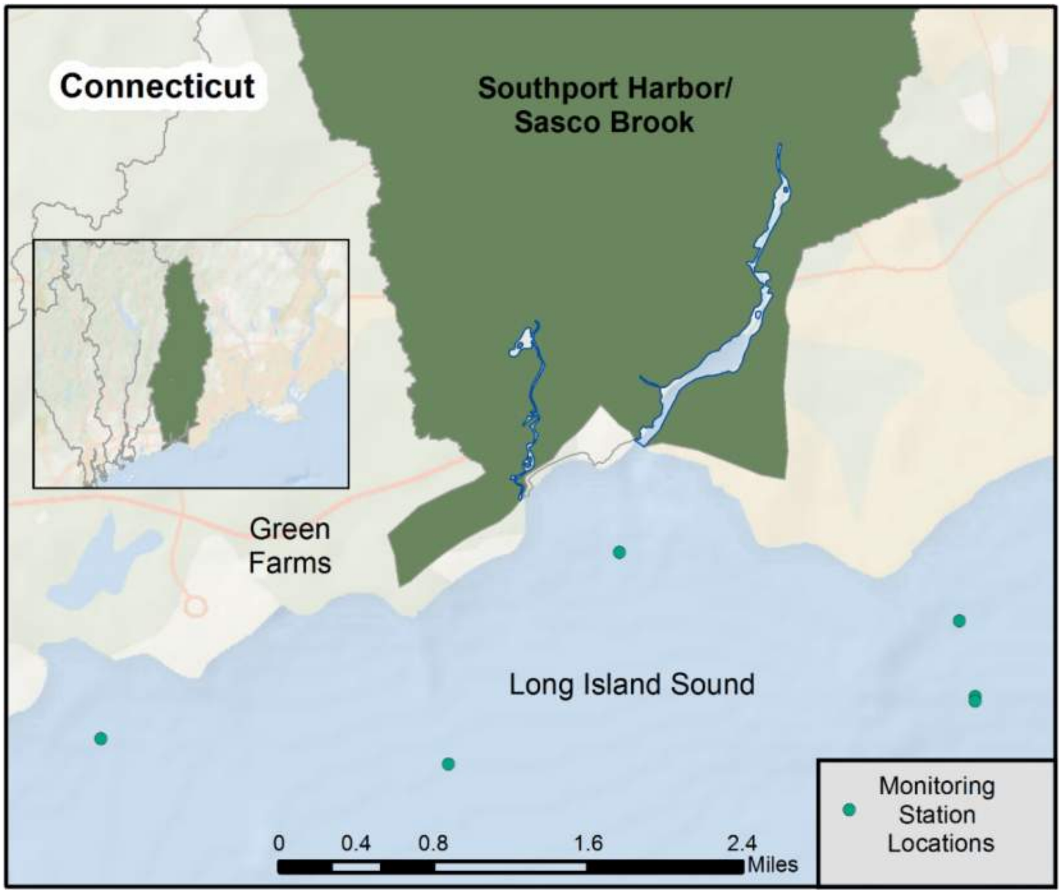


Figure D-9. Southport Harbor/Sasco Brook, CT Embayment and Nearby Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

[4] Includes two Vaudrey et al. (2016) embayments: Mill River, CT and Sasco Brook, CT.

D.9 Northport–Centerport Harbor Complex, NY[5]

Water quality monitoring data were available for the Northport–Centerport Harbor Complex embayment from 2 monitoring organizations corresponding to 11 monitoring stations and 5,649 samples from 2006–2016. Data were provided by Suffolk County from 2006–2015 (5,524 samples) and by Stony Brook University–Dr. Christopher Gobler from 2014–2016 (125 samples).

Figure D-10 shows all monitoring station locations within and around the Northport–Centerport Harbor Complex embayment. Table D-12 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-12 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-12, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

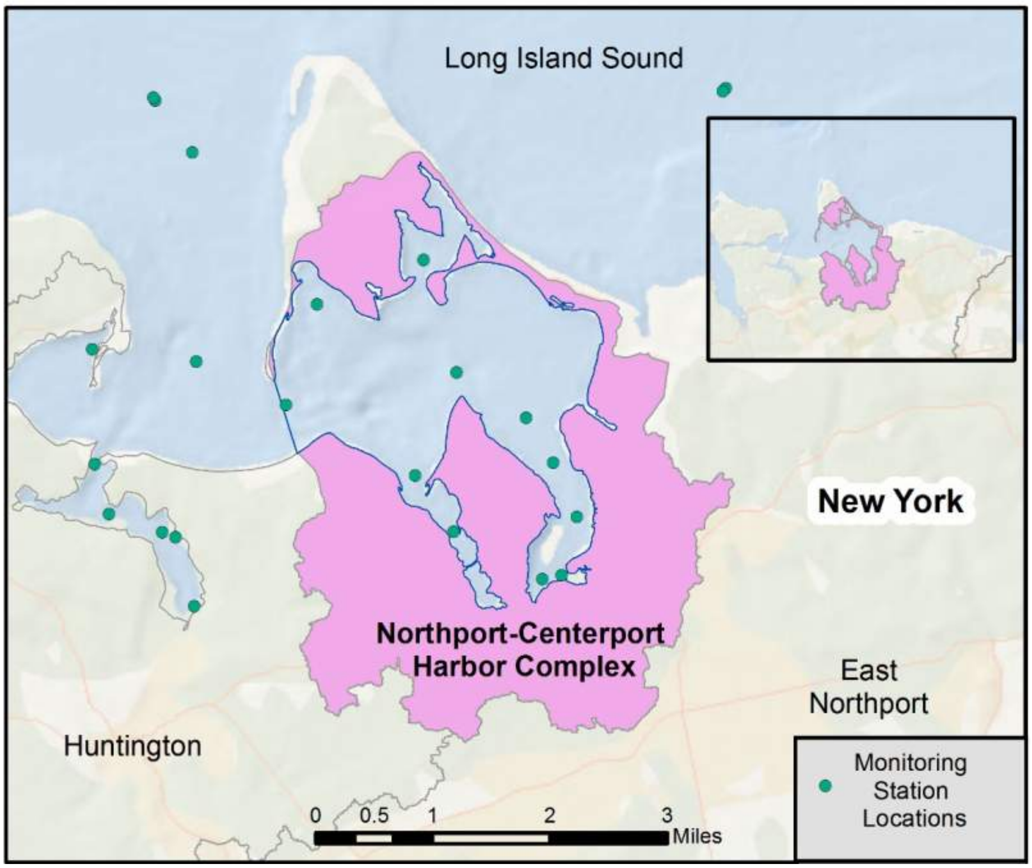


Figure D-10. Northport–Centerport Harbor Complex, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

[5] Includes three Vaudrey et al. (2016) embayments: Centerport Harbor, NY; Northport Bay, NY; and Northport Harbor, NY.

Table D-12. Parameter Counts of Stations and Samples for Northport–Centerport Harbor Complex, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	9	338	0	0	338	0.01	0.08	0.03
NH3_mgL	Ammonia–nitrogen [mg/L]	2006–2015	9	338	0	0	338	0.01	0.09	0.01
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	9	338	0	0	338	0.00	0.37	0.07
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	9	333	0	0	333	0.17	0.66	0.34
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	9	333	0	0	333	0.03	0.07	0.03
TN_mgL	Total nitrogen [mg/L]	2006–2015	9	332	0	0	332	0.22	0.67	0.40
TP_mgL	Total phosphorus [mg/L]	2006–2015	9	332	0	0	332	0.03	0.09	0.05
Response Parameters										
CHLA_ugL[b]	Chl *a* [ug/L]	2014–2016	1	36	30	0	0	6.67	40.46	16.90
CHLAC_µgL[b]	Chl *a*, corrected [µg/L]	2006–2015	9	320	0	0	320	1.51	21.04	5.74
do_mgL	Dissolved oxygen [mg/L]	2006–2016	11	713	368	0	339	5.70	12.30	8.40
secchi_m	Secchi depth [m]	2006–2016	10	376	30	0	340	0.91	2.74	1.52
Physical Parameters										
DOC_mgL	Dissolved organic carbon [mg/L]	2007	7	7	0	0	7	1.95	2.16	2.03
pH	pH	2010–2015	9	451	162	0	289	7.60	8.22	7.90
salinity_ppt	Salinity [ppt]	2006–2015	10	677	338	0	339	23.70	27.10	25.50
temp_C	Temperature [deg C]	2006–2016	11	694	355	0	339	5.20	23.60	14.75
TOC_mgL	Total organic carbon [mg/L]	2007	7	7	0	0	7	2.09	2.26	2.13
TSS_mgL	Total suspended solids [mg/L]	2006–2010	2	24	0	0	24	7.30	13.40	11.00
Total		**2006–2016**	**11**	**5,649**	**1,283**	**0**	**4,348**			

[a] Some data had missing depth information in the original source and, therefore, have no depth codes. In this case, adding together the three totals from *# of samples by depth* will not add up to the total for *# of samples*.
[b] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.10 Port Jefferson Harbor, NY

Water quality monitoring data were available for the Port Jefferson Harbor embayment from 2 monitoring organizations corresponding to 15 monitoring stations and 8,145 samples from 2006–2016. Data were provided by Suffolk County from 2006–2015 (8,021 samples) and by Stony Brook University–Dr. Christopher Gobler from 2014–2016 (124 samples).

Figure D-11 shows all monitoring station locations within and around the Port Jefferson Harbor embayment. Table D-13 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-13 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-13, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

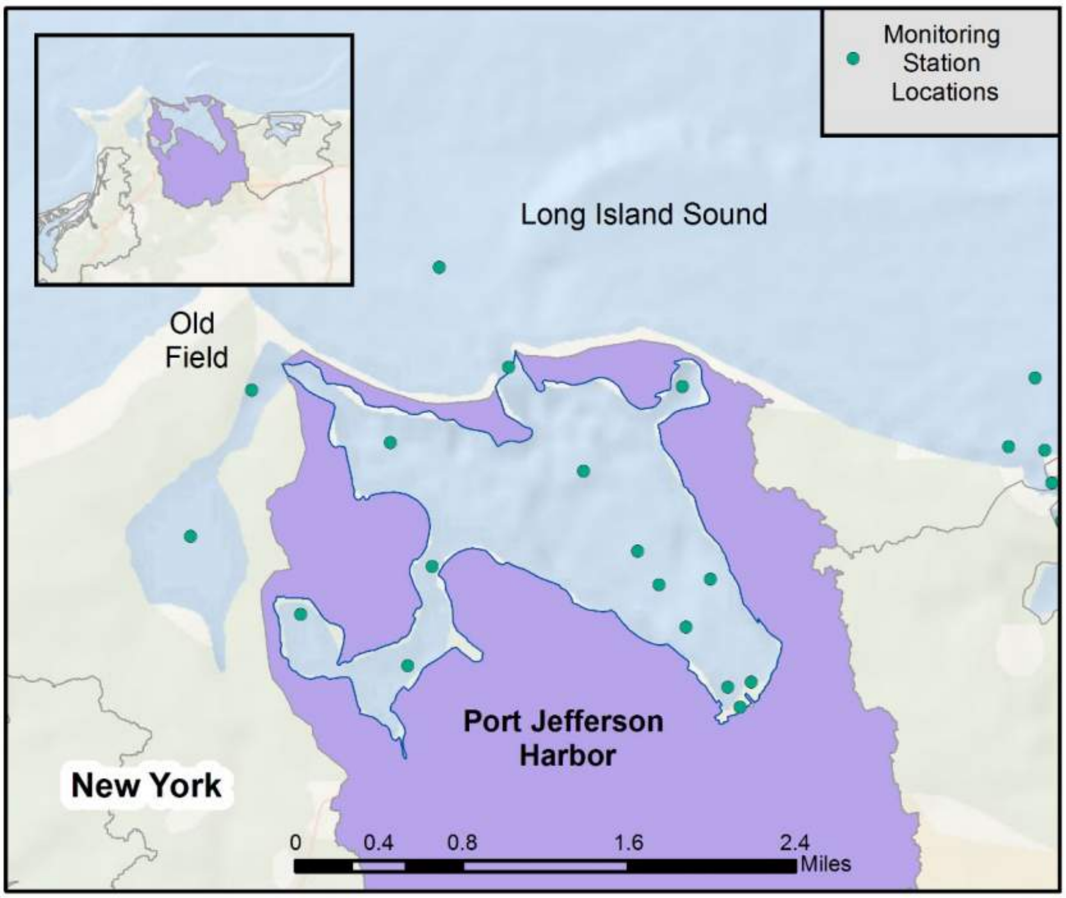


Figure D-11. Port Jefferson Harbor, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-13. Parameter Counts of Stations and Samples for Port Jefferson Harbor, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	14	495	0	0	495	0.01	0.08	0.03
NH3_mgL	Ammonia–nitrogen [mg/L]	2006–2015	14	484	0	0	484	0.01	0.06	0.01
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	14	495	0	0	495	0.00	0.29	0.02
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	14	495	0	0	495	0.13	0.51	0.25
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	14	495	0	0	495	0.03	0.06	0.03
TN_mgL	Total nitrogen [mg/L]	2006–2015	14	495	0	0	495	0.16	0.53	0.29
TP_mgL	Total phosphorus [mg/L]	2006–2015	14	495	0	0	495	0.03	0.07	0.03
Response Parameters										
CHLA_ugL[b]	Chl *a* [ug/L]	2014–2016	1	36	29	0	0	2.99	8.72	5.47
CHLAC_µgL[b]	Chl *a*, corrected [µg/L]	2006–2015	13	464	0	0	464	1.07	11.98	4.27
do_mgL	Dissolved oxygen [mg/L]	2006–2016	15	1,008	515	0	486	6.40	12.30	8.60
secchi_m	Secchi depth [m]	2006–2016	15	522	29	0	487	1.22	3.66	2.13
Physical Parameters										
DOC_mgL	Dissolved organic carbon [mg/L]	2007	11	11	0	0	11	1.81	1.91	1.84
pH	pH	2010–2015	12	622	237	0	385	7.80	8.30	8.00
salinity_ppt	Salinity [ppt]	2006–2015	14	973	486	0	487	24.90	28.10	26.70
temp_C	Temperature [deg C]	2006–2016	15	1,012	512	0	498	2.31	23.20	12.45
TOC_mgL	Total organic carbon [mg/L]	2007	11	11	0	0	11	1.80	2.08	1.90
TSS_mgL	Total suspended solids [mg/L]	2006–2009	4	32	0	0	32	2.75	21.90	10.50
Total		**2006–2016**	**15**	**8,145**	**1,808**	**0**	**6,315**			

[a] Some data had missing depth information in the original source and, therefore, have no depth codes. In this case, adding together the three totals from *# of samples by depth* will not add up to the total for *# of samples*.

[b] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.11 Nissequogue River, NY

Water quality monitoring data were available for the Nissequogue River embayment from 2 monitoring organizations corresponding to 11 monitoring stations and 1,361 samples from 2006–2015. Data were provided by Suffolk County from 2006–2015 (1,089 samples) and from University of Connecticut (Vaudrey) from 2013–2014 (272 samples).

Figure D-12 shows all monitoring station locations within and around the Nissequogue River embayment. Table D-14 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-14 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-14, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

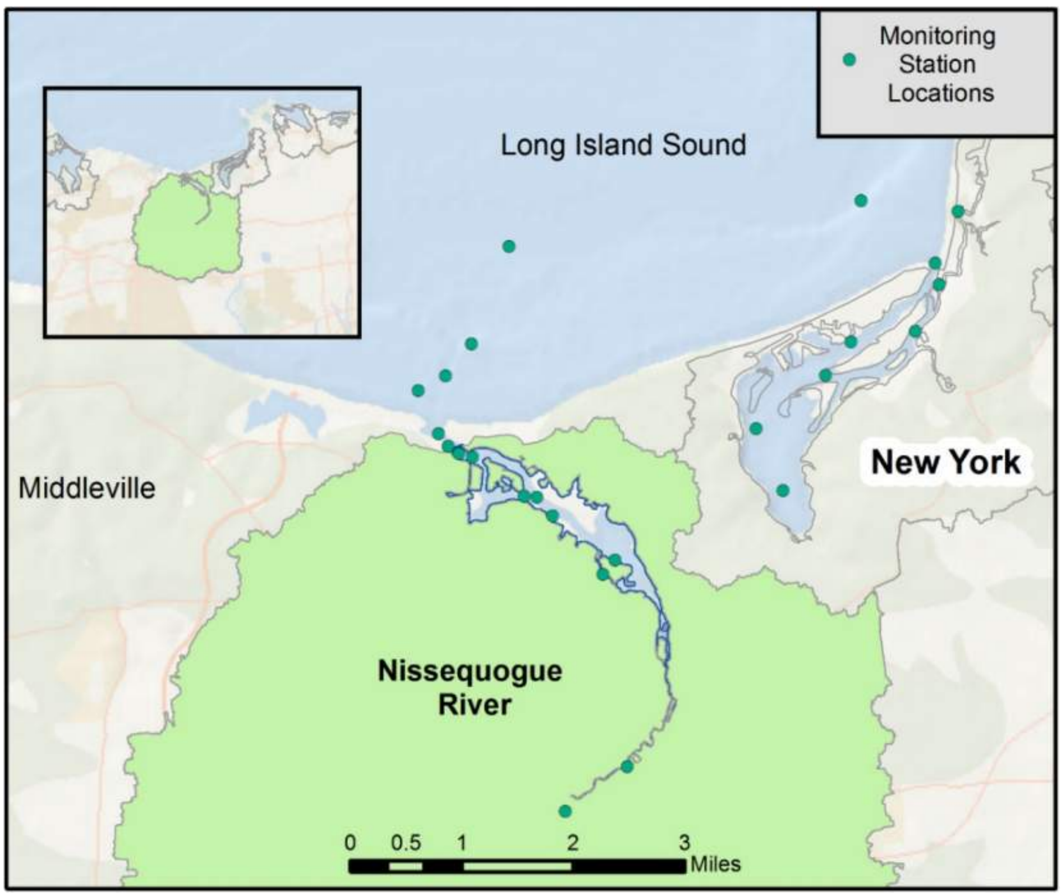


Figure D-12. Nissequogue River, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-14. Parameter Counts of Stations and Samples for Nissequogue River, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	3	69	0	0	69	0.01	0.07	0.04
NH3_mgL	Ammonia–nitrogen [mg/L]	2006–2015	3	66	0	0	66	0.01	0.06	0.03
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	3	69	0	0	69	0.02	0.28	0.11
PN_mgL	Particulate nitrogen [mg/L]	2013–2014	5	20	4	0	16	0.05	0.24	0.13
PO4_mgL	Phosphate–P [mg/L]	2013–2014	8	27	4	0	23	0.01	0.07	0.03
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	8	88	4	0	84	0.20	1.50	0.35
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	3	69	0	0	69	0.03	0.06	0.03
TN_mgL	Total nitrogen [mg/L]	2006–2015	8	88	4	0	84	0.23	1.64	0.38
TP_mgL	Total phosphorus [mg/L]	2006–2015	3	69	0	0	69	0.03	0.07	0.03
Response Parameters										
CHLAC_µgL	Chl *a*, corrected [µg/L]	2006–2015	6	64	4	0	60	1.48	17.98	3.25
do_mgL	Dissolved oxygen [mg/L]	2006–2015	9	165	77	11	77	5.34	12.50	8.20
do_perc	Dissolved oxygen [% saturation]	2013–2014	6	33	11	11	11	62.16	94.94	70.45
Macroalgae_gm2	Total macrophyte dry weight [g m–2]	2014	3	3	0	0	3	0.00	93.92	0.00
Macrophyte_DW_gm2	Total macroalgae [g m–2]	2014	3	3	0	0	3	30.80	114.42	102.52
Seagrass_gm2	Seagrass [g m–2]	2014	3	3	0	0	3	0.00	0.00	0.00
secchi_m	Secchi depth [m]	2006–2015	3	66	0	0	66	1.52	3.05	2.13
Physical Parameters										
DOC_mgL	Dissolved organic carbon [mg/L]	2007	3	3	0	0	3	1.62	1.67	1.65
pH	pH	2010–2015	8	108	40	10	58	7.40	8.18	7.70
salinity_ppt	Salinity [ppt]	2006–2015	9	165	77	11	77	14.72	27.20	25.20
temp_C	Temperature [deg C]	2006–2015	9	165	77	11	77	4.40	23.16	15.40
TOC_mgL	Total organic carbon [mg/L]	2007	3	3	0	0	3	1.55	1.58	1.56
TSS_mgL	Total suspended solids [mg/L]	2006–2014	4	15	4	0	11	2.96	10.00	7.00
Total		**2006–2015**	**11**	**1,361**	**306**	**54**	**1,001**			

D.12 Stony Brook Harbor, NY

Water quality monitoring data were available for the Stony Brook Harbor embayment from 2 monitoring organizations corresponding to 10 monitoring stations and 3,294 samples from 2006–2016. Data were provided by Suffolk County from 2006–2015 (3,173 samples) and by Stony Brook University–Dr. Christopher Gobler from 2014–2016 (121 samples).

Figure D-13 shows all monitoring station locations within and around the Stony Brook Harbor embayment. Table D-15 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-15 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-15, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

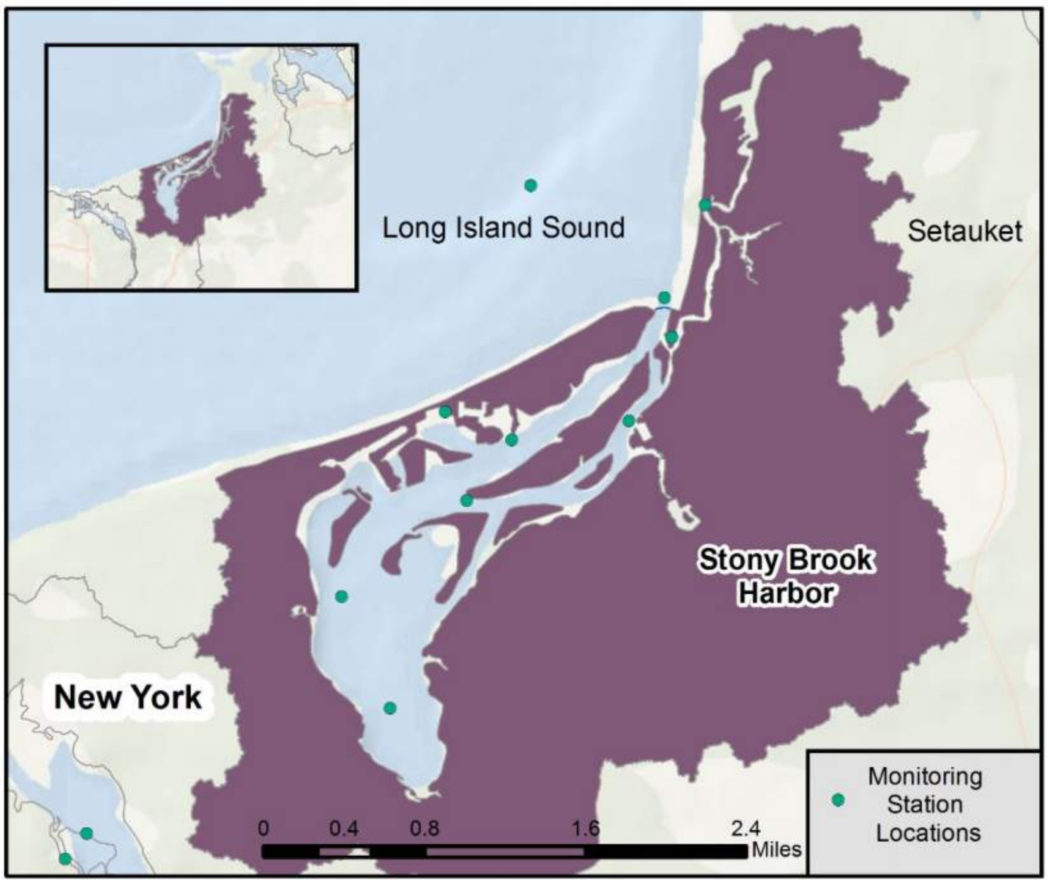


Figure D-13. Stony Brook Harbor, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-15. Parameter Counts of Stations and Samples for Stony Brook Harbor, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	9	205	0	0	205	0.01	0.07	0.04
NH3_mgL	Ammonia–nitrogen [mg/L]	2006–2015	9	206	0	0	206	0.01	0.05	0.01
NO2_mgL	Nitrite [mg/L]	2006–2007	2	11	0	0	11	0.01	0.02	0.01
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	9	207	0	0	207	0.00	0.18	0.05
NO3_mgL	Nitrate [mg/L]	2006	2	5	0	0	5	0.10	0.64	0.10
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	9	212	0	0	212	0.14	0.44	0.28
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	9	212	0	0	212	0.03	0.06	0.03
TN_mgL	Total nitrogen [mg/L]	2006–2015	9	212	0	0	212	0.14	0.46	0.31
TP_mgL	Total phosphorus [mg/L]	2006–2015	9	212	0	0	212	0.03	0.07	0.03
Response Parameters										
CHLA_ugL[b]	Chl *a* [ug/L]	2014–2016	1	36	23	0	6	2.57	6.615	4.69
CHLAC_µgL[b]	Chl *a*, corrected [µg/L]	2006–2015	7	148	0	0	148	1.54	12.52	3.37
do_mgL	Dissolved oxygen [mg/L]	2006–2016	10	395	179	0	209	6.2	12.7	8.9
secchi_m	Secchi depth [m]	2006–2016	8	190	21	0	164	1.22	3.35	1.98
Physical Parameters										
cond_µScm	Conductivity [µS/cm]	2011–2015	2	32	0	0	32	37,288.83	41,024.44	40,044.50
DOC_mgL	Dissolved organic carbon [mg/L]	2007	5	5	0	0	5	1.61	1.76	1.69
pH	pH	2006–2015	9	253	92	0	161	7.50	8.30	7.90
salinity_ppt	Salinity [ppt]	2006–2015	9	359	156	0	203	24.48	27.60	26.20
temp_C	Temperature [deg C]	2006–2016	10	376	169	0	205	3.5	23.9	14.6
TOC_mgL	Total organic carbon [mg/L]	2007	5	5	0	0	5	1.63	1.79	1.71
TSS_mgL	Total suspended solids [mg/L]	2006–2010	2	13	0	0	13	3.00	16.80	7.00
Total		**2006–2016**	**10**	**3,294**	**640**	**0**	**2,633**			

[a] Some data had missing depth information in the original source and, therefore, have no depth codes. In this case, adding together the three totals from *# of samples by depth* will not add up to the total for *# of samples*.
[b] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.13 Mt. Sinai Harbor, NY

Water quality monitoring data were available for the Mt. Sinai Harbor embayment from 3 monitoring organizations corresponding to 10 monitoring stations and 1,695 samples from 2006–2016. Data were provided by Suffolk County from 2006–2015 (1,333 samples), from Stony Brook University–Dr. Christopher Gobler from 2014–2016 (124 samples), and from University of Connecticut (Vaudrey) from 2013–2014 (238 samples).

Figure D-14 shows all monitoring station locations within and around the Mt. Sinai Harbor embayment. Table D-16 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-16 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-16, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

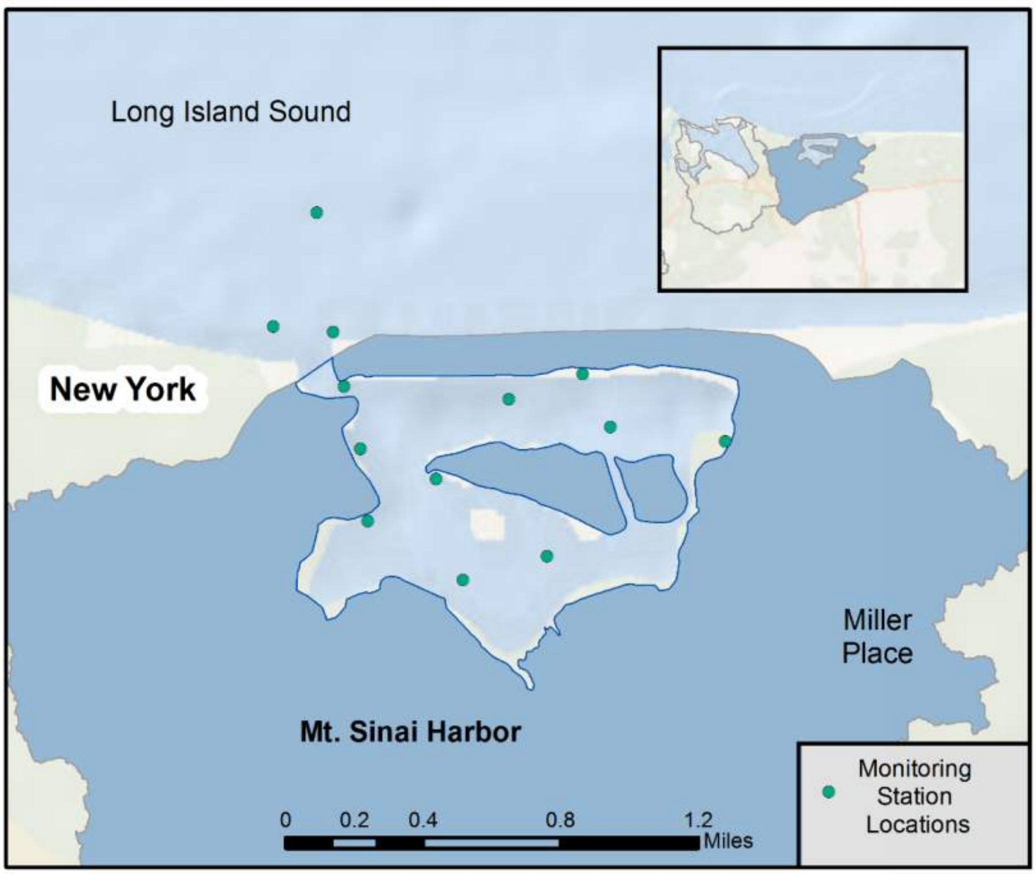


Figure D-14. Mt. Sinai Harbor, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-16. Parameter Counts of Stations and Samples for Mt. Sinai Harbor, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	4	81	0	0	81	0.01	0.07	0.02
NH3_mgL	Ammonia–nitrogen [mg/L]	2006–2015	4	77	0	0	77	0.01	0.06	0.01
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	4	81	0	0	81	0.00	0.17	0.04
PN_mgL	Particulate nitrogen [mg/L]	2013–2014	2	16	4	0	12	0.10	0.19	0.16
PO4_mgL	Phosphate–P [mg/L]	2013–2014	5	22	4	0	18	0.01	0.07	0.03
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	6	97	4	0	93	0.15	0.46	0.26
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	4	81	0	0	81	0.03	0.04	0.03
TN_mgL	Total nitrogen [mg/L]	2006–2015	6	97	4	0	93	0.19	0.50	0.33
TP_mgL	Total phosphorus [mg/L]	2006–2015	4	81	0	0	81	0.03	0.06	0.03
Response Parameters										
CHLA_ugL[b]	Chl *a* [ug/L]	2014–2016	1	36	29	0	0	3.90	8.13	5.95
CHLAC_µgL[b]	Chl *a*, corrected [µg/L]	2006–2015	6	81	3	0	78	0.91	12.01	3.71
do_mgL	Dissolved oxygen [mg/L]	2006–2016	10	226	119	9	91	4.80	13.75	7.85
do_perc	Dissolved oxygen [% saturation]	2013–2014	5	28	9	9	10	74.93	92.11	86.59
Macroalgae_gm2	Total macrophyte dry weight [g m–2]	2013–2014	3	5	0	0	5	0.00	626.96	1.73
Macrophyte_DW_gm2	Total macroalgae [g m–2]	2013–2014	3	5	0	0	5	17.10	626.96	69.08
Seagrass_gm2	Seagrass [g m–2]	2013–2014	3	5	0	0	5	0.00	0.00	0.00
secchi_m	Secchi depth [m]	2006–2016	5	116	29	0	81	0.91	3.35	2.10
Physical Parameters										
pH	pH	2010–2015	9	152	64	8	80	7.50	8.22	8.00
salinity_ppt	Salinity [ppt]	2006–2015	9	190	90	9	91	24.39	28.01	26.90
temp_C	Temperature [deg C]	2006–2016	10	206	104	9	91	2.35	23.44	14.85
TSS_mgL	Total suspended solids [mg/L]	2006–2014	3	12	4	0	8	5.91	10.39	8.96
Total		**2006–2016**	**10**	**1,695**	**467**	**44**	**1,162**			

[a] Some data had missing depth information in the original source and, therefore, have no depth codes. In this case, adding together the three totals from *# of samples by depth* will not add up to the total for *# of samples*.
[b] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.14 Eastern Narrows, CT and NY

Water quality monitoring data were available for the Eastern Narrows watershed from 9 monitoring organizations corresponding to 110 monitoring stations and 65,689 samples from 2003–2016. Data were provided by the following:

- CT DEEP (31,638 samples from 2006–2015)
- EPA NCCA (88 samples from 2006 and 2010)
- EPA ORD (63 samples from 2003)
- Friends of the Bay (609 samples from 2008–2014)
- Harbor Watch (1,296 samples from 2009 and 2012–2015)
- IEC (20,839 samples from 2006–2015)
- Stony Brook University–Dr. Christopher Gobler (375 samples from 2014–2016)
- Suffolk County (9,857 samples from 2006–2015)
- University of Connecticut (Vaudrey) (924 samples from 2013–2014)

Figure D-15 shows all monitoring station locations within and around the Eastern Narrows watershed. Table D-17 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, near bottom, middle, or surface). Table D-17 is organized by all available parameters (nutrient, response, and other physical) for the Eastern Narrows.

To determine protective endpoints for the Eastern Narrows, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-17, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

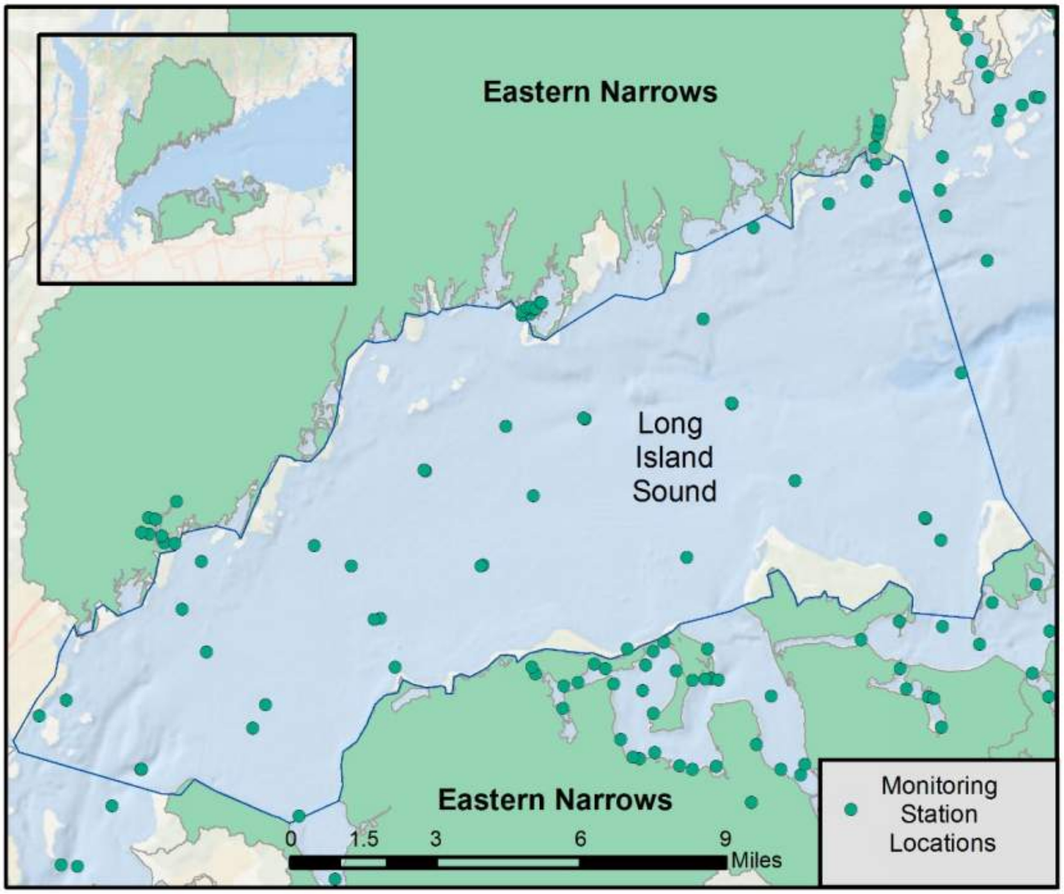


Figure D-15. Eastern Narrows, CT and NY Watershed and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-17. Parameter Counts of Stations and Samples for Eastern Narrows, CT and NY Watershed

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]				Values		
					Bottom	Near Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters											
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2006–2010	7	7	0	0	0	7	0.00	0.02	0.01
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	39	1,954	638	0	4	1,312	0.01	0.09	0.05
NH3_mgL	Ammonia–nitrogen [mg/L]	2006–2015	41	1,966	643	0	4	1,319	0.00	0.10	0.02
NO2_mgL	Nitrite [mg/L]	2006–2010	3	3	0	0	0	3	0.00	0.00	0.00
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	36	1,961	643	0	4	1,314	0.00	0.24	0.04
NO3_mgL	Nitrate [mg/L]	2006–2010	3	3	0	0	0	3	0.00	0.02	0.01
PN_mgL	Particulate nitrogen [mg/L]	2006–2015	31	1,414	655	0	4	755	0.04	0.21	0.08
PO4_mgL	Phosphate–P [mg/L]	2013–2014	21	80	12	0	0	68	0.02	0.14	0.08

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]				Values		
					Bottom	Near Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
PP_mgL	Particulate phosphorus [mg/L]	2006–2015	18	1,298	617	0	4	677	0.00	0.03	0.01
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	47	2,012	655	0	4	1,353	0.16	0.54	0.27
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	34	1,948	643	0	4	1,301	0.03	0.10	0.06
TN_mgL	Total nitrogen [mg/L]	2006–2015	73	2,624	1,233	0	4	1,387	0.24	1.93	0.41
TP_mgL	Total phosphorus [mg/L]	2006–2015	41	1,899	617	0	4	1,278	0.03	0.11	0.07
Response Parameters											
BOD_mgL	Biological oxygen demand [mg/L]	2015	7	42	0	0	0	42	1.50	6.01	3.42
CHLA_µgL[b]	Chl *a* [µg/L]	2006–2016	34	1,637	730	0	4	883	1.30	19.64	5.20
CHLAC_µgL[b]	Chl *a*, corrected [µg/L]	2006–2015	39	763	12	0	0	751	1.76	20.57	7.14
do_mgL	Dissolved oxygen [mg/L]	2003–2016	85	9,378	3,176	805	1,883	3,494	2.73	10.46	5.77
do_perc	Dissolved oxygen [% saturation]	2009–2015	27	436	202	0	36	198	53.18	98.16	75.64
Kd	Kd [m–1], computed from 1–5m photosynthetically active radiation data	2006–2015	17	1,316	0	0	0	1,316	0.39	0.80	0.62
Macroalgae_gm2	Total macrophyte dry weight [g m–2]	2013–2014	6	9	0	0	0	9	0.00	42.01	18.03
Macrophyte_DW_gm2	Total macroalgae [g m–2]	2013–2014	6	9	0	0	0	9	5.04	169.69	30.15
PAR_AMB_µmolm2s	Ambient photosynthetically active radiation [µmol/m2/s]	2010	2	4	2	0	0	2	1,415.74	2,088.10	1,682.78
PAR_UW_µmolm2s	Underwater photosynthetically active radiation [µmol/m2/s]	2010	2	4	2	0	0	2	81.91	1,111.10	467.13
Seagrass_gm2	Seagrass [g m–2]	2013–2014	6	9	0	0	0	9	0.00	0.00	0.00
secchi_m	Secchi depth [m]	2003–2016	60	2,934	86	0	9	2,819	1.20	3.10	1.83
Physical Parameters											
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2006–2015	18	1,344	643	0	4	697	0.32	1.32	0.62
DOC_mgL	Dissolved organic carbon [mg/L]	2006–2015	28	1,256	588	0	4	664	1.60	3.02	1.90
PC_mgL	Particulate carbon [mg/L]	2006–2015	18	1,351	643	0	4	704	0.30	1.28	0.52
pH	pH	2006–2015	62	6,417	1,969	386	1,628	2,434	7.43	8.20	7.80
salinity_ppt	Salinity [ppt]	2003–2015	82	9,389	3,132	795	1,884	3,578	24.00	27.80	26.30
Si_mgL	Dissolved silica [mg/L]	2006–2015	18	1,353	643	0	4	706	0.11	2.68	1.61
temp_C	Temperature [deg C]	2003–2016	85	9,454	3,186	795	1,887	3,586	8.70	23.40	20.90
TOC_mgL	Total organic carbon [mg/L]	2007	13	13	0	0	0	13	1.91	2.40	2.13

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]				Values		
					Bottom	Near Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
TSS_mgL	Total suspended solids [mg/L]	2006–2015	40	1,402	591	0	4	807	3.00	13.00	6.00
Total		**2003–2016**	**110**	**65,689**	**21,961**	**2,781**	**7,387**	**33,500**			

[a] Some data had missing depth information in the original source and, therefore, have no depth codes. In this case, adding together the four totals from *# of samples by depth* will not add up to the total for *# of samples*.

[b] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.15 Western Narrows, NY

Water quality monitoring data were available for the Western Narrows watershed from 5 monitoring organizations corresponding to 58 monitoring stations and 130,125 samples from 2006–2015. Data were provided by the following:

- EPA NCCA (49 samples from 2006 and 2010)
- IEC (13,144 samples from 2006–2015)
- NOAA (1,019 samples from 2012)
- NYC DEP (115,786 samples from 2006–2015)
- University of Connecticut (Yarish) (127 samples from 2011–2013)

Figure D-16 shows all monitoring station locations within and around the Western Narrows watershed. Table D-18 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-18 is organized by all available parameters (nutrient, response, and other physical) for the Western Narrows.

To determine protective endpoints for the Western Narrows, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-18, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

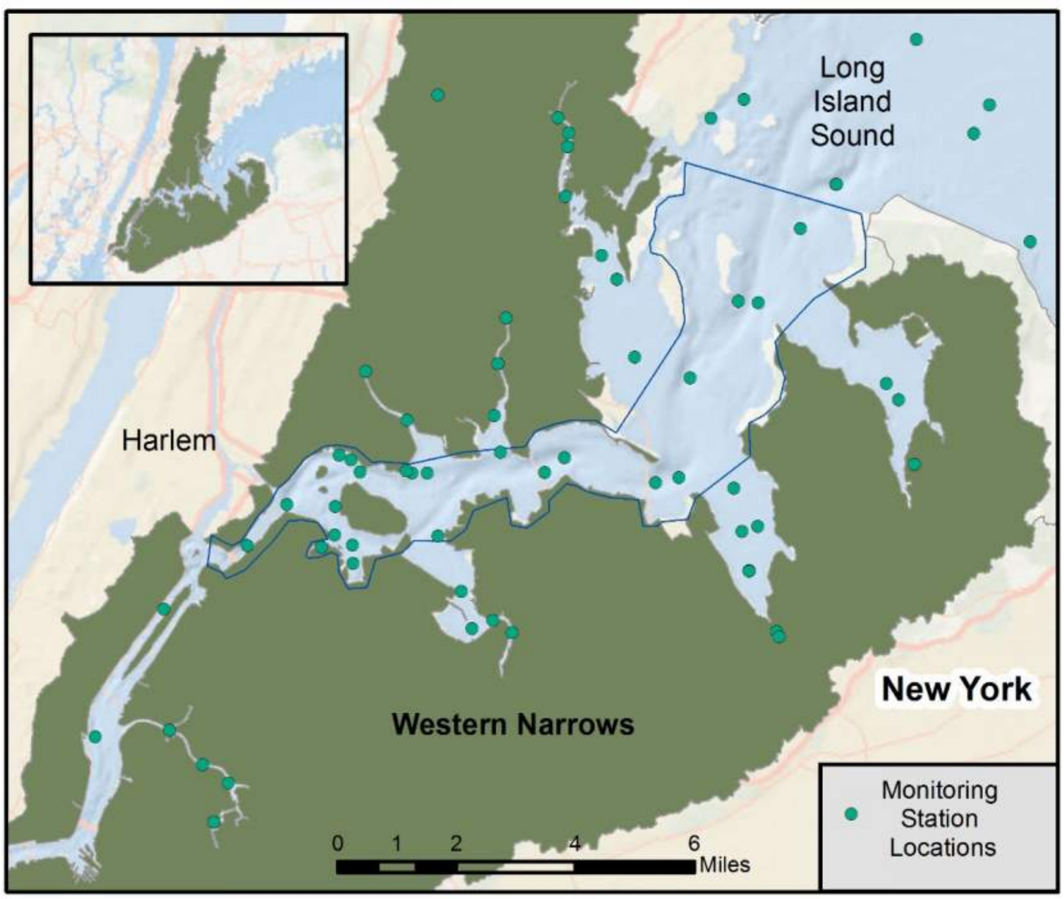


Figure D-16. Western Narrows, NY Watershed and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-18. Parameter Counts of Stations and Samples for Western Narrows, NY Watershed

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth: Bottom	Middle	Surface	Values: 10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2010	1	2	0	0	2	0.10	0.31	0.21
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	42	4,076	0	0	4,076	0.06	0.19	0.13
NH3_mgL	Ammonia-nitrogen [mg/L]	2006–2015	42	5,219	0	0	5,219	0.10	0.63	0.33
NH4_mgL	Ammonium [mg/L]	2011–2013	1	23	3	0	20	0.00	0.52	0.22
NO2_mgL	Nitrite [mg/L]	2010–2012	2	18	3	0	15	0.03	0.07	0.05
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	43	5,231	0	0	5,231	0.10	0.53	0.28
NO3_mgL	Nitrate [mg/L]	2010–2012	2	18	3	0	15	0.10	0.35	0.17
PN_mgL	Particulate nitrogen [mg/L]	2014–2015	4	36	0	0	36	0.10	0.48	0.29
PO4_mgL	Phosphate-P [mg/L]	2011–2013	2	49	3	0	46	0.10	0.45	0.20
PP_mgL	Particulate phosphorus [mg/L]	2014–2015	4	36	0	0	36	0.02	0.09	0.05
TDN_mgL	Total dissolved nitrogen [mg/L]	2014–2015	4	36	0	0	36	0.30	0.75	0.50
TDP_mgL	Total dissolved phosphorus [mg/L]	2014–2015	4	36	0	0	36	0.11	0.24	0.15
TKN_mgL	Total Kjeldahl nitrogen [mg/L]	2006–2015	37	5,180	0	0	5,180	0.44	1.72	0.90
TN_mgL	Total nitrogen [mg/L]	2006–2015	43	5,243	0	0	5,243	0.67	2.11	1.23
TP_mgL	Total phosphorus [mg/L]	2006–2015	42	5,223	0	0	5,223	0.12	0.34	0.20
Response Parameters										
BOD_mgL	Biological oxygen demand [mg/L]	2015	4	24	0	0	24	1.50	6.84	4.19
CHLA_µgL [a]	Chl *a* [µg/L]	2006–2010	9	146	0	0	146	3.45	38.45	12.40
CHLAC_µgL [a]	Chl *a*, corrected [µg/L]	2006–2015	47	5,411	0	0	5,411	1.30	34.90	6.14
do_mgL	Dissolved oxygen [mg/L]	2006–2015	46	10,906	4,509	1,042	5,355	3.07	10.14	5.31
do_perc	Dissolved oxygen [% saturation]	2012	1	143	0	0	143	52.92	78.57	67.86
Kd	Kd [m-1], computed from 1-5m photosynthetically active radiation data	2010–2011	2	5	0	0	5	0.62	0.84	0.68
Light_perc	Light transmissivity [%Trans]	2009–2015	27	4,384	2,018	0	2,366	14.67	78.58	66.08
PAR_0.5m	Photosynthetically active radiation at 0.5 m	2012	1	65	0	0	65	4.65	104.54	43.57
PAR_1m	Photosynthetically active radiation at 1 m	2012	1	65	0	0	65	13.32	76.45	38.02
PAR_AMB_µmol m2s	Ambient photosynthetically active radiation [µmol/m2/s]	2010	1	4	2	0	2	674.64	1,434.10	1,085.68
PAR_µEsm2	Photosynthetically active radiation [µE/s m2]	2006–2015	31	5,857	2,742	0	3,115	0.00	2,242.80	41.33

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
PAR_UW_µmolm2s	Underwater photosynthetically active radiation [µmol/m2/s]	2010	1	4	2	0	2	0.23	743.32	100.75
PARF_µEsm2	Photosynthetically active radiation reference [400-700nm light] [µE/s m2]	2006–2015	22	2,721	0	0	2,721	476.89	2,128.30	1665.70
secchi_m	Secchi depth [m]	2006–2015	50	8,943	3,706	0	5,237	0.00	1.52	0.61
Physical Parameters										
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2014–2015	4	32	0	0	32	0.19	0.55	0.31
cond_µScm	Conductivity [µS/cm]	2006–2015	38	7,451	3,504	0	3,947	23,100.00	38,100.00	33,100.00
DOC_mgL	Dissolved organic carbon [mg/L]	2006–2015	41	5,193	0	0	5,193	2.37	4.22	3.18
PC_mgL	Particulate carbon [mg/L]	2014–2015	4	36	0	0	36	0.49	2.45	1.44
pH	pH	2006–2015	51	11,456	4,452	890	6,114	7.13	7.87	7.42
salinity_ppt	Salinity [ppt]	2006–2015	52	10,597	4,459	1,036	5,102	21.30	26.33	24.26
Si_mgL	Dissolved silica [mg/L]	2014–2015	4	36	0	0	36	0.32	2.38	1.38
SiO2_mgL	Silicon dioxide [mg/L]	2006–2015	37	5,905	719	0	5,186	0.81	4.10	2.23
SiO3_mgL	Silicate [mg/L]	2012	1	24	0	0	24	0.92	3.49	1.59
temp_C	Temperature [deg C]	2006–2015	52	10,626	4,470	1,038	5,118	8.25	23.77	21.17
TSS_mgL	Total suspended solids [mg/L]	2006–2015	47	8,912	3,614	0	5,298	4.80	27.00	11.00
TURB_NTU	Turbidity [nephelometric turbidity units]	2006–2015	34	753	0	0	753	1.69	51.61	7.98
Total		**2006–2015**	**58**	**130,125**	**34,209**	**4,006**	**91,910**			

[a] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.16 Eastern and Western Narrows (Combined), CT and NY

Water quality monitoring data were available for the Eastern and Western Narrows watersheds from 12 monitoring organizations corresponding to 168 monitoring stations and 195,814 samples from 2003–2016. Data were provided by the following:

- CT DEEP (31,638 samples from 2006–2015)
- EPA NCCA (137 samples from 2006 and 2010)
- EPA ORD (63 samples from 2003)
- Friends of the Bay (609 samples from 2008–2014)
- Harbor Watch (1,296 samples from 2009 and 2012–2015)
- IEC (33,983 samples from 2006–2015)
- NOAA (1,019 samples from 2012)
- NYC DEP (115,786 samples from 2006–2015)
- Stony Brook University–Dr. Christopher Gobler (375 samples from 2014–2016)
- Suffolk County (9,857 samples from 2006–2015)
- University of Connecticut (Vaudrey) (924 samples from 2013–2014)
- University of Connecticut (Yarish) (127 samples from 2011–2013)

Figure D-17 shows all monitoring station locations within and around the Eastern and Western Narrows watersheds. Table D-19 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, near bottom, middle, or surface). Table D-19 is organized by all available parameters (nutrient, response, and other physical) for the Eastern and Western Narrows combined.

To determine protective endpoints for the Eastern and Western Narrows combined, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-19, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

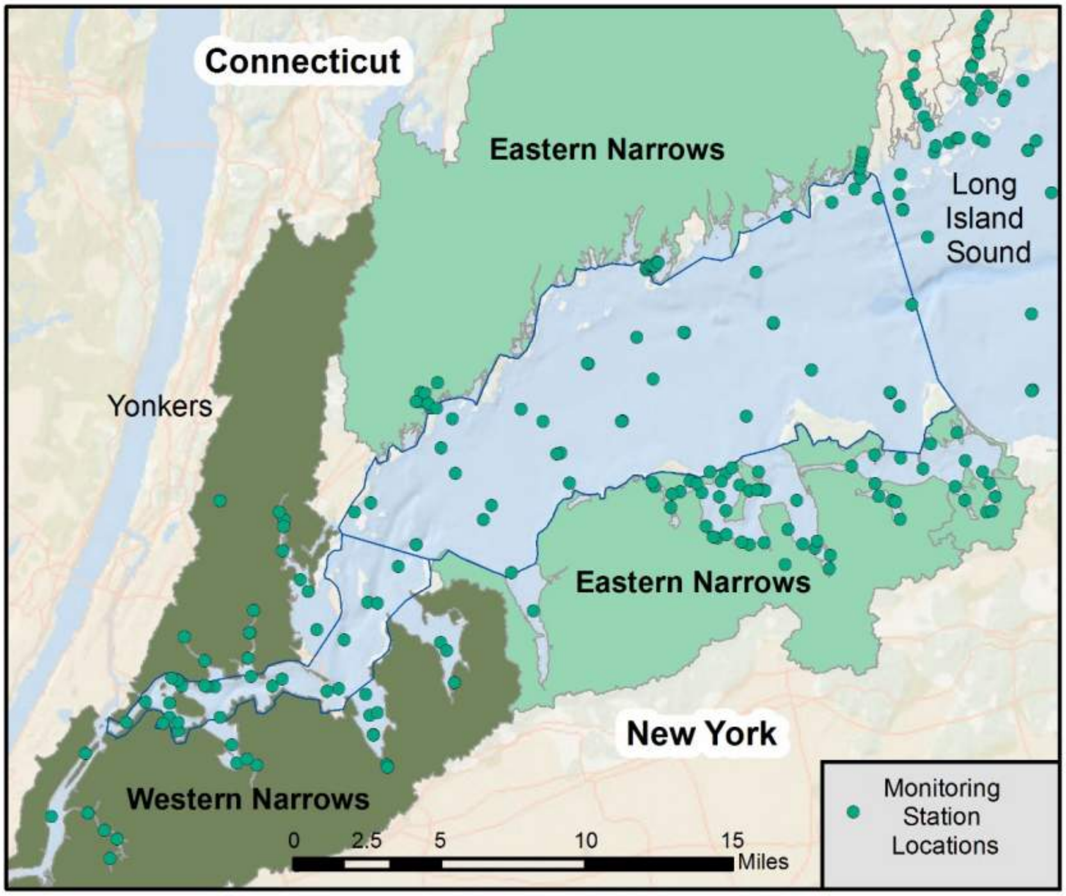


Figure D-17. Eastern and Western Narrows (Combined), CT and NY Watersheds and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-19. Parameter Counts of Stations and Samples for Eastern and Western Narrows (Combined), CT and NY Watersheds

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]				Values		
					Bottom	Near Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters											
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2006–2010	8	9	0	0	0	9	0.00	0.13	0.01
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	81	6,030	638	0	4	5,388	0.03	0.18	0.10
NH3_mgL	Ammonia-nitrogen [mg/L]	2006–2015	83	7,185	643	0	4	6,538	0.01	0.58	0.24
NH4_mgL	Ammonium [mg/L]	2011–2013	1	23	3	0	0	20	0.00	0.52	0.22
NO2_mgL	Nitrite [mg/L]	2006–2012	5	21	3	0	0	18	0.00	0.07	0.04
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	79	7,192	643	0	4	6,545	0.01	0.50	0.23
NO3_mgL	Nitrate [mg/L]	2006–2012	5	21	3	0	0	18	0.02	0.35	0.15

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]				Values		
					Bottom	Near Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
PN_mgL	Particulate nitrogen [mg/L]	2006–2015	35	1,450	655	0	4	791	0.04	0.22	0.08
PO4_mgL	Phosphate-P [mg/L]	2011–2014	23	129	15	0	0	114	0.03	0.30	0.12
PP_mgL	Particulate phosphorus [mg/L]	2006–2015	22	1,334	617	0	4	713	0.00	0.04	0.01
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	51	2,048	655	0	4	1,389	0.16	0.55	0.27
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	38	1,984	643	0	4	1,337	0.03	0.10	0.06
TKN_mgL	Total Kjeldahl nitrogen [mg/L]	2006–2015	37	5,180	0	0	0	5,180	0.44	1.72	0.90
TN_mgL	Total nitrogen [mg/L]	2006–2015	116	7,867	1,233	0	4	6,630	0.32	2.08	1.02
TP_mgL	Total phosphorus [mg/L]	2006–2015	83	7,122	617	0	4	6,501	0.06	0.31	0.17
Response Parameters											
BOD_mgL	Biological oxygen demand [mg/L]	2015	11	66	0	0	0	66	1.50	6.46	3.76
CHLA_µgL[b]	Chl *a* [µg/L]	2006–2015	43	1,783	730	0	4	1,029	1.40	21.49	5.50
CHLAC_µgL[b]	Chl *a*, corrected [µg/L]	2006–2015	86	6,174	12	0	0	6,162	1.33	34.40	6.28
do_mgL	Dissolved oxygen [mg/L]	2003–2016	131	20,284	7,685	805	2,925	8,849	2.90	10.28	5.50
do_perc	Dissolved oxygen [% saturation]	2009–2015	28	579	202	0	36	341	52.92	94.42	73.38
Kd	Kd [m-1], computed from 1-5m photosynthetically active radiation data	2006–2015	19	1,321	0	0	0	1,321	0.39	0.80	0.62
Light_perc	Light transmissivity [%Trans]	2009–2015	27	4,384	2,018	0	0	2,366	14.67	78.58	66.08
Macroalgae_gm2	Total macrophyte dry weight [g m-2]	2013–2014	6	9	0	0	0	9	0.00	42.01	18.03
Macrophyte_DW_gm2	Total macroalgae [g m-2]	2013–2014	6	9	0	0	0	9	5.04	169.69	30.15
PAR_0.5m	Photosynthetically active radiation at 0.5 m	2012	1	65	0	0	0	65	4.65	104.54	43.57
PAR_1m	Photosynthetically active radiation at 1 m	2012	1	65	0	0	0	65	13.32	76.45	38.02
PAR_AMB_µmolm2s	Ambient photosynthetically active radiation [µmol/m2/s]	2010	3	8	4	0	0	4	719.62	1,906.90	1,429.50
PAR_µEsm2	Photosynthetically active radiation [µE/s m2]	2006–2015	31	5,857	2,742	0	0	3,115	0.00	2,242.80	41.33
PAR_UW_µmolm2s	Underwater photosynthetically active radiation [µmol/m2/s]	2010	3	8	4	0	0	4	0.27	1,074.01	236.65
PARF_µEsm2	Photosynthetically active radiation reference [400-700nm light] [µE/s m2]	2006–2015	22	2,721	0	0	0	2,721	476.89	2,128.30	1,665.70
Seagrass_gm2	Seagrass [g m-2]	2013–2014	6	9	0	0	0	9	0.00	0.00	0.00

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]				Values		
					Bottom	Near Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
secchi_m	Secchi depth [m]	2003–2016	110	11,877	3,792	0	9	8,056	0.00	2.13	0.91
Physical Parameters											
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2006–2015	22	1,376	643	0	4	729	0.31	1.31	0.62
cond_µScm	Conductivity [µS/cm]	2006–2015	38	7,451	3,504	0	0	3,947	23,100.00	38,100.00	33,100.00
DOC_mgL	Dissolved organic carbon [mg/L]	2006–2015	69	6,449	588	0	4	5,857	1.81	4.10	3.00
PC_mgL	Particulate carbon [mg/L]	2006–2015	22	1,387	643	0	4	740	0.30	1.33	0.53
pH	pH	2006–2015	113	17,873	6,421	386	2,518	8,548	7.18	8.06	7.54
salinity_ppt	Salinity [ppt]	2003–2015	134	19,986	7,591	795	2,920	8,680	22.27	27.32	25.37
Si_mgL	Dissolved silica [mg/L]	2006–2015	22	1,389	643	0	4	742	0.11	2.68	1.61
SiO2_mgL	Silicon dioxide [mg/L]	2006–2015	38	5,905	719	0	0	5,186	0.80	4.07	2.22
SiO3_mgL	Silicate [mg/L]	2012	1	24	0	0	0	24	0.92	3.49	1.59
temp_C	Temperature [deg C]	2003–2016	137	20,080	7,656	795	2,925	8,704	8.55	23.60	21.01
TOC_mgL	Total organic carbon [mg/L]	2007	13	13	0	0	0	13	1.91	2.40	2.13
TSS_mgL	Total suspended solids [mg/L]	2006–2015	87	10,314	4,205	0	4	6,105	4.00	25.61	10.00
TURB_NTU	Turbidity [nephelometric turbidity units]	2006–2015	34	753	0	0	0	753	1.69	51.61	7.98
Total		**2003–2016**	**168**	**195,814**	**56,170**	**2,781**	**11,393**	**125,410**			

[a] Some data had missing depth information in the original source and, therefore, have no depth codes. In this case, adding together the four totals from *# of samples by depth* will not add up to the total for *# of samples*.
[b] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.17 Connecticut River, CT

Water quality monitoring data were available for the Connecticut River embayment from 3 monitoring organizations corresponding to 11 monitoring stations and 346 samples from 2006 and 2017. Data were provided by CT DEEP for 2006 (36 samples), EPA NCCA for 2006 (13 samples), and EPA Region 1 for 2017 (297 samples).

Figure D-18 shows all monitoring station locations within and around the Connecticut River embayment. Table D-20 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-20 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-20, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

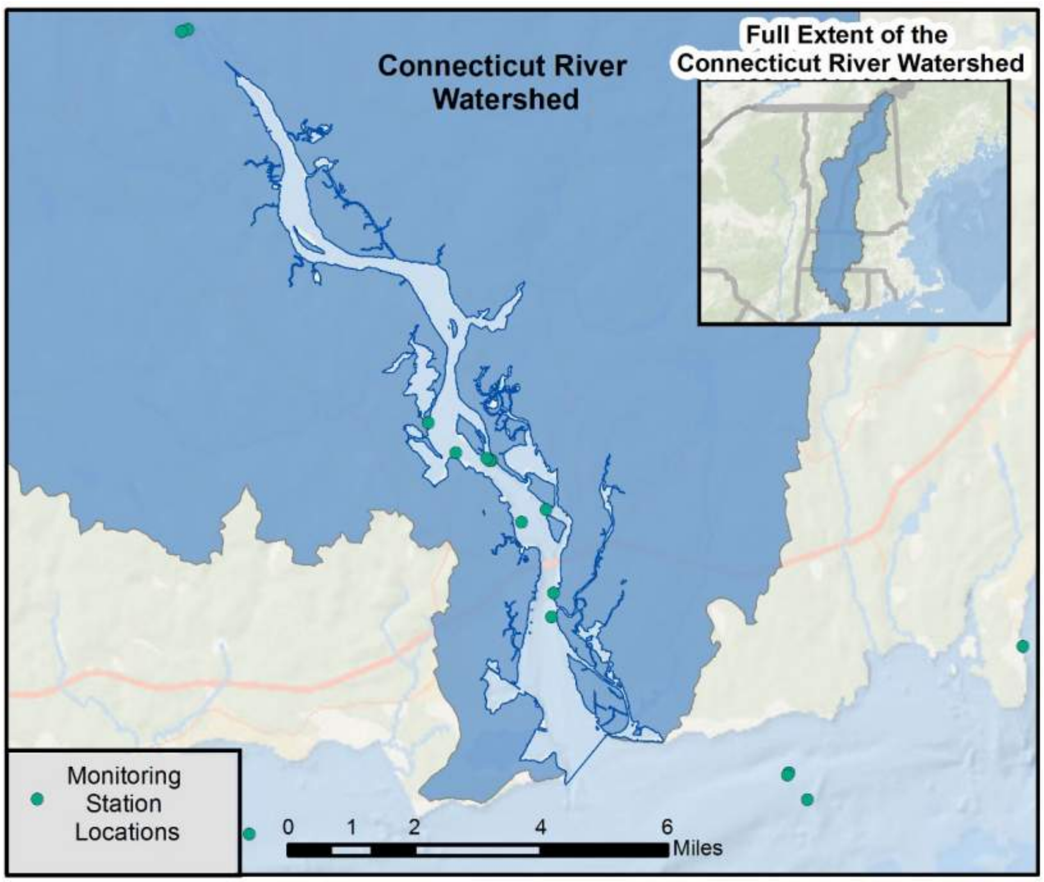


Figure D-18. Connecticut River, CT Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-20. Parameter Counts of Stations and Samples for Connecticut River, CT Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2006	2	2	0	0	2	0.44	0.47	0.46
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2017	4	4	0	2	2	0.04	0.06	0.05
NH3_mgL	Ammonia–nitrogen [mg/L]	2006–2017	11	27	23	2	2	0.02	0.05	0.03
NO23_mgL	Nitrate + nitrite [mg/L]	2006	9	25	23	2	0	0.13	0.35	0.20
PN_mgL	Particulate nitrogen [mg/L]	2006	2	2	0	2	0	0.07	0.08	0.07
PP_mgL	Particulate phosphorus [mg/L]	2006	2	2	0	2	0	0.01	0.02	0.01
TDN_mgL	Total dissolved nitrogen [mg/L]	2006	2	2	0	2	0	0.69	0.70	0.69
TDP_mgL	Total dissolved phosphorus [mg/L]	2006	2	2	0	2	0	0.05	0.06	0.05
TN_mgL	Total nitrogen [mg/L]	2006–2017	11	27	23	2	2	0.41	0.76	0.50
TP_mgL	Total phosphorus [mg/L]	2006–2017	11	27	23	2	2	0.03	0.07	0.04
Response Parameters										
CHLA_µgL	Chl *a* [µg/L]	2006–2017	11	27	23	2	2	2.42	19.80	8.80
do_mgL	Dissolved oxygen [mg/L]	2006–2017	9	25	23	2	0	7.72	8.67	8.15
do_perc	Dissolved oxygen [% saturation]	2006–2017	7	23	23	0	0	89.16	101.36	97.10
secchi_m	Secchi depth [m]	2006–2017	7	21	21	0	0	0.98	1.30	1.24
Physical Parameters										
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2006	2	2	0	2	0	0.35	0.39	0.37
cond_µScm	Conductivity [µS/cm]	2006–2017	7	23	23	0	0	925.20	15,981	8,892
DOC_mgL	Dissolved organic carbon [mg/L]	2006	2	2	0	2	0	5.03	5.33	5.18
PC_mgL	Particulate carbon [mg/L]	2006	2	2	0	2	0	0.48	0.56	0.52
pH	pH	2006–2017	7	23	23	0	0	7.49	7.74	7.65
salinity_ppt	Salinity [ppt]	2006–2017	9	25	23	2	0	0.19	9.43	4.04
Si_mgL	Dissolved silica [mg/L]	2006	2	2	0	2	0	5.64	5.77	5.71
temp_C	Temperature [deg C]	2006–2017	9	25	23	2	0	20.07	24.48	21.48
TSS_mgL	Total suspended solids [mg/L]	2006–2017	10	26	23	2	1	3.80	14.00	8.80
Total		**2006–2017**	**11**	**346**	**297**	**36**	**13**			

D.18 Other Data Used for Modeling

Other Embayments

Water quality monitoring data were available for other embayment stations throughout LIS from 9 monitoring organizations corresponding to 147 monitoring stations and 89,909 samples from 2000–2015. Data were provided by the following:

- EPA NCCA (26 samples from 2006 and 2010)
- EPA ORD (2,712 samples from 2000–2009)
- Friends of the Bay (197 samples from 2008–2014)

- Harbor Watch (1,112 samples from 2009–2015)
- IEC (3,284 samples from 2006–2015)
- NYC DEP (75,857 samples from 2006–2015)
- Suffolk County (3,086 samples from 2006–2015)
- University of Connecticut (Vaudrey) (1,076 samples from 2013–2014)
- URIWW (2,559 samples from 2008–2015)

Figure D-19 shows all other embayment monitoring station locations within and around LIS. Table D-21 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-21 is organized by all available parameters (nutrient, response, and other physical) for these embayments.

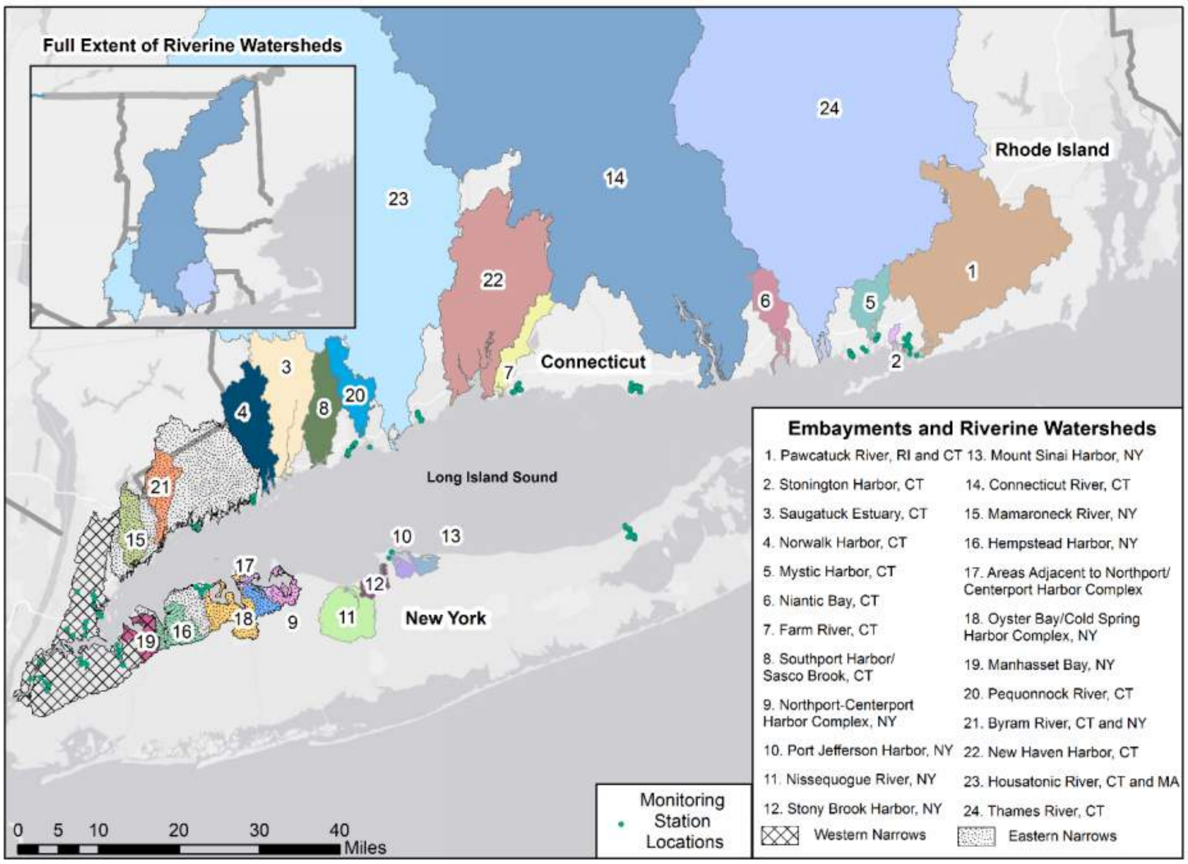


Figure D-19. Other Embayment Water Quality Monitoring Station Locations, as Delineated by Dr. Jamie Vaudrey (University of Connecticut). Portions of the Maps that are Not Highlighted as Part of a Selected Watershed Indicate that No Loading Data are Available for a Given Area (e.g., the Small Portion of Land between the Eastern and Western Narrows).

Table D-21. Parameter Counts of Stations and Samples for Other Embayment Data

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2000–2010	14	70	28	0	42	0.00	0.04	0.01
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	45	3,691	10	0	3,681	0.03	0.20	0.13
DON_mgL	Dissolved organic nitrogen [mg/L]	2002–2003	10	54	24	0	30	0.18	0.29	0.22
NH3_mgL	Ammonia–nitrogen [mg/L]	2006–2015	45	3,969	10	0	3,959	0.04	0.65	0.32
NH4_mgL	Ammonium [mg/L]	2000–2003	13	70	29	1	40	0.00	0.03	0.01
NO2_mgL	Nitrite [mg/L]	2003–2010	5	25	8	0	17	0.00	0.00	0.00
NO23_mgL	Nitrate + nitrite [mg/L]	2000–2015	58	4,048	38	1	4,009	0.02	0.57	0.26
NO3_mgL	Nitrate [mg/L]	2003	4	24	8	0	16	0.00	0.01	0.00
PN_mgL	Particulate nitrogen [mg/L]	2013–2015	19	92	14	0	78	0.08	0.37	0.17
PO4_mgL	Phosphate–P [mg/L]	2013–2014	24	91	14	0	77	0.01	0.09	0.02
PP_mgL	Particulate phosphorus [mg/L]	2014–2015	2	18	0	0	18	0.04	0.09	0.05
TDN_mgL	Total dissolved nitrogen [mg/L]	2002–2015	36	334	38	0	296	0.16	0.51	0.27
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	9	204	0	0	204	0.03	0.07	0.03
TKN_mgL	Total Kjeldahl nitrogen [mg/L]	2006–2015	23	3,542	0	0	3,542	0.48	1.83	0.99
TN_mgL	Total nitrogen [mg/L]	2006–2015	69	4,240	197	0	4,043	0.50	2.27	1.27
TP_mgL	Total phosphorus [mg/L]	2006–2015	45	3,977	10	0	3,967	0.07	0.36	0.21
Response Parameters										
BOD_mgL	Biological oxygen demand [mg/L]	2015	2	12	0	0	12	3.37	6.85	4.02
CHLA_µgL[a]	Chl *a* [µg/L]	2000–2010	20	113	23	1	89	2.31	25.25	5.10
CHLAC_µgL[a]	Chl *a*, corrected [µg/L]	2006–2015	57	4,035	11	0	4,024	1.60	41.60	8.40
do_mgL	Dissolved oxygen [mg/L]	2000–2015	130	7,147	2,996	166	3,985	3.27	10.63	5.95
do_perc	Dissolved oxygen [% saturation]	2009–2015	27	408	185	42	181	50.79	96.71	75.17
Kd	Kd [m–1], computed from 1–5m photosynthetically active radiation data	2010–2014	7	13	0	0	13	0.67	1.27	0.79
Light_perc	Light transmissivity [%Trans]	2009–2015	20	2,776	1,216	0	1,560	19.68	77.35	61.81
Macroalgae_gm2	Total macrophyte dry weight [g m–2]	2013–2014	11	19	0	0	19	12.06	1,085	98.11
Macrophyte_DW_gm2	Total macroalgae [g m–2]	2013–2014	11	19	0	0	19	12.06	1,082	98.11
PAR_AMB_umolm2s	Ambient photosynthetically active radiation [umol/m2/s]	2010	1	2	1	0	1	394.33	403.33	398.83
PAR_uEsm2	Photosynthetically active radiation [uE/s m2]	2006–2015	20	3,665	1,648	0	2,017	0.00	2,343	49.71
PAR_UW_umolm2s	Underwater photosynthetically active radiation [umol/m2/s]	2010	1	2	1	0	1	70.51	184.95	127.73

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
PARF_uEsm2	Photosynthetically active radiation reference [400-700nm light] [uE/s m2]	2006–2015	13	1,738	0	0	1,738	476.34	2,130	1,656
Seagrass_gm2	Seagrass [g m–2]	2013–2014	11	19	0	0	19	0.00	0.00	0.00
secchi_m	Secchi depth [m]	2000–2015	78	5,773	2,226	305	3,242	0.00	1.52	0.61
Physical Parameters										
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2014–2015	2	16	0	0	16	0.20	0.52	0.30
cond_uScm	Conductivity [uS/cm]	2006–2015	21	4,575	2,074	0	2,501	22,300	37,500	32,600
DOC_mgL	Dissolved organic carbon [mg/L]	2006–2015	26	3,542	0	0	3,542	2.44	4.40	3.28
PC_mgL	Particulate carbon [mg/L]	2014-2015	2	18	0	0	18	1.08	2.17	1.77
pH	pH	2006–2015	69	6,817	2,597	134	4,086	7.09	7.94	7.41
salinity_ppt	Salinity [ppt]	2000–2015	132	7,101	3,037	164	3,900	20.00	26.80	23.63
Si_mgL	Dissolved silica [mg/L]	2014–2015	2	18	0	0	18	0.30	2.54	1.64
SiO2_mgL	Silicon dioxide [mg/L]	2006–2015	23	3,981	437	0	3,544	0.90	5,18	2.39
temp_C	Temperature [deg C]	2000–2015	131	7,163	3,029	166	3,968	6.55	24.06	21.08
TOC_mgL	Total organic carbon [mg/L]	2007	1	1	0	0	1	2.04	2.04	2.04
TSS_mgL	Total suspended solids [mg/L]	2000–2015	46	5,791	2,170	1	3,620	4.71	28.00	11.20
TURB_NTU	Turbidity [nephelometric turbidity units]	2009–2015	24	696	0	0	696	1.70	54.50	8.60
Total		**2000–2015**	**147**	**89,909**	**22,079**	**981**	**66,849**			

[a] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

Open Water

Water quality monitoring data were available for open water stations throughout LIS from 10 monitoring organizations corresponding to 167 monitoring stations and 164,154 samples from 2006–2016. Data were provided by the following:

- CT DEEP (95,846 samples from 2006–2015)
- EPA NCCA (766 samples from 2006 and 2010)
- Harbor Watch (946 samples from 2006–2015)
- IEC (23,906 samples from 2006–2015)
- NOAA (1,019 samples from 2012)
- NYC DEP (39,929 samples from 2006–2015)
- Suffolk (950 samples from 2006–2015)
- University of Connecticut (Vaudrey) (375 from 2013–2014)
- University of Connecticut (Yarish) (377 samples from 2011–2014 and 2016)
- URIWW (40 samples from 2015)

Figure D-20 shows all open water monitoring station locations within and around LIS. Table D-22 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, near bottom, middle, or surface).

Table D-22 is organized by all available parameters (nutrient, response, and other physical) for the open water.

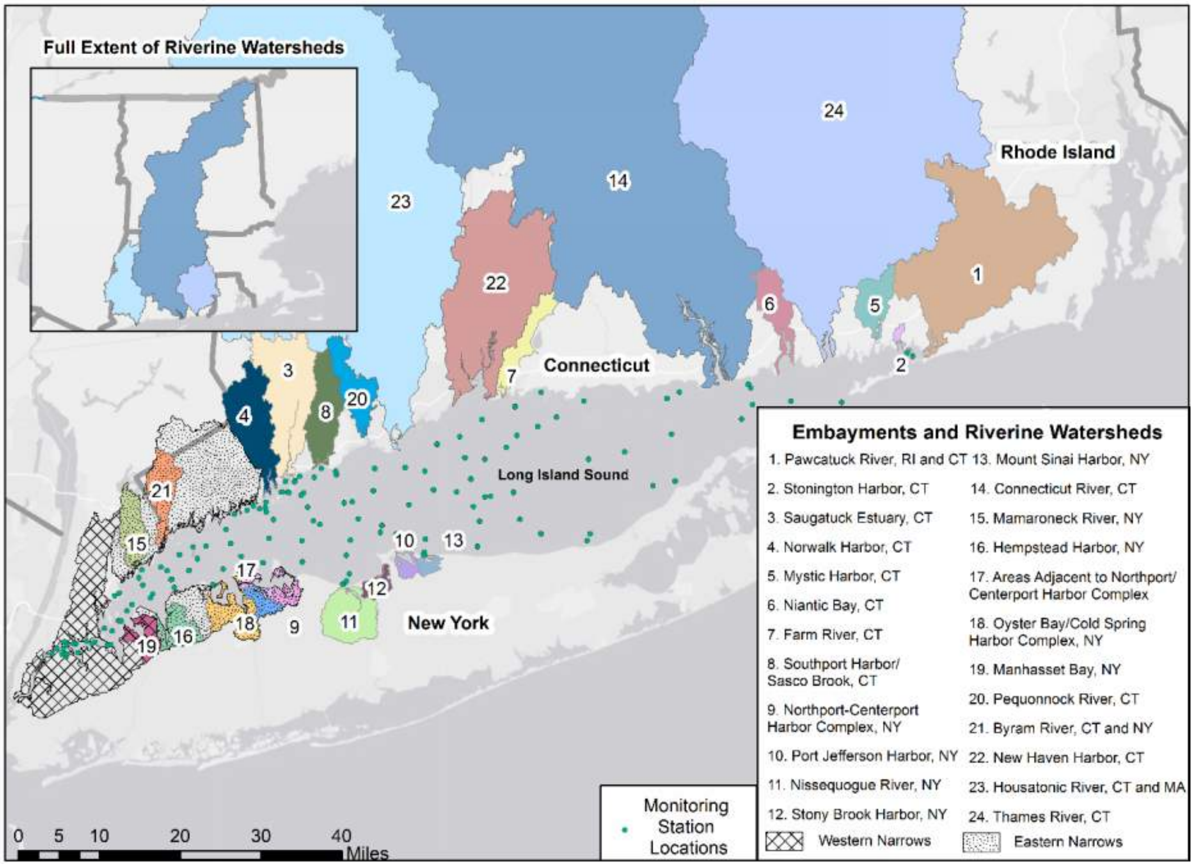


Figure D-20. Open Waters Water Quality Monitoring Station Locations, as Delineated by Dr. Jamie Vaudrey (University of Connecticut). Portions of the Maps that are Not Highlighted as Part of a Selected Watershed Indicate that No Loading Data are Available for a Given Area (e.g., the Small Portion of Land between the Eastern and Western Narrows).

Table D-22. Parameter Counts of Stations and Samples for Open Waters Data

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth				Values		
					Bottom	Near Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters											
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2006–2010	47	49	0	0	0	49	0.01	0.08	0.03
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	99	4,951	2,013	0	17	2,921	0.02	0.11	0.05
NH3_mgL	Ammonia–nitrogen [mg/L]	2006–2015	105	5,879	2,030	0	17	3,832	0.00	0.36	0.02
NH4_mgL	Ammonium [mg/L]	2011–2014	3	75	3	0	0	72	0.00	0.36	0.05
NO2_mgL	Nitrite [mg/L]	2006–2012	33	73	3	0	0	70	0.00	0.05	0.03
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	79	5,892	2,031	0	17	3,844	0.00	0.32	0.07

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth				Values		
					Bottom	Near Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
NO3_mgL	Nitrate [mg/L]	2006–2012	29	69	3	0	0	66	0.00	0.20	0.03
PN_mgL	Particulate nitrogen [mg/L]	2006–2015	47	4,162	2,034	0	17	2,111	0.03	0.14	0.06
PO4_mgL	Phosphate–P [mg/L]	2011–2014	12	135	12	0	0	123	0.02	0.29	0.08
PP_mgL	Particulate phosphorus [mg/L]	2006–2015	39	4,018	1,974	0	17	2,027	0.00	0.03	0.01
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	50	4,226	2,036	0	17	2,173	0.14	0.36	0.21
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	42	4,190	2,026	0	17	2,147	0.03	0.09	0.05
TKN_mgL	Total Kjeldahl nitrogen [mg/L]	2006–2015	14	1,638	0	0	0	1,638	0.38	1.43	0.74
TN_mgL	Total nitrogen [mg/L]	2006–2015	111	5,935	2,038	0	17	3,880	0.20	1.18	0.34
TP_mgL	Total phosphorus [mg/L]	2006–2015	101	5,763	1,977	0	17	3,769	0.04	0.19	0.08
Response Parameters											
BOD_mgL	Biological oxygen demand [mg/L]	2015	7	42	0	0	0	42	1.50	5.84	3.20
CHLA_µgL[a]	Chl *a* [µg/L]	2006-2015	91	4,170	1,929	0	17	2,224	1.00	11.70	3.20
CHLAC_µgL[a]	Chl *a*, corrected [µg/L]	2006–2015	39	2,002	8	0	0	1,994	1.10	14.59	3.30
do_mgL	Dissolved oxygen [mg/L]	2006-2015	150	17,201	5,647	2,098	2,378	7,078	3.17	10.45	5.93
do_perc	Dissolved oxygen [% saturation]	2007–2015	22	392	119	0	12	261	58.85	112.25	84.02
Kd	Kd [m–1], computed from 1–5m photosynthetically active radiation data	2006–2015	78	3,728	0	0	0	3,728	0.32	0.75	0.53
Light_perc	Light transmissivity [%Trans]	2009-2015	7	1,608	802	0	0	806	10.71	79.92	70.71
Macroalgae_gm2	Total macrophyte dry weight [g m–2]	2013–2014	3	4	0	0	0	4	0.00	16.46	0.00
Macrophyte_DW_gm2	Total macroalgae [g m–2]	2013–2014	3	4	0	0	0	4	28.67	54.07	44.91
PAR_0.5m	Photosynthetically active radiation at 0.5 m	2012	1	65	0	0	0	65	4.65	104.54	43.57
PAR_1m	Photosynthetically active radiation at 1 m	2012	1	65	0	0	0	65	13.32	76.45	38.02
PAR_AMB_µmolm2s	Ambient photosynthetically active radiation [µmol/m2/s]	2010	19	42	21	0	0	21	170.70	1,672	859.88
PAR_uEsm2	Photosynthetically active radiation [uE/s m2]	2006–2015	11	2,192	1,094	0	0	1,098	0.00	2,133.98	23.10
PAR_UW_µmolm2s	Underwater photosynthetically active radiation [µmol/m2/s]	2010	19	41	20	0	0	21	0.01	723.60	32.30
PARF_uEsm2	Photosynthetically active radiation reference [400-700nm light] [uE/s m2]	2006–2015	9	983	0	0	0	983	479	2,122.68	1,675.70
Seagrass_gm2	Seagrass [g m–2]	2013–2014	3	4	0	0	0	4	0.00	34.39	0.00
secchi_m	Secchi depth [m]	2006–2016	113	7,090	1,480	0	0	5,610	0.00	3.10	1.60

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth				Values		
					Bottom	Near Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Physical Parameters											
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2006–2016	39	4,121	2,025	0	17	2,079	0.22	1.14	0.52
cond_uScm	Conductivity [uS/cm]	2006–2015	17	2,876	1,430	0	0	1,446	24,350	38,700	33,900
DOC_mgL	Dissolved organic carbon [mg/L]	2006–2015	52	5,659	1,971	0	17	3,671	1.50	3.50	1.90
PC_mgL	Particulate carbon [mg/L]	2006–2015	39	4,128	2,025	0	17	2,086	0.27	0.95	0.43
pH	pH	2006–2015	122	12,433	4,136	1,111	2,034	5,152	7.28	8.16	7.66
salinity_ppt	Salinity [ppt]	2006–2015	158	17,428	5,753	2,086	2,379	7,210	23.88	28.30	26.46
Si_mgL	Dissolved silica [mg/L]	2006–2015	39	4,133	2,027	0	17	2,089	0.14	2.44	1.11
SiO2_mgL	Silicon dioxide [mg/L]	2006–2015	14	1,924	282	0	0	1,642	0.68	3.07	1.92
SiO3_mgL	Silicate [mg/L]	2012	1	24	0	0	0	24	0.92	3.49	1.59
temp_C	Temperature [deg C]	2006–2015	157	17,443	5,757	2,086	2,381	7,219	6.72	23.18	20.39
TOC_mgl	Total organic carbon [mg/L]	2007	2	2	0	0	0	2	1.61	1.70	1.66
TSS_mgL	Total suspended solids [mg/L]	2006–2015	94	7,238	3,414	0	17	3,807	3.00	19.00	7.00
TURB_NTU	Turbidity [nephelometric turbidity units]	2010–2015	10	57	0	0	0	57	1.45	10.69	3.90
Total		**2006–2016**	**167**	**164,154**	**58,120**	**7,381**	**9,439**	**89,214**			

[a] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.19 Mamaroneck River, NY

Water quality monitoring data were available for the Mamaroneck River embayment from 1 monitoring organization corresponding to 8 monitoring stations and 446 samples from 2013–2014. Data were provided from the University of Connecticut (Vaudrey).

Figure D-21 shows all monitoring station locations within and around the Mamaroneck River embayment. Table D-23 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-23 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-23, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

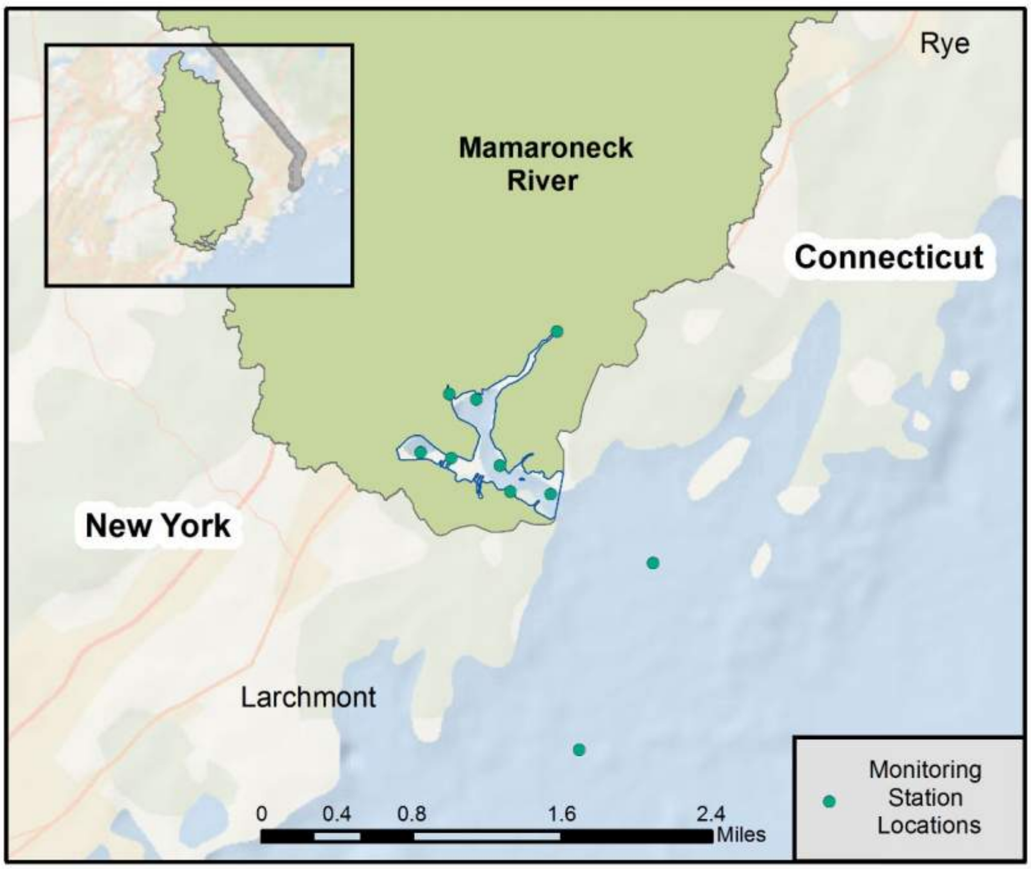


Figure D-21. Mamaroneck River, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-23. Parameter Counts of Stations and Samples for Mamaroneck River, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
PN_mgL	Particulate nitrogen [mg/L]	2013–2014	6	35	4	0	31	0.07	0.42	0.18
PO4_mgL	Phosphate-P [mg/L]	2013–2014	8	40	4	0	36	0.02	0.16	0.09
TDN_mgL	Total dissolved nitrogen [mg/L]	2013–2014	6	36	4	0	32	0.26	1.19	0.40
TN_mgL	Total nitrogen [mg/L]	2013–2014	6	35	4	0	31	0.45	1.40	0.74
Response Parameters										
CHLAC_ugL	Chl *a*, corrected [ug/L]	2013–2014	6	15	4	0	11	2.15	23.83	7.43
do_mgL	Dissolved oxygen [mg/L]	2013–2014	8	56	20	16	20	3.29	6.46	4.91
do_perc	Dissolved oxygen [% saturation]	2013–2014	8	56	20	16	20	44.35	82.83	65.05
Kd	Kd [m-1], computed from 1-5m photosynthetically active radiation data	2013–2014	2	4	0	0	4	0.68	0.93	0.84
Macroalgae_gm2	Total macrophyte dry weight [g m-2]	2013–2014	2	2	0	0	2	8.24	24.51	16.38
Macrophyte_DW_gm2	Total macroalgae [g m-2]	2013–2014	2	2	0	0	2	8.44	26.33	17.39
Seagrass_gm2	Seagrass [g m-2]	2013–2014	2	2	0	0	2	0.00	0.00	0.00
secchi_m	Secchi depth [m]	2013–2014	2	4	0	0	4	1.47	2.21	1.80
Physical Parameters										
pH	pH	2013–2013	8	32	12	8	12	7.49	7.72	7.58
salinity_ppt	Salinity [ppt]	2013–2014	8	56	20	16	20	15.19	27.05	25.77
temp_C	Temperature [deg C]	2013–2014	8	56	20	16	20	21.13	22.96	22.29
TSS_mgL	Total suspended solids [mg/L]	2013–2014	6	15	4	0	11	1.69	6.21	3.43
Total		**2013–2014**	**8**	**446**	**116**	**72**	**258**			

D.20 Hempstead Harbor, NY

Water quality monitoring data were available for the Hempstead Harbor embayment from 1 monitoring organization corresponding to 2 monitoring stations and 2,760 samples from 2006–2015. Data were provided by IEC.

Figure D-22 shows all monitoring station locations within and around the Hempstead Harbor embayment. Table D-24 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-24 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-24, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

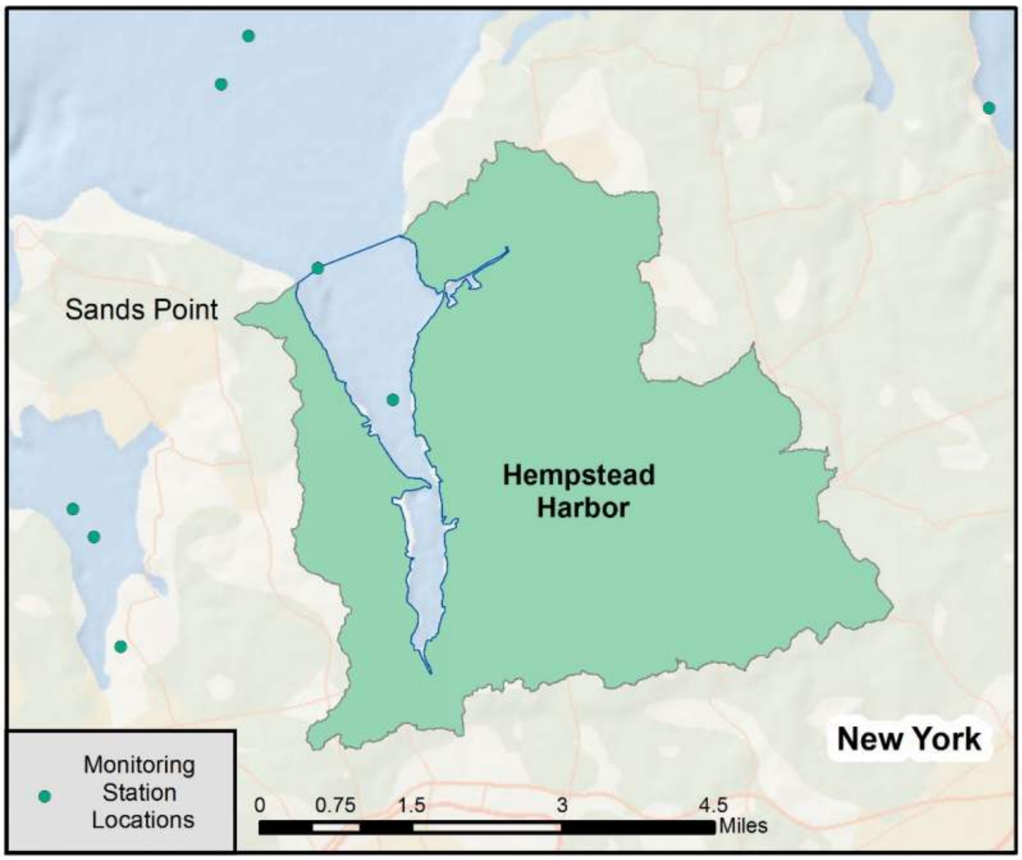


Figure D-22. Hempstead Harbor, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-24. Parameter Counts of Stations and Samples for Hempstead Harbor, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2014–2015	1	9	0	0	9	0.04	0.10	0.07
NH3_mgL	Ammonia-nitrogen [mg/L]	2014–2015	1	9	0	0	9	0.01	0.04	0.01
NO23_mgL	Nitrate + nitrite [mg/L]	2014–2015	1	9	0	0	9	0.00	0.08	0.01
PN_mgL	Particulate nitrogen [mg/L]	2014–2015	1	9	0	0	9	0.29	0.43	0.37
PP_mgL	Particulate phosphorus [mg/L]	2014–2015	1	9	0	0	9	0.05	0.11	0.07
TDN_mgL	Total dissolved nitrogen [mg/L]	2014–2015	1	9	0	0	9	0.25	0.35	0.33
TDP_mgL	Total dissolved phosphorus [mg/L]	2014–2015	1	9	0	0	9	0.08	0.17	0.11
TN_mgL	Total nitrogen [mg/L]	2014–2015	1	9	0	0	9	0.55	0.78	0.67
TP_mgL	Total phosphorus [mg/L]	2014–2015	1	9	0	0	9	0.15	0.30	0.18
Response Parameters										
CHLA_ugL [a]	Chl *a* [ug/L]	2006–2008	2	36	0	0	36	7.70	36.05	19.15
CHLAC_ugL [a]	Chl *a*, corrected [ug/L]	2014–2015	2	24	0	0	24	6.10	25.95	12.62
do_mgL	Dissolved oxygen [mg/L]	2006–2015	2	602	205	181	216	2.30	8.90	5.32
secchi_m	Secchi depth [m]	2006–2015	2	216	0	0	216	0.91	3.02	1.50
Physical Parameters										
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2014–2015	1	8	0	0	8	0.16	0.43	0.25
BOD_mgL	Biological oxygen demand [mg/L]	2015–2015	1	6	0	0	6	3.74	6.75	5.07
DOC_mgL	Dissolved organic carbon [mg/L]	2014–2015	1	9	0	0	9	2.44	3.65	3.12
PC_mgL	Particulate carbon [mg/L]	2014–2015	1	9	0	0	9	1.51	2.89	2.20
pH	pH	2007–2015	2	530	181	157	192	7.40	8.10	7.76
salinity_ppt	Salinity [ppt]	2006–2015	2	602	205	181	216	23.23	27.70	25.80
Si_mgL	Dissolved silica [mg/L]	2014–2015	1	9	0	0	9	0.64	2.07	1.58
temp_C	Temperature [deg C]	2006–2015	2	604	205	182	217	19.40	23.90	22.40
TSS_mgL	Total suspended solids [mg/L]	2014–2015	2	24	0	0	24	4.02	20.52	11.90
Total		**2006–2015**	**2**	**2,760**	**796**	**701**	**1,263**			

[a] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.21 Areas Adjacent to the Northport-Centerport Harbor Complex, NY

Figure D-23 shows a map of the Huntington Bay, Huntington Harbor, and Lloyd Harbor watersheds.

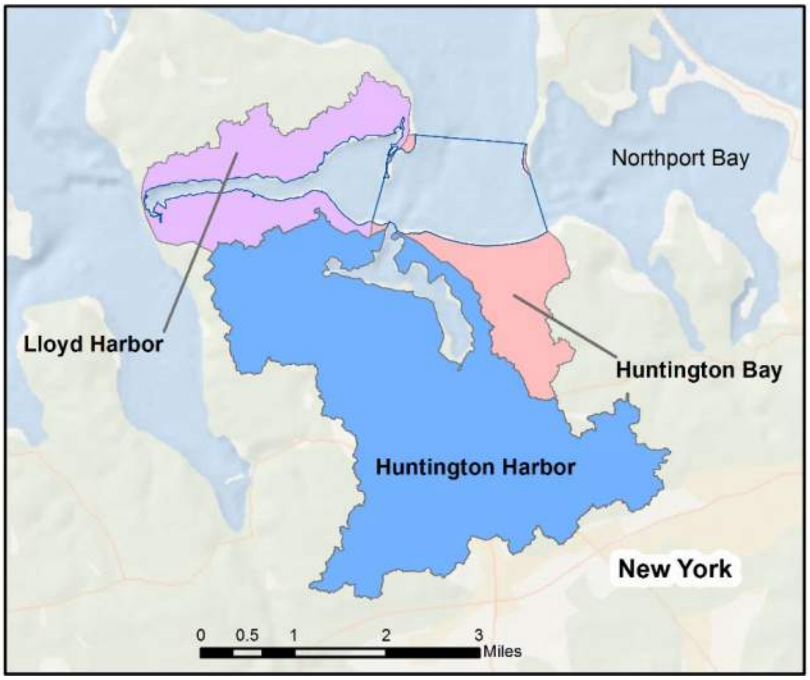


Figure D-23. Huntington Bay, Huntington Harbor, and Lloyd Harbor Watersheds, NY

Huntington Bay, NY

Water quality monitoring data were available for the Huntington Bay embayment from 1 monitoring organization corresponding to 2 monitoring stations and 1,275 samples from 2006–2015. Data were provided by Suffolk County.

Figure D-24 shows all monitoring station locations within and around the Huntington Bay embayment. Table D-25 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-25 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-25, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

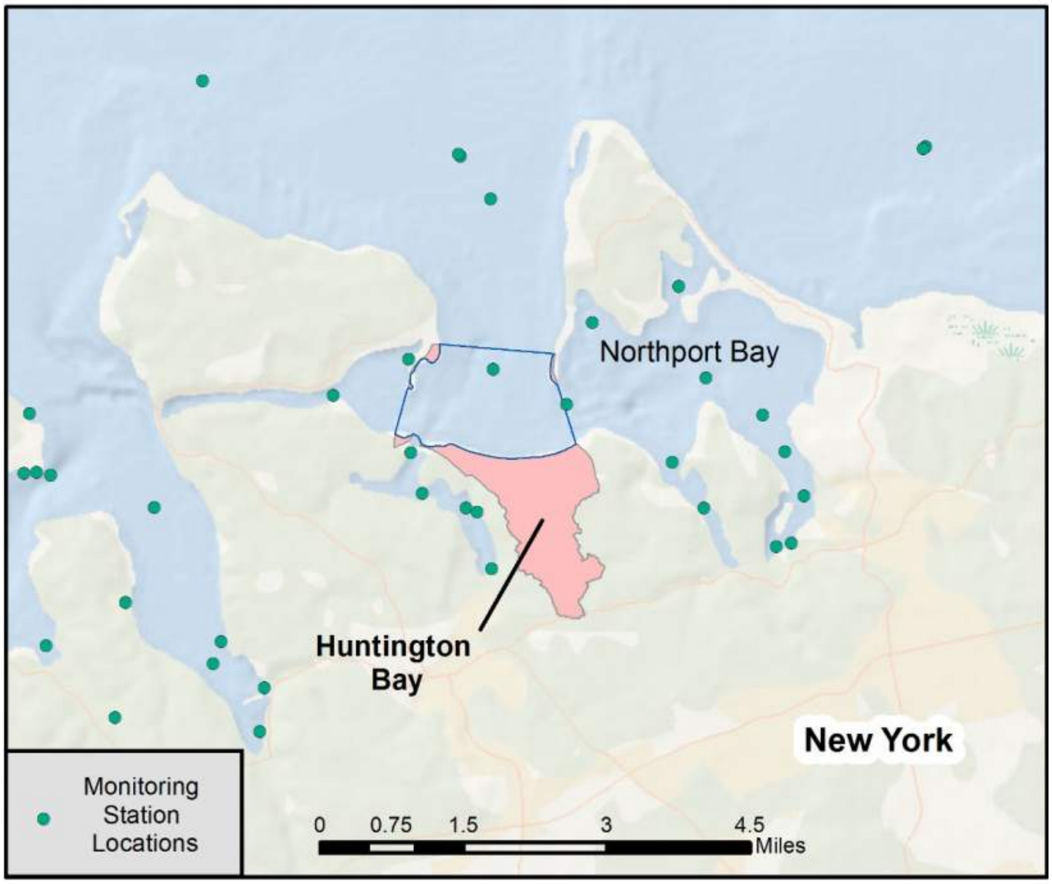


Figure D-24. Huntington Bay, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-25. Parameter Counts of Stations and Samples for Huntington Bay, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10^{th} Percentile	90^{th} Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	2	79	0	0	79	0.01	0.09	0.04
NH3_mgL	Ammonia-nitrogen [mg/L]	2006–2015	2	79	0	0	79	0.01	0.08	0.01
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	2	79	0	0	79	0.00	0.17	0.01
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	2	77	0	0	77	0.14	0.45	0.26
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	2	77	0	0	77	0.03	0.08	0.03
TN_mgL	Total nitrogen [mg/L]	2006–2015	2	77	0	0	77	0.18	0.49	0.29
TP_mgL	Total phosphorus [mg/L]	2006–2015	2	77	0	0	77	0.03	0.09	0.03

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Response Parameters										
CHLAC_ugL	Chl *a*, corrected [ug/L]	2006–2015	2	73	0	0	73	1.78	11.04	4.87
do_mgL	Dissolved oxygen [mg/L]	2006–2015	2	154	77	0	77	6.33	12.00	8.20
secchi_m	Secchi depth [m]	2006–2015	2	79	0	0	79	1.49	3.35	2.44
Physical Parameters										
DOC_mgL	Dissolved organic carbon [mg/L]	2007	2	2	0	0	2	1.80	1.81	1.81
pH	pH	2010–2015	2	100	35	0	65	7.77	8.20	7.90
salinity_ppt	Salinity [ppt]	2006–2015	2	154	77	0	77	24.83	27.70	26.10
temp_C	Temperature [deg C]	2006–2015	2	154	77	0	77	4.20	22.54	14.70
TOC_mgL	Total organic carbon [mg/L]	2007	2	2	0	0	2	1.86	1.87	1.87
TSS_mgL	Total suspended solids [mg/L]	2006–2010	1	12	0	0	12	2.75	10.90	6.00
Total		**2006–2015**	**2**	**1,275**	**266**	**0**	**1,009**			

Huntington Harbor, NY

Water quality monitoring data were available for the Huntington Harbor embayment from 2 monitoring organizations corresponding to 5 monitoring stations and 2,706 samples from 2006–2016. Data were provided by Suffolk County from 2006–2015 (2,581 samples) and Stony Brook University—Dr. Christopher Gobler from 2014–2016 (125 samples).

Figure D-25 shows all monitoring station locations within and around the Huntington Harbor embayment. Table D-26 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-26 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-26, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

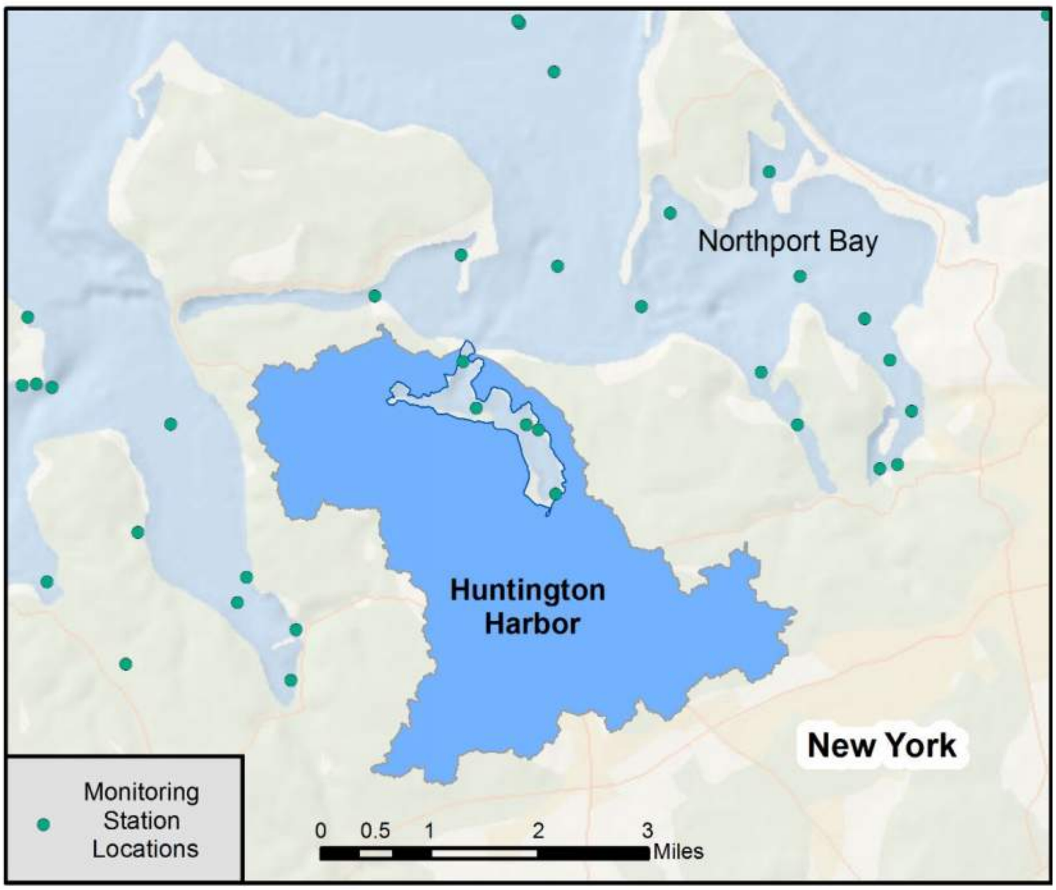


Figure D-25. Huntington Harbor, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-26. Parameter Counts of Stations and Samples for Huntington Harbor, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	4	150	0	0	150	0.01	0.08	0.04
NH3_mgL	Ammonia-nitrogen [mg/L]	2006–2015	4	150	0	0	150	0.01	0.13	0.05
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	4	150	0	0	150	0.00	0.55	0.16
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	4	147	0	0	147	0.19	0.82	0.40
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	4	147	0	0	147	0.03	0.08	0.03
TN_mgL	Total nitrogen [mg/L]	2006–2015	4	147	0	0	147	0.25	0.84	0.44
TP_mgL	Total phosphorus [mg/L]	2006–2015	4	147	0	0	147	0.03	0.09	0.05
Response Parameters										
CHLA_ugL[b]	Chl *a* [ug/L]	2014–2016	1	36	28	0	1	5.80	19.10	11.34
CHLAC_ugL[b]	Chl *a*, corrected [ug/L]	2006–2015	4	144	0	0	144	1.50	25.57	6.60
do_mgL	Dissolved oxygen [mg/L]	2006–2016	5	330	175	0	148	4.28	12.40	8.20
secchi_m	Secchi depth [m]	2006–2016	5	186	28	0	151	1.22	2.74	1.68
Physical Parameters										
DOC_mgL	Dissolved organic carbon [mg/L]	2007	3	3	0	0	3	2.30	2.79	2.49
pH	pH	2010–2015	4	200	72	0	128	7.50	8.20	7.90
salinity_ppt	Salinity [ppt]	2006–2015	4	294	147	0	147	23.36	26.90	25.30
stationDepth_m	Station depth [m]	2006–2015	4	150	0	0	150	3.96	6.40	5.11
temp_C	Temperature [deg C]	2006–2016	5	310	164	0	146	4.98	23.80	17.05
TOC_mgL	Total organic carbon [mg/L]	2007	3	3	0	0	3	2.11	2.62	2.27
TSS_mgL	Total suspended solids [mg/L]	2006–2010	1	12	0	0	12	2.75	18.40	7.00
Total		**2006–2016**	**5**	**2,706**	**614**	**0**	**2,071**			

[a] Some data had missing depth information in the original source and, therefore, have no depth codes. In this case, adding together the three totals from *# of samples by depth* will not add up to the total for *# of samples*.
[b] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

Lloyd Harbor, NY

Water quality monitoring data were available for the Lloyd Harbor embayment from 2 monitoring organizations corresponding to 2 monitoring stations and 649 samples from 2006–2015. Data were provided by EPA NCCA from 2010 (22 samples) and Suffolk County from 2006–2015 (627 samples).

Figure D-26 shows all monitoring station locations within and around the Lloyd Harbor embayment. Table D-27 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-27 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-27, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

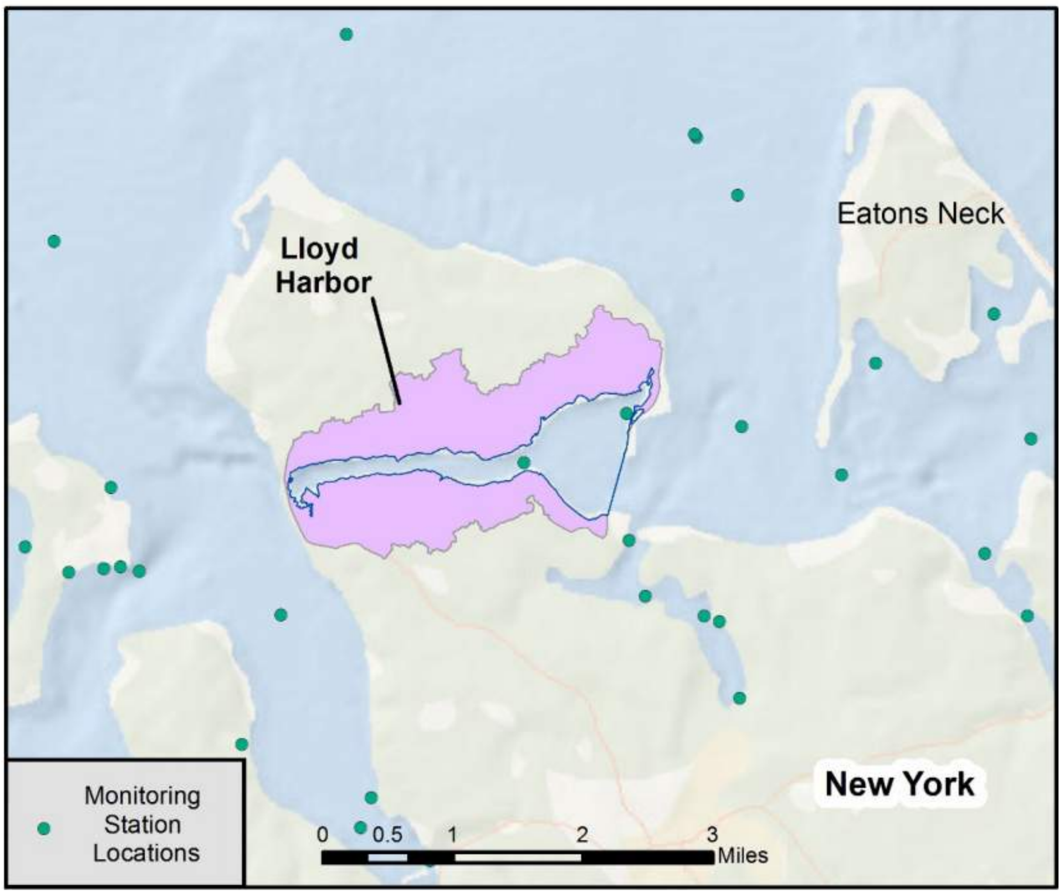


Figure D-26. Lloyd Harbor, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-27. Parameter Counts of Stations and Samples for Lloyd Harbor, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2010	1	1	0	0	1	0.01	0.01	0.01
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2015	1	39	0	0	39	0.01	0.07	0.04
NH3_mgL	Ammonia-nitrogen [mg/L]	2006–2015	2	40	0	0	40	0.01	0.09	0.01
NO2_mgL	Nitrite [mg/L]	2010	1	1	0	0	1	0.00	0.00	0.00
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2015	2	40	0	0	40	0.00	0.19	0.02
NO3_mgL	Nitrate [mg/L]	2010	1	1	0	0	1	0.01	0.01	0.01
TDN_mgL	Total dissolved nitrogen [mg/L]	2006–2015	1	38	0	0	38	0.14	0.50	0.27
TDP_mgL	Total dissolved phosphorus [mg/L]	2006–2015	1	38	0	0	38	0.03	0.07	0.03
TN_mgL	Total nitrogen [mg/L]	2006–2015	2	39	0	0	39	0.22	0.54	0.31
TP_mgL	Total phosphorus [mg/L]	2006–2015	2	39	0	0	39	0.03	0.08	0.05
Response Parameters										
CHLA_ugL[a]	Chl *a* [ug/L]	2010	1	1	0	0	1	4.10	4.10	4.10
CHLAC_ugL[a]	Chl *a*, corrected [ug/L]	2006–2015	1	39	0	0	39	1.49	12.18	4.94
do_mgL	Dissolved oxygen [mg/L]	2006–2015	2	78	39	0	39	6.54	12.43	8.60
Kd	Kd [m-1], computed from 1-5m photosynthetically active radiation data	2010	1	1	0	0	1	1.41	1.41	1.41
PAR_AMB_umolm2s	Ambient photosynthetically active radiation [umol/m2/s]	2010	1	2	1	0	1	1,657.50	2,161.06	1,909.28
PAR_UW_umolm2s	Underwater photosynthetically active radiation [umol/m2/s]	2010	1	2	1	0	1	375.24	1,200.36	787.80
secchi_m	Secchi depth [m]	2006–2015	2	40	0	0	40	1.07	2.30	1.75
Physical Parameters										
DOC_mgL	Dissolved organic carbon [mg/L]	2007	1	1	0	0	1	2.30	2.30	2.30
pH	pH	2010–2015	2	52	19	0	33	7.70	8.20	7.90
salinity_ppt	Salinity [ppt]	2006–2015	2	78	39	0	39	24.37	27.10	25.70
temp_C	Temperature [deg C]	2006–2015	2	78	39	0	39	4.48	24.13	14.65
TOC_mgL	Total organic carbon [mg/L]	2007	1	1	0	0	1	2.43	2.43	2.43
Total		**2006–2015**	**2**	**649**	**138**	**0**	**511**			

[a] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.22 Oyster Bay/Cold Spring Harbor Complex, NY

Water quality monitoring data were available for the Oyster Bay/Cold Spring Harbor Complex embayment from 3 monitoring organizations corresponding to 27 monitoring stations and 947 samples from 2008–2016. Data were provided by University of Connecticut (Vaudrey) from 2013–2014 (407 samples), from Friends of the Bay from 2008–2014 (415 samples), and from Stony Brook University—Dr. Christopher Gobler from 2014–2016 (125 samples).

Figure D-27 shows all monitoring station locations within and around the Oyster Bay/Cold Spring Harbor Complex embayment. Table D-28 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-28 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-28, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

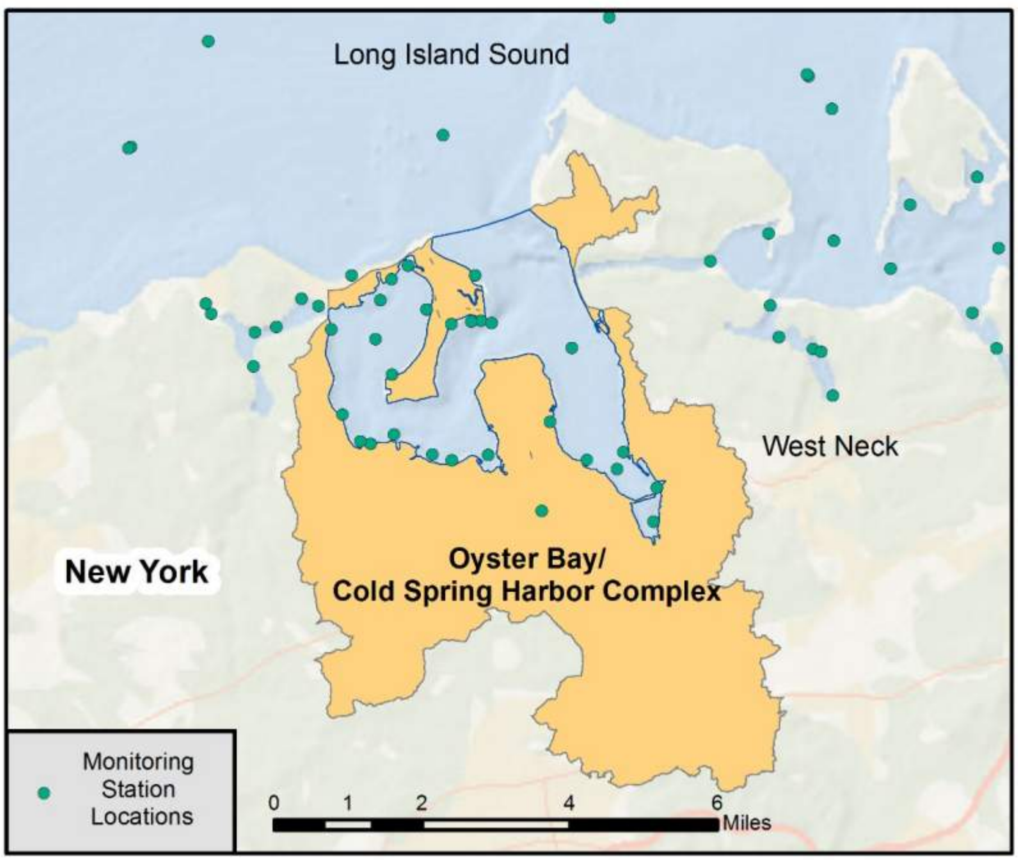


Figure D-27. Oyster Bay/Cold Spring Harbor Complex, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-28. Parameter Counts of Stations and Samples for Oyster Bay/Cold Spring Harbor Complex, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth[a]			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
PN_mgL	Particulate nitrogen [mg/L]	2013–2014	5	20	6	0	14	0.15	0.29	0.20
PO4_mgL	Phosphate-P [mg/L]	2013–2014	11	32	6	0	26	0.03	0.14	0.07
TDN_mgL	Total dissolved nitrogen [mg/L]	2013–2014	5	20	6	0	14	0.16	0.41	0.20
TN_mgL	Total nitrogen [mg/L]	2008–2014	20	435	414	0	21	0.31	3.16	1.65
Response Parameters										
CHLA_ugL[b]	Chl *a* [ug/L]	2014–2016	1	36	28	0	1	10.57	30.91	16.29
CHLAC_ugL[b]	Chl *a*, corrected [ug/L]	2013–2014	3	12	6	0	6	5.05	16.25	10.03
do_mgL	Dissolved oxygen [mg/L]	2013–2016	10	90	46	18	19	0.00	6.14	5.25
do_perc	Dissolved oxygen [% saturation]	2013–2014	9	54	18	18	18	67.87	89.70	75.29
Macroalgae_gm2	Total macrophyte dry weight [g m-2]	2013–2014	4	7	0	0	7	0.00	44.06	18.03
Macrophyte_DW_gm2	Total macroalgae [g m-2]	2013–2014	4	7	0	0	7	10.97	189.22	39.96
Seagrass_gm2	Seagrass [g m-2]	2013–2014	4	7	0	0	7	0.00	0.00	0.00
secchi_m	Secchi depth [m]	2014–2016	1	36	28	0	1	0.85	1.70	1.15
Physical Parameters										
pH	pH	2013–2014	9	54	18	18	18	7.69	8.19	7.84
salinity_ppt	Salinity [ppt]	2013–2014	9	54	18	18	18	27.22	27.84	27.47
temp_C	Temperature [deg C]	2013–2016	10	71	35	18	18	22.50	24.55	23.15
TSS_mgL	Total suspended solids [mg/L]	2013–2014	3	12	6	0	6	6.09	11.68	8.29
Total		**2008–2016**	**27**	**947**	**635**	**90**	**201**			

[a] Some data had missing depth information in the original source and, therefore, have no depth codes. In this case, adding together the three totals from *# of samples by depth* will not add up to the total for *# of samples*.
[b] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.23 Manhasset Bay, NY

Water quality monitoring data were available for the Manhasset Bay embayment from 1 monitoring organization corresponding to 3 monitoring stations and 4,033 samples from 2006–2015. Data were provided by IEC.

Figure D-28 shows all monitoring station locations within and around the Manhassett Bay embayment. Table D-29 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-29 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-29, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

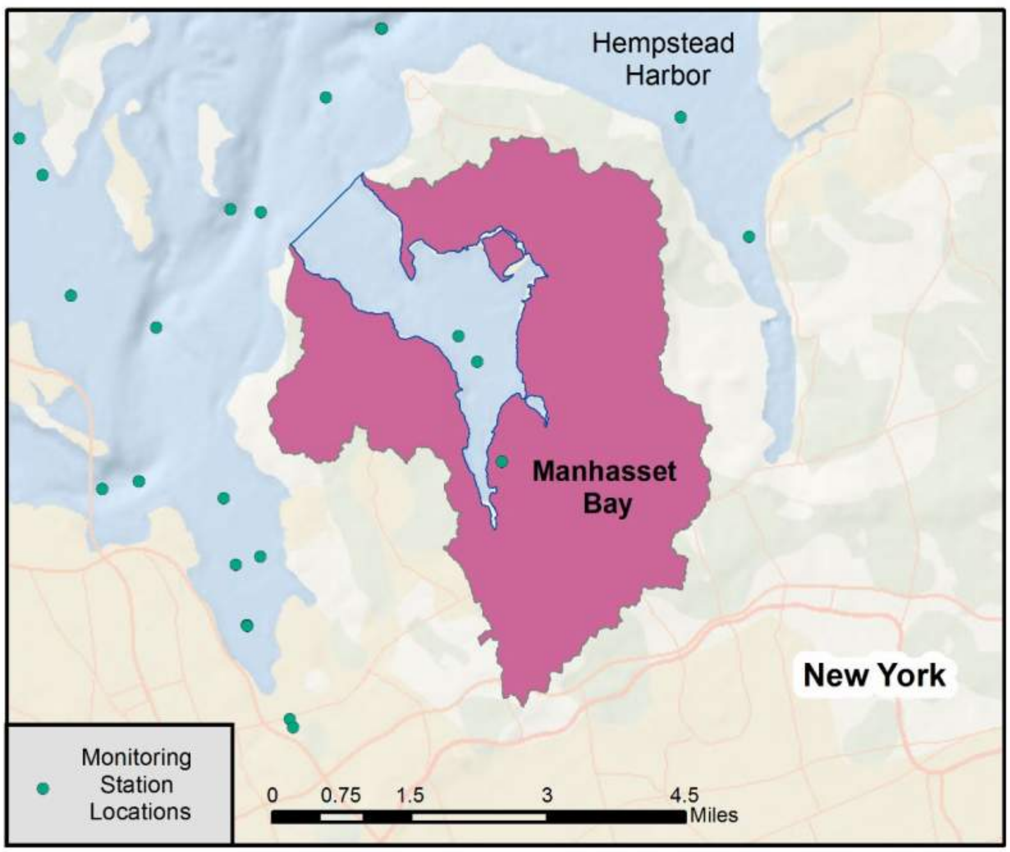


Figure D-28. Manhasset Bay, NY Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-29. Parameter Counts of Stations and Samples for Manhasset Bay, NY Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2014–2015	1	9	0	0	9	0.06	0.16	0.14
NH3_mgL	Ammonia-nitrogen [mg/L]	2014–2015	1	9	0	0	9	0.01	0.13	0.05
NO23_mgL	Nitrate + nitrite [mg/L]	2014–2015	1	9	0	0	9	0.01	0.09	0.02
PN_mgL	Particulate nitrogen [mg/L]	2014–2015	1	9	0	0	9	0.33	0.51	0.37
PP_mgL	Particulate phosphorus [mg/L]	2014–2015	1	9	0	0	9	0.05	0.10	0.07
TDN_mgL	Total dissolved nitrogen [mg/L]	2014–2015	1	9	0	0	9	0.29	0.72	0.40
TDP_mgL	Total dissolved phosphorus [mg/L]	2014–2015	1	9	0	0	9	0.08	0.22	0.19
TN_mgL	Total nitrogen [mg/L]	2014–2015	1	9	0	0	9	0.68	1.25	0.77
TP_mgL	Total phosphorus [mg/L]	2014–2015	1	9	0	0	9	0.16	0.31	0.24
Response Parameters										
BOD_mgL	Biological oxygen demand [mg/L]	2015	1	6	0	0	6	4.16	8.16	5.60
CHLA_ugL [a]	Chl *a* [ug/L]	2006–2008	3	54	0	0	54	11.09	47.37	24.75
CHLAC_ugL [a]	Chl *a*, corrected [ug/L]	2014–2015	3	36	0	0	36	6.25	29.70	13.71
do_mgL	Dissolved oxygen [mg/L]	2006–2015	3	889	321	234	334	2.61	8.82	5.26
secchi_m	Secchi depth [m]	2006–2015	3	334	0	0	334	0.90	3.00	1.20
Physical Parameters										
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2014–2015	1	8	0	0	8	0.18	0.49	0.33
DOC_mgL	Dissolved organic carbon [mg/L]	2014–2015	1	9	0	0	9	2.66	4.71	3.21
PC_mgL	Particulate carbon [mg/L]	2014–2015	1	9	0	0	9	1.22	2.59	1.92
pH	pH	2007–2015	3	784	283	205	296	7.34	8.20	7.69
salinity_ppt	Salinity [ppt]	2006–2015	3	887	319	234	334	22.80	27.20	25.30
Si_mgL	Dissolved silica [mg/L]	2014–2015	1	9	0	0	9	0.29	2.36	1.65
temp_C	Temperature [deg C]	2006–2015	3	891	323	234	334	20.20	24.10	22.70
TSS_mgL	Total suspended solids [mg/L]	2014–2015	3	36	0	0	36	6.50	22.05	13.80
Total		**2006–2015**	**3**	**4,033**	**1,246**	**907**	**1,880**			

[a] Chl *a* values are not based on paired samples of uncorrected and corrected chl *a*; therefore, the values cannot be compared. Corrected versus uncorrected chl *a* samples were collected at different sample locations (surface versus bottom) and times.

D.24 Pequonnock River, CT

No water quality data were available for the Pequonnock River embayment. Figure D-29 shows the Pequonnock River embayment. To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used data from other embayments and open water. Refer to Subtasks F and G for additional information.

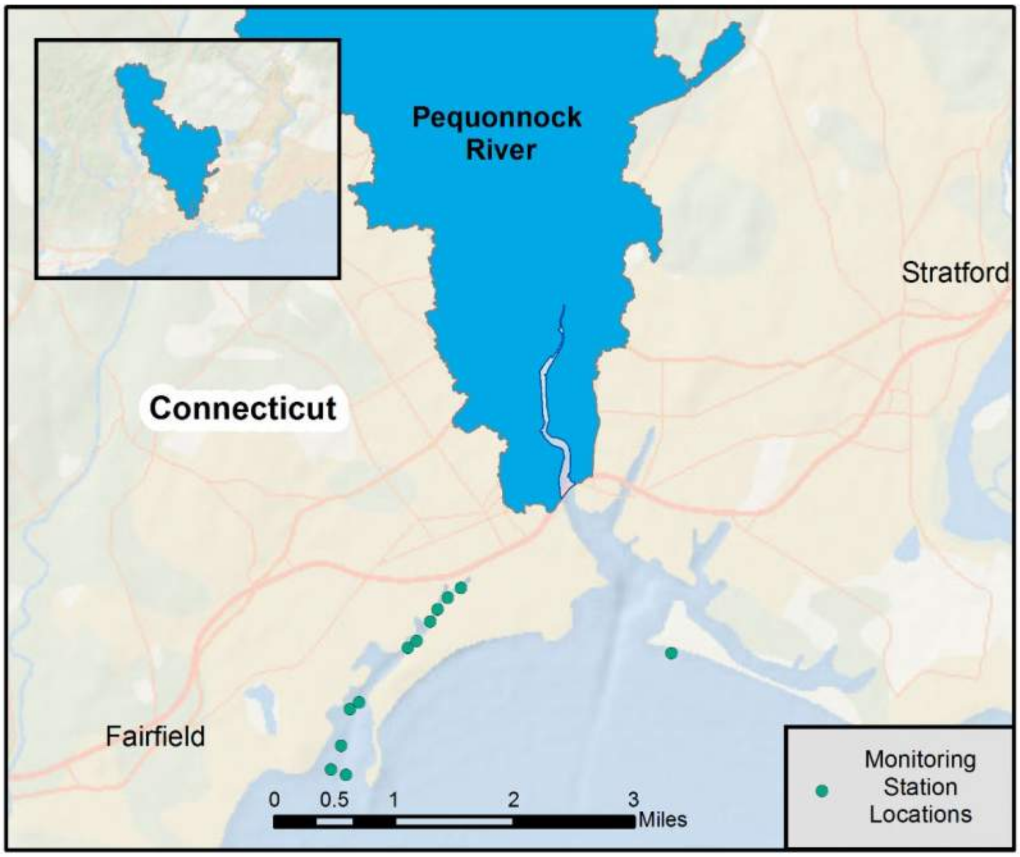


Figure D-29. Pequonnock River, CT Embayment and Nearby Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

D.25 Byram River, CT and NY

No water quality data were available for the Byram River embayment. Figure D-30 shows the Byram River embayment. To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used data from other embayments and open water. Refer to Subtasks F and G for additional information.

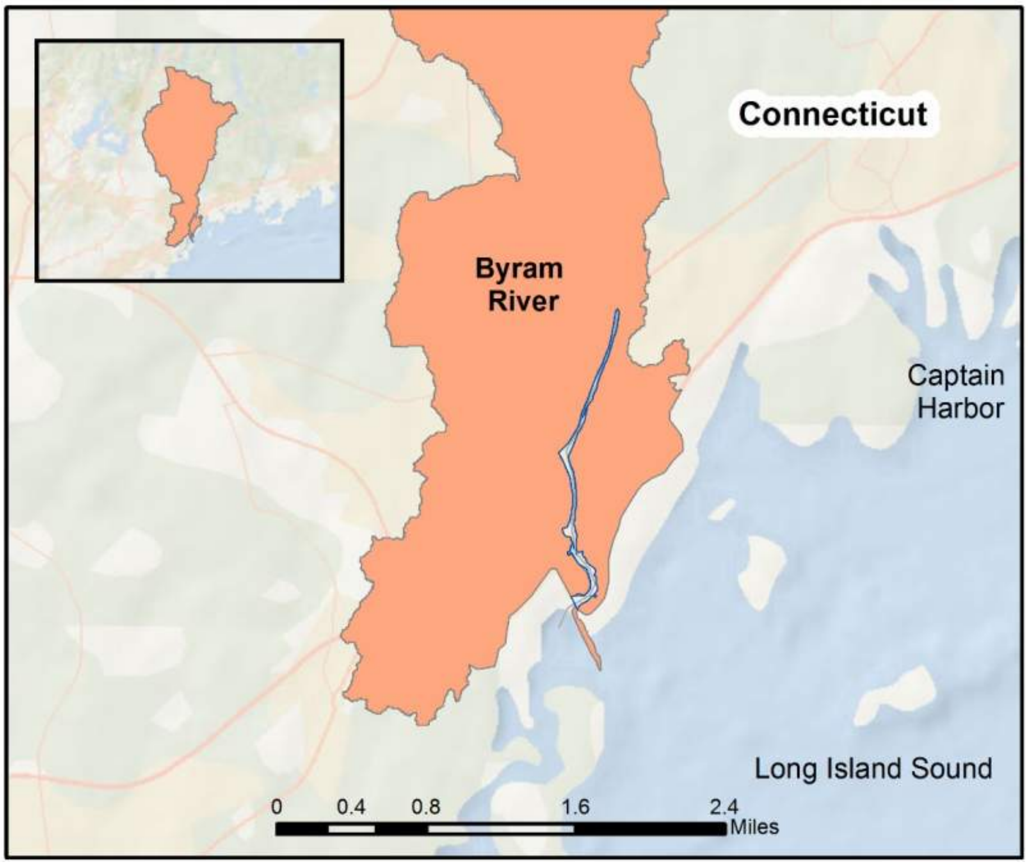


Figure D-30. Byram River, CT and NY Embayment. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

D.26 New Haven Harbor, CT

Water quality monitoring data were available for the New Haven Harbor embayment from 2 monitoring organizations corresponding to 2 monitoring stations and 24 samples from 2006. Data were provided by CTDEEP (18 samples) and EPA NCCA (6 samples).

Figure D-31 shows all monitoring station locations within and around the New Haven Harbor embayment. Table D-30 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-30 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-30, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

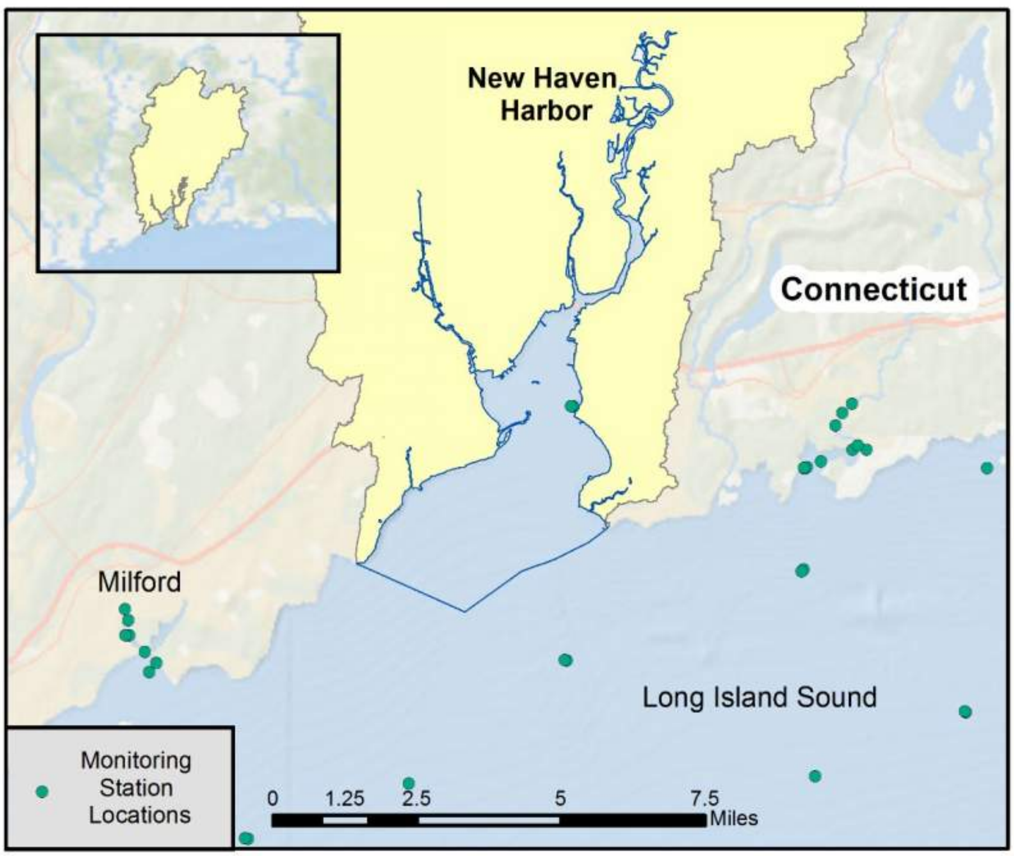


Figure D-31. New Haven Harbor, CT Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-30. Parameter Counts of Stations and Samples for New Haven Harbor, CT Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2006	1	1	0	0	1	0.02	0.02	0.02
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006	2	2	0	1	1	0.05	0.05	0.05
NH3_mgL	Ammonia-nitrogen [mg/L]	2006	1	1	0	1	0	0.00	0.00	0.00
NO23_mgL	Nitrate + nitrite [mg/L]	2006	1	1	0	1	0	0.02	0.02	0.02
PN_mgL	Particulate nitrogen [mg/L]	2006	1	1	0	1	0	0.19	0.19	0.19
PP_mgL	Particulate phosphorus [mg/L]	2006	1	1	0	1	0	0.03	0.03	0.03
TDN_mgL	Total dissolved nitrogen [mg/L]	2006	1	1	0	1	0	0.22	0.22	0.22
TDP_mgL	Total dissolved phosphorus [mg/L]	2006	1	1	0	1	0	0.07	0.07	0.07
TN_mgL	Total nitrogen [mg/L]	2006	2	2	0	1	1	0.41	0.41	0.41
TP_mgL	Total phosphorus [mg/L]	2006	2	2	0	1	1	0.10	0.10	0.10
Response Parameters										
CHLA_ugL	Chl *a* [ug/L]	2006	2	2	0	1	1	14.12	14.12	14.12
do_mgL	Dissolved oxygen [mg/L]	2006	1	1	0	1	0	9.41	9.41	9.41
Physical Parameters										
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2006	1	1	0	1	0	1.60	1.60	1.60
DOC_mgL	Dissolved organic carbon [mg/L]	2006	1	1	0	1	0	3.48	3.48	3.48
PC_mgL	Particulate carbon [mg/L]	2006	1	1	0	1	0	1.09	1.09	1.09
salinity_ppt	Salinity [ppt]	2006	1	1	0	1	0	25.34	25.34	25.34
Si_mgL	Dissolved silica [mg/L]	2006	1	1	0	1	0	0.76	0.76	0.76
temp_C	Temperature [deg C]	2006	1	1	0	1	0	21.32	21.32	21.32
TSS_mgL	Total suspended solids [mg/L]	2006	2	2	0	1	1	12.50	12.50	12.50
Total		**2006**	**2**	**24**	**0**	**18**	**6**			

D.27 Housatonic River, MA and CT

No water quality data were available for the Housatonic River embayment. Figure D-32 shows the Housatonic River embayment. To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used data from other embayments and open water. Refer to Subtasks F and G for additional information.

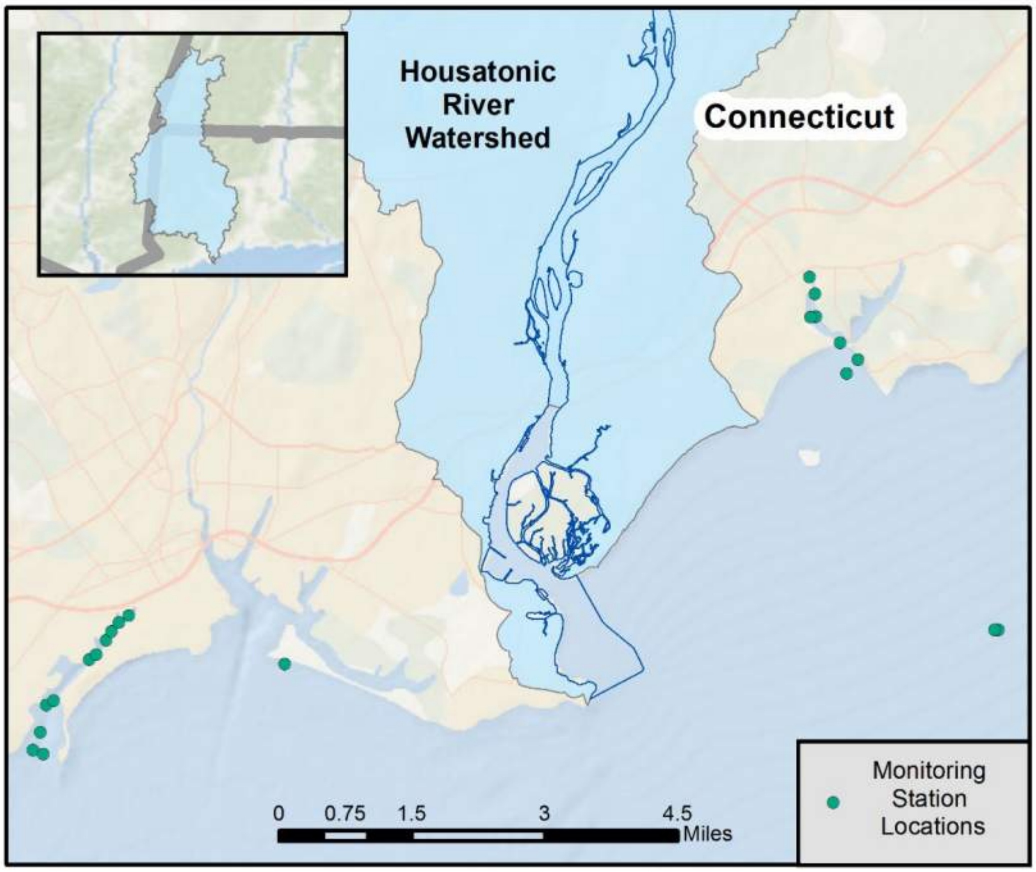


Figure D-32. Housatonic River, MA and CT Embayment and Nearby Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

D.28 Thames River, CT

Water quality monitoring data were available for the Thames River embayment from 2 monitoring organizations corresponding to 3 monitoring stations and 45 samples from 2006–2010. Data were provided by CTDEEP from 2006 (15 samples) and EPA NCCA from 2006–2010 (30 samples).

Figure D-33 shows all monitoring station locations within and around the Thames River embayment. Table D-31 summarizes by parameter the data collection period for which data were available, the number of stations, and the number of samples, by both total and depth (bottom, middle, or surface). Table D-31 is organized by all available parameters (nutrient, response, and other physical) for this embayment.

To determine protective endpoints for this embayment, as described in Subtasks F and G, Tetra Tech used a subset of the available paired data from Table D-31, as well as additional data from other embayments and open water. Refer to Subtasks F and G for additional information.

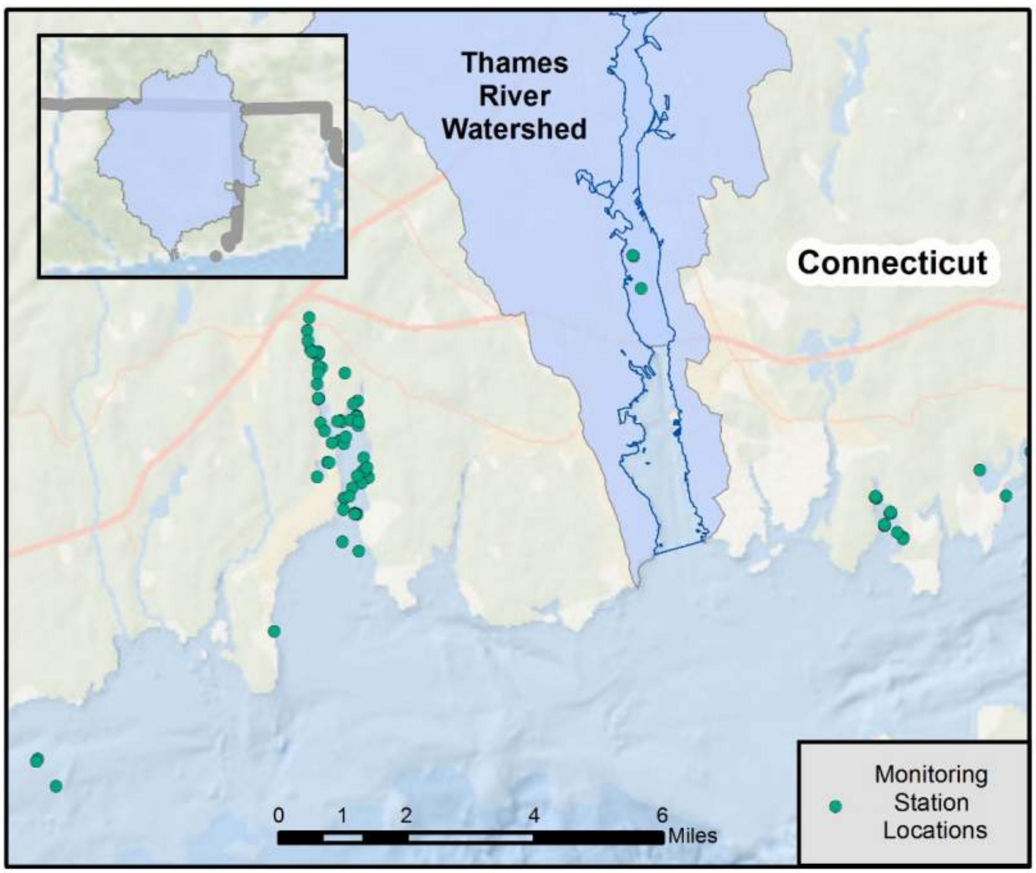


Figure D-33. Thames River, CT Embayment and Water Quality Monitoring Station Locations. Watershed Boundaries are Those Delineated by Dr. Jamie Vaudrey (University of Connecticut).

Table D-31. Parameter Counts of Stations and Samples for Thames River, CT Embayment

Parameter Name in Database	Parameter Description	Data Collection Period	# of Stations	# of Samples	# of Samples by Depth			Values		
					Bottom	Middle	Surface	10th Percentile	90th Percentile	Median
Nutrient Parameters										
DIN_mgL	Dissolved inorganic nitrogen [mg/L]	2006–2010	2	2	0	0	2	0.05	0.08	0.06
DIP_mgL	Dissolved inorganic phosphorus [mg/L]	2006–2010	3	3	0	1	2	0.03	0.04	0.04
NH3_mgL	Ammonia-nitrogen [mg/L]	2006–2010	3	3	0	1	2	0.03	0.03	0.03
NO2_mgL	Nitrite [mg/L]	2010	1	1	0	0	1	0.01	0.01	0.01
NO23_mgL	Nitrate + nitrite [mg/L]	2006–2010	2	2	0	1	1	0.02	0.07	0.05
NO3_mgL	Nitrate [mg/L]	2010	1	1	0	0	1	0.01	0.01	0.01
PN_mgL	Particulate nitrogen [mg/L]	2006	1	1	0	1	0	0.07	0.07	0.07
PP_mgL	Particulate phosphorus [mg/L]	2006	1	1	0	1	0	0.01	0.01	0.01
TDN_mgL	Total dissolved nitrogen [mg/L]	2006	1	1	0	1	0	0.25	0.25	0.25
TDP_mgL	Total dissolved phosphorus [mg/L]	2006	1	1	0	1	0	0.04	0.04	0.04
TN_mgL	Total nitrogen [mg/L]	2006–2010	3	3	0	1	2	0.31	0.32	0.32
TP_mgL	Total phosphorus [mg/L]	2006–2010	3	3	0	1	2	0.05	0.06	0.05
Response Parameters										
CHLA_ugL	Chl *a* [ug/L]	2006–2010	3	3	0	1	2	6.29	10.24	10.24
do_mgL	Dissolved oxygen [mg/L]	2010	1	2	1	0	1	5.91	6.35	6.13
Kd	Kd [m-1], computed from 1-5m photosynthetically active radiation data	2010	1	1	0	0	1	0.52	0.52	0.52
PAR_AMB_umol m2s	Ambient photosynthetically active radiation [umol/m2/s]	2010	1	2	1	0	1	481.62	641.74	561.68
PAR_UW_umol m2s	Underwater photosynthetically active radiation [umol/m2/s]	2010	1	2	1	0	1	39.76	150.64	95.20
secchi_m	Secchi depth [m]	2010	1	1	0	0	1	1.90	1.90	1.90
Physical Parameters										
BiSi_mgL	Biogenic silica, polycarbonate filter digestion [mg/L]	2006	1	1	0	1	0	0.41	0.41	0.41
DOC_mgL	Dissolved organic carbon [mg/L]	2006	1	1	0	1	0	3.24	3.24	3.24
PC_mgL	Particulate carbon [mg/L]	2006	1	1	0	1	0	0.50	0.50	0.50
pH	pH	2010	1	2	1	0	1	7.90	7.94	7.92
salinity_ppt	Salinity [ppt]	2010	1	2	1	0	1	27.80	28.56	28.18
Si_mgL	Dissolved silica [mg/L]	2006	1	1	0	1	0	2.05	2.05	2.05
temp_C	Temperature [deg C]	2010	1	2	1	0	1	20.44	20.72	20.58
TSS_mgL	Total suspended solids [mg/L]	2006	2	2	0	1	1	3.50	3.50	3.50
Total		**2006–2010**	**3**	**45**	**6**	**15**	**24**			

Sources Cited

Tetra Tech. 2017. *Secondary Data Quality Assurance Project Plan for Application of Technical Approach for Establishing Nitrogen Thresholds and Allowable Loads for Three LIS Watershed Groupings: Embayments, Large Riverine Systems, and Western LIS Point Source Discharges to Open Water*. Prepared for U.S. Environmental Protection Agency Region 1 by Tetra Tech, Inc., Fairfax, VA.

Vaudrey, J.M.P., J. Alonzo, A. Esposito, C. Johnson, M.D. Murphy, and C. Yarish. 2013. *Evaluation of Current Community-Based Monitoring Efforts and Recommendations for Developing a Cohesive Network of Support for Monitoring Long Island Sound Embayments*. Final Report. Funded by and prepared for the New England Interstate Water Pollution Control Commission and Long Island Sound Study. Accessed January 2017. http://digitalcommons.uconn.edu/marine_sci/2/.

Vaudrey, J.M.P, C. Yarish, J.K. Kim, C. Pickerell, L. Brousseau, J. Eddings, and M. Sautkulis. 2016. *Connecticut Sea Grant Project Report: Comparative Analysis and Model Development for Determining the Susceptibility to Eutrophication of Long Island Sound Embayments*. Project number R/CE-34-CTNY. 46 p. Final report submitted to Connecticut Sea Grant, New York Sea Grant, and Long Island Sound Study.

Appendix D: LIS Water Quality Data

See Excel file.

ATTACHMENT 3

UWS QAPP

Save the Sound
Action for our region's environment.

April 21, 2020

Christopher Dere, EPA Region II
UWS EPA Project Manager
290 Broadway
New York, NY 10007
Dere.Christopher@epa.gov

Esther Nelson, EPA Region II
UWS EPA Quality Assurance Officer
2890 Woodbridge Avenue
Edison, NJ 08837
Nelson.Esther@epa.gov

Dear Mr. Dere and Ms. Nelson:

Circumstances surrounding Covid-19 and efforts to stop the spread of the virus are leading to a delayed start of the 2020 Unified Water Study (UWS) season. The season will officially begin on, or around, June 1, 2020 instead of May 1, 2020. The season will maintain its end date of October 31, 2020. The start date will have some flexibility given there are 23 monitoring groups across two states and numerous municipalities. Safety and adherence to state and local orders is of the upmost importance and these will inform each group's respective ability to start their monitoring in the field this year.

Annual trainings are being offered remotely via a virtual platform and annual field audits will commence in June utilizing video conferencing technology. The 2020 training will contain a module on sampling during Covid-19 and a guidance document on best practices will also be shared with all UWS groups.

Please accept this letter as an addendum to the approved Quality Assurance Project Plan titled: *Long Island Sound Embayments Water Quality Monitoring QAPP for Monitoring Activities Conducted in the Unified Water Study: Long Island Sound Embayment Research*. This monitoring program is conducted under EPA Agreement No. LI96259818.

Best Regards,

Peter H. Linderoth
Save the Sound
UWS Monitoring Program Coordinator
plinderoth@savethesound.org

Long Island Sound Embayments Water Quality Monitoring QAPP

For monitoring activities conducted in the Unified Water Study: Long Island Sound Embayment Research.

Monitoring Organizations

Ash Creek Conservation Association, Bronx River Alliance, Clean up Sound and Harbors (CUSH), Coalition to Save Hempstead Harbor, Connecticut River Conservancy, Cornell Cooperative Extension of Suffolk County Marine Program, Derecktor Shipyards, Friends of the Bay, Friends of the Farm River Estuary, Group for the East End, Earthplace, Inc. (Harbor Watch), Interstate Environmental Commission, New England Science & Sailing Foundation, Salonga Wetland Advocates Network, Save the River – Save the Hills, Inc., Save the Sound – Connecticut Fund for the Environment, Setauket Harbor Task Force, SoundWaters, The Maritime Aquarium at Norwalk, Town of Darien, Town of Fairfield – Conservation Department, Town of Stratford – Conservation Department, River Advocates of South Central Connecticut

Coordinating Organization

Save the Sound – Connecticut Fund for the Environment

Funded By

The United States Environmental Protection Agency – Long Island Sound Study

Version Date (yyyy.mm.dd)

2020.03.16

Date Approved

2020.03.16

Prior Associated Approved QAPP:

Mamaroneck Harbor and Little Neck Bay, NY, UWS Water Quality Monitoring QAPP
Approved by Kathryn Drisco, Quality Assurance Officer, EPA, Region 2, 8/3/2017
NFWF grant 53526, Connecticut Fund for the Environment, Water Quality Monitoring Initiative for Long Island Sound Embayments (NY), EPA Cooperative Agreement LI-00A00129-0 (FC.R278). Long Island Sound Embayment Water Quality Monitoring QAPP. For monitoring activities conducted as part of the Long Island Sound Tier 1 Unified Water Study (UWS). Approved by Esther Nelson, Quality Assurance Officer, EPA, Region 2, 6/5/2018. National Fish and Wildlife Foundation (NFWF), US EPA recipient via Cooperative Agreement LI 00A00382 (NFWF FC.R334). Long Island Sound Embayments Water Quality Monitoring QAPP. For monitoring activities conducted in the Unified Water Study: Long Island Sound Embayment Research Approved by Esther Nelson, Quality Assurance Officer, EPA Region 2, 5/2/2019, EPA Agreement No. LI96259818.

A. Project Management

A.1. Approval Page

_______________ date: 3/20/2020

Tracy Brown, Monitoring Program Project Manager
Save the Sound – CT Fund for the Environment

_______________ date: 3/20/2020

Peter Linderoth, Monitoring Program Coordinator
Save the Sound – CT Fund for the Environment

_______________ date: 3/20/2020

Jamie Vaudrey, UWS Science Advisor
Department of Marine Sciences, University of Connecticut

_______________ date: 3/20/2020

Jason Krumholz, UWS Science Advisor
McLaughlin Research Corporation

_______________ date: 3/23/2020

Christopher E. Dere, Onondaga Lake Program Manager
US Environmental Protection Agency, Region 2

_______________ date: 3/23/20

Esther Nelson, Quality Assurance Officer
US Environmental Protection Agency, Region 2

A.2. Table of Contents

A.3. Distribution List

Tracy Brown, Monitoring Program Project Manager
Save the Sound – CT Fund for the Environment
545 Tompkins Avenue, 3rd Floor
914-381-3140
tbrown@savethesound.org

Peter Linderoth, Monitoring Program Coordinator
Save the Sound – CT Fund for the Environment
545 Tompkins Avenue, 3rd Floor
914-381-3140
plinderoth@savethesound.org

Elena Colón, Monitoring Program Field Coordinator
Save the Sound – CT Fund for the Environment
545 Tompkins Avenue, 3rd Floor
914-381-3140
ecolon@savethesound.org

Peter Linderoth, Monitoring Program Quality Assurance Officer
Save the Sound – CT Fund for the Environment
545 Tompkins Avenue, 3rd Floor
914-381-3140
plinderoth@savethesound.org

Peter Linderoth, Monitoring Program Lab Coordinator
Save the Sound – CT Fund for the Environment
545 Tompkins Avenue, 3rd Floor
914-381-3140
plinderoth@savethesound.org

Elena Colón, Monitoring Program Data Management Coordinator
Save the Sound – CT Fund for the Environment
545 Tompkins Avenue, 3rd Floor
914-381-3140
ecolon@savethesound.org

Jamie Vaudrey, UWS Science Advisor
Department of Marine Sciences, University of Connecticut
1080 Shennecossett Road, Groton, CT 06335
860-405-9149
jamie.vaudrey@uconn.edu

Jason Krumholz, UWS Science Advisor
McLaughlin Research Corporation
132 Johnnycake Hill Rd., Middletown RI 02842
401-787-0944
jkrumholz@gmail.com

Christopher E. Dere, EPA Project Officer
Onondaga Lake Program Manager
USEPA Region 2
290 Broadway, 24th Floor
New York, NY
212-637-3828
dere.christopher@epa.gov

Esther Nelson, EPA Quality Assurance Officer
2890 Woodbridge Ave
Edison, NJ 08837
732-906-6837
Nelson.esther@epa.gov

Katie Obrien-Clayton, CTDEEP Contact
CTDEEP WPLR, Environmental Analyst 2
79 Elm Street
Hartford, CT 06106
860-424-3176
Katie.obrien-clayton@ct.gov

Kelly Streich, CT DEEP Contact
Bureau of Water Management and Land Reuse
79 Elm Street
Hartford, CT 06106
860-424-3176
Kelly.streich@ct.gov

Alene Onion, NYSDEC Contact
NYSDEC, WAVE Coordinator
625 Broadway
Albany, NY 12233
518-402-8166
Alene.onion@dec.ny.gov

Ryan O’Donnell, UWS Monitoring Group Lead
Connecticut River Conservancy
15 Bank Row, Greenfield, MA 01301
860-704-0057
rodonnell@ctriver.org

Carolyn Sukowski, UWS Monitoring Group Lead
Cornell Cooperative Extension of Suffolk County Marine Program
423 Griffing Ave, Suite 100, Riverhead, NY 11901
631-293-1800 ext.21
cs424@cornell.edu

Chris Ray, UWS Monitoring Group Lead
Derecktor Shipyards
311 E Boston Post Road, Mamaroneck, NY 10543
914-698-5020
cray@derecktor.com

Heather Johnson, UWS Monitoring Group Lead
Friends of the Bay
111 South Street, Oyster Bay, NY 11771
516-922-6666
h.johnson@friendsofthebay.org

Greg Carpenter, UWS Monitoring Group Lead
Friends of the Farm River Estuary
P.O. Box 2337
203-376-8120
farmriverfriends@gmail.com

Aaron Virgin, UWS Monitoring Group Lead
Group for the East End
54895 Main Road (Rte. 25), Southold, NY 11971
631-765-6450 ext. 218
acvirgin@eastendenvironment.org

Sarah Crosby, UWS Monitoring Group Lead
Earthplace, Inc. (Harbor Watch)
10 Woodside Lane, Westport, CT 06880
203-557-4403
s.crosby@earthplace.org

Evelyn Powers, UWS Monitoring Group Lead
and UWS Project Laboratory Manager
Interstate Environmental Commission District
2800 Victory Blvd, Staten Island, NY 10314
718-982-3792
epowers@iec-nynjct.org

Megan Strand, UWS Monitoring Group Lead
New England Science & Sailing Foundation
72 Water Street, Stonington, CT 06378
860-595-9362
mstrand@nessf.org

Charles Muller, UWS Monitoring Group Lead
Salonga Wetland Advocates Network, Inc.
28 Marions Lane, Northport, NY 11768
631-626-8328
cjmul2003@yahoo.com

Fred Grimsey, UWS Monitoring Group Lead
Save the River, Save the Hills, Inc.
35 Oswegatchie Road, Waterford, CT 06385
860-442-8349
president@savetheriversavethehills.org

George Hoffman, UWS Monitoring Group Lead
Setauket Harbor Task Force, Inc.
146 Main Street, Setauket, NY 11733
631-786-6699
geohoff@optonline.net

Leigh Shemitz, UWS Monitoring Group Lead
SoundWaters
1281 Cove Road, Stamford, CT 06902
203-406-3304
lshemitz@soundwaters.org

Dave Hudson, UWS Monitoring Group Lead
The Maritime Aquarium of Norwalk
10 N Water Street, Norwalk, CT 06854
203-852-0700 ext. 2304
dhudson@maritimeaquarium.org

William Cavers, UWS Monitoring Group Lead
Town of Darien
2 Renshaw Road, Darien, CT 06820
203-940-0757
wwcavers@gmail.com

Brian Carey, UWS Monitoring Group Lead
Town of Fairfield – Conservation Department
725 Old Post Road, Fairfield, CT 06824
203-256-3071
bcarey@fairfieldct.org

Kelly Kerrigan, UWS Monitoring Group Lead
Town of Stratford – Conservation Department
550 Patterson Avenue, Stratford, CT 06614
203-385-4006
kkerrigan@townofstratford.com

Carol DiPaolo, UWS Monitoring Group Lead
Coalition to Save Hempstead Harbor
PO Box 159, Sea Cliff, NY 11579
516-801-6792
cshh@optonline.net

Michelle A. Luebke, UWS Monitoring Group Lead
Bronx River Alliance
1 Bronx River Parkway
Bronx, NY 10462
718-430-4665
michelle.luebke@bronxriver.org

Gail Robinson, UWS Monitoring Group Lead
Ash Creek Conservation Association
Bridgeport, CT
203-335-6690
ashcreekassoc@optonline.org

Mary Mushinsky, UWS Monitoring Group Lead
River Advocates of South Central Connecticut
1253 Whitney Avenue
Hamden, CT 06517
203-430-0921
marymushinsky@att.net

Kyle Rabin
Program Manager, Long Island Nitrogen Action Plan
Long Island Regional Planning Council
1864 Muttontown Road
Syosset, NY 11791
516-571-7613
krabin@lirpc.org

David Lipsky
Senior Policy Advisor
Bureau of Sustainability
NYC Department of Environmental Protection
59-17 Junction Blvd, 11th Floor
Flushing, NY 11363
718-595-5340
dlipsky@dep.nyc.gov

Beau Ranheim
Section Chief, Marine Sciences
New York City Department of Environmental Protection
718-595-5709
BeauR@dep.nyc.gov

A.4. Project / Task Organization

Table 1: Project Organization.
Key project personnel and their corresponding responsibilities.

Name(s)	***Project Title*** - Responsibility
Tracy Brown	***Monitoring Program Project Manager*** – Oversees all aspects of project that incorporate the monitoring program including: fiscal management, project objectives, data uses, program changes, etc.
Peter Linderoth	***Monitoring Program Coordinator*** – Monitoring Group recruitment and training. Develops the QAPP. Produces monitoring report. Produces or oversees outreach efforts, in coordination with project manager.
Elena Colón	***Monitoring Program Field Coordinator*** – Responsible for assistance in training and quality assurance of monitoring groups for field work. Ensures field datasheets are properly filled out, samples and forms are transported to laboratories as needed, Standard Operations Procedures (SOPs) are being followed in entirety; and performs QA checks, including field audits, to make sure procedures are followed or corrected as needed (in collaboration QA officer and UWS Science Advisors).
Peter Linderoth	***Monitoring Program Lab Coordinator*** – Makes arrangements with any lab(s) used to perform analyses according to QAPP. Ensures correct procedures are used, holding times are met, and adequate documentation is provided.
Elena Colón	***Monitoring Program Data Management Coordinator*** – Maintains the data systems for the program. Performs/oversees data entry and checks entries for accuracy against field and lab forms.
Peter Linderoth	***Monitoring Program Quality Assurance Officer*** – Runs Quality Assurance (QA) program.
Jamie Vaudrey and Jason Krumholz	**UWS Science Advisors –** Science consultants offering guidance and participating in trainings and station selection among other aspects of the project including quality assurance.
Christopher E. Dere	***USEPA Project Officer*** – Oversees US EPA Cooperative Agreement compliance including processing recipient/subrecipient requests for QA/QC within EPA Regions
See Distribution List	**UWS Monitoring Group Leads** – Undertake UWS in their respective embayment(s) following all aspects of this QAPP.
Esther Nelson	***USEPA Quality Assurance Officer*** – Reviews, comments and approves QAPP.
Changes by year. Individual names are not listed.	***Monitoring Program Field Staff*** – Sample, perform field analyses, and assist in laboratory analyses and/or data entry.

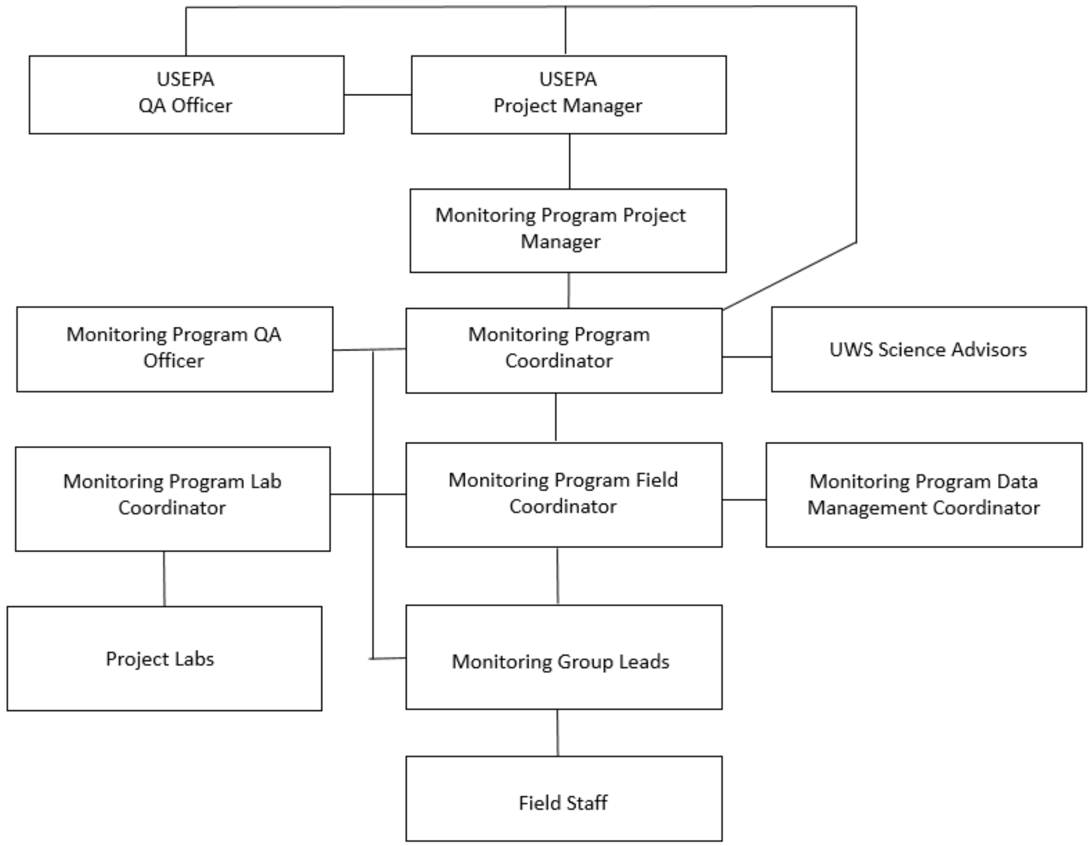


Figure 1: Organizational Chart.
Lines between boxes indicate direct communication.

A.5. Problem Definition / Background

Despite three decades of effort to improve water quality, Long Island Sound (LIS) remains a severely stressed environment. In the western Sound, from Greenwich to Nassau County, dissolved oxygen concentrations—a key measure of the Sound's health—consistently fall to levels too low to sustain aquatic wildlife. Low levels of dissolved oxygen, or hypoxia, are worsened by excess nitrogen (N) from outdated sewage collection systems, failing septic systems, contaminated stormwater runoff, and fertilizers. Moreover, there are serious eutrophication-related impacts in embayments throughout the Sound[1]. According to the EPA's Nitrogen Reduction Strategy, "Impairments linked to excess discharges of N include harmful algal blooms, low DO, poor water clarity, loss of submerged aquatic vegetation and tidal wetlands, and coastal acidification."

Main-stem Long Island Sound water quality data are abundant and readily available from Connecticut Department of Energy and Environmental Protection, New York City Department of Environmental Protection, and the Interstate Environmental Commission for analyses. However, there are limited environmental health data being collected in LIS embayments. The Unified Water Study (UWS) will fill in many of the data gaps that exist amongst LIS embayments. These data sets will have myriad of uses including comparing embayment environmental health, informing water quality management decisions, and conveying the information to the public so they can be better informed about the environmental health of LIS embayments.

The groups selected to participate in the 2018 UWS season went through an application process administered by the Monitoring Program Project Manager, Monitoring Program Coordinator, and the Monitoring Program Field Coordinator. A standardized application form was distributed and the administrators used a metric to select groups. In 2018, there were 19 monitoring groups monitoring a total of 33 embayments. In 2019, three new groups were added to the UWS. The 2019 group and embayment total is 22 groups in 37 embayments. 12 of the 37 embayments in the UWS will also receive Tier II monitoring. In 2020, one new group is being added to the UWS. The 2020 group and embayment total is 23 groups in 38 embayments. 13 of the embayments will receive Tier II monitoring.

The final locations of the Tier I embayments in the UWS were dependent on the applications and respective monitoring group's interests. Tier II embayments were selected referencing priority embayment plans put forth by Connecticut Department of Energy and Environmental Protection, New York State Department of Environmental Conservation, and Long Island Sound Study. Monitoring group experience was also a factor in the decision.

Organizational History and Mission

The mission of Connecticut Fund for the Environment (CFE) and its bi-state program Save the Sound is to protect and improve the land, air and water of Connecticut and Long Island Sound. Founded in 1978, CFE merged in 2004 with Save the Sound, a respected voice for the protection of Long Island Sound's shoreline, marine habitat and water quality with a track record of more

---

[1] Vaudrey, J. M., Yarish, C., Kim, J. K., Pickerell, C., Brousseau, L., Eddings, J., & Sautkulis, M. (2016). Comparative analysis and model development for determining the susceptibility to eutrophication of Long Island Sound embayments. Connecticut Sea Grant Final Project Report, 38.

than 40 years. The proposed project is in line with one of Save the Sound's strategic goals: "Our Long Island Sound, rivers and lakes are safe for people and wildlife."

Data collected under this QAPP will be collected in a manner to allow the data to be used as part of the Unified Water Study. The UWS is a coordinated effort among groups monitoring Long Island Sound with the goal of comparing water quality parameters associated with eutrophication within and among embayments. The UWS is comprised of two tiers, Tier I and Tier II. Tier I data is required for entry into the study. The parameters monitored in Tier I of the study are dissolved oxygen, conductivity (salinity), chlorophyll a, temperature, turbidity, and qualitative macrophyte assessments. Tier II parameters monitored as part of the UWS are nutrient concentrations, logged dissolved oxygen and conductivity (salinity) data, and underwater camera quantitative assessments of macrophytes. Tier I and Tier II parameters are covered in this QAPP.

Monitoring History and Status

The New York Office of Save the Sound initiated a pathogen-indicator and water quality monitoring program in 2013 and has since expanded the spatial and temporal scale of the water quality monitoring program. Save the Sound was the lead facilitator in the development of the UWS and participated in the 2016 UWS pilot season. Save the Sound continues to participate in the UWS as the coordinating organization as well as a monitoring group. Measuring the eutrophic conditions in the bays and harbors of Long Island Sound directly relates to Save the Sound's overarching goal of reducing nitrogen and other pollutants in the Sound.

The UWS conducted a pilot season for the Tier I parameters with four existing monitoring groups in 2016. The goal of the 2016 season was to develop protocols that followed standard methods for embayment monitoring. All groups involved with the 2016 season had previous experience monitoring their embayments and were involved in ongoing monitoring programs. Groups involved with the 2016 pilot season, and other advisory participants such as academics and federal and municipal agencies, assisted with developing and finalizing the UWS Tier I SOPs.

2017 marked the inaugural season of the UWS with twelve groups participating in the study. Eleven of these groups monitored in Long Island Sound and one monitored off the south shore of Long Island, NY. These groups maintained their own QAPPs based on a template. These QAPPs provided integrity to the Study but monitoring groups in the UWS now operate under a collective EPA-approved QAPP, this document. The groups are responsible for adhering to the QAPP and Save the Sound will ensure that quality objectives are met for each embayment in the study as outlined in this document. The collective QAPP will be updated upon changes to embayments, participating groups, or procedures in the study.

Monitoring and Data Use Objectives

Data collected under this QAPP will be collected in a manner to allow the data to be used as part of the UWS. The UWS is designed to facilitate equitable water quality comparisons across Long Island Sound embayments. All data will be available to the public via request or download from Save the Sound's website. Data will also be uploaded to the Environmental Protection Agency Water Quality Portal. Save the Sound has met, and continues to meet and discuss, UWS data usage by Connecticut Department of Energy and Environmental Protection, New York State Department of Environmental Conservation, and UWS monitoring groups are welcome and encouraged to share their data on a local level to potentially elicit changes that could improve water quality in their respective embayments. There is also an overarching primary project goal to include the UWS data sets in the Long Island Sound Report Card which is issued by Save the Sound. The report card compares water quality indicators (dissolved oxygen, nutrients, chlorophyll a, and water clarity) to scientifically derived thresholds or goals. These indicators are combined into an overarching Water Quality Index, which is presented as a subregion percent score. The report card provides a geographically specific assessment of annual Long Island Sound ecosystem health.

Additionally, the activities covered under this QAPP will provide quality-controlled data that can support secondary goals such as the assessment and restoration of coastal embayments and watersheds through the implementation of programs such as but not limited to:

- EPA's 305(b) water body health assessments and 303(d) TMDL development for impaired waters
- Clean Water Act Section 319 projects
- Connecticut Department of Energy and Environmental Protection and New York Department of Environmental Conservation Watershed Management Plans
- Long Island Sound Study's Comprehensive Conservation and Management Plan
- Long Island Sound Study Environmental Indicators Project
- New York State Department of Environmental Conservation Long Island Nitrogen Action Plan

A.6. Project / Task Description

Five types of monitoring stations are included:

1) *Tier I water quality* stations are sampled within three hours of sunrise between the months of May through October using a multiparameter sonde. A minimum of four

stations per embayment are required. If multiple regions of the embayment are delineated, a minimum of three stations are required per region. Monitoring groups will plan to sample Tier I water quality stations at a minimum every two weeks from May to October. However, if unforeseeable circumstances make this plan not possible, a minimum of six sample events between June and September are required for inclusion in the UWS; including at least one sample event in the months of June, July, August, and September. The number and location of Tier I water quality stations for embayments in the UWS are provided in Section A.6.b.

Tier I Water Quality – Water quality parameters are selected to facilitate comparisons between embayments. Monitoring groups must collect the following data to be included in the UWS:

- for each station
    - GPS coordinates of stations, recorded each sample date
    - Date and time
    - Total water depth
  - 0.5 m below the surface, 0.5 m above bottom, mid-depth if total depth >10 m; if total depth is less than 1.5 m, only a mid-depth reading will be collected
    - Temperature
    - Conductivity (salinity)
    - Dissolved oxygen
    - Chlorophyll a
    - Turbidity
  - Once per field day undertake a replicate profile including all parameters
- Obtain from an online NOAA tide table and weather station approved by Monitoring Program Coordinator:
  - Time of high and low tide nearest time of sampling
  - High and low air temperature for 24 hours preceding field sampling
  - Precipitation out a week preceding sampling event
- Within 1 day of the field sampling day, read the GPS of a land-based reference station

Monitoring groups will collect water quality data for the Unified Water Study according to procedures provided in the UWS SOP Depth and GPS, UWS SOP Sonde Profile, and UWS SOP Filtered Chlorophyll in Appendix A.

2) *Qualitative Tier I Macrophyte* stations are land-based or boat-based. They are sampled only mid-summer and may be sampled on different days from the water quality stations. Sampling occurs on three separate days between July 15 and August 7. Two sample days or a date slightly outside of the date criteria may be sufficient in the event of unforeseen complications. This decision will be made by the Monitoring Program Quality Assurance Officer and UWS Science Advisor(s).

The goal of this part of the UWS is to identify potential problem areas, versus characterizing the overall condition of the embayment; field teams will look for areas with the highest macrophyte abundance they can find. Groups will also look for and note the presence of eelgrass (a beneficial condition). This is not intended to be a quantitative assessment. Macrophyte surveys will complement chlorophyll a concentrations to better understand the dominant primary producer in the system.

Qualitative Tier I Macrophytes - Monitoring groups must collect the following data to be included in the UWS:

- for each macrophyte station
  - GPS coordinates of stations, recorded each sampling date
  - Date and time
  - Photos of macrophytes
- Within 1 day of the field sampling day, read the GPS of a land-based reference station

Groups will submit data and photos to the Unified Water Study according to methods provided in the UWS SOP Qualitative Macrophytes in Appendix A.

3) *Quantitative Tier II Macrophyte* stations are boat-based. They are sampled only mid-summer and are typically sampled on different days from the water quality stations. Sampling occurs on one day between July 15 and August 7.

Quantitative Tier II Macrophytes - Monitoring groups must collect the following data to be included in the UWS:

- For each macrophyte station
  - GPS coordinates
  - Date and time interval
  - Video of macrophyte abundance
- Within 1 day of the field sampling day, read the GPS of a land-based reference station

Groups will submit data and photos to the Unified Water Study according to methods provided in the UWS SOP Macrophyte Percent Coverage Via Camera in Appendix A.

4) *Tier II nutrients* stations are sampled a minimum every two weeks from May to October. However, if unforeseeable circumstances make this plan not possible, a minimum of six sample events between June and September are required for inclusion in the UWS; including at least one sample event in the months of June, July, August, and September. At a minimum, there will be two stations per embayment. In embayments with multiple regions, there will be a minimum of two stations per region. The number and location of Tier II nutrients stations for embayments in the UWS are provided in Section A.6.b. Stations in tributaries are sampled for nutrients on the same day as the embayment they flow into is sampled. These stations are chosen with respect to access and salinity value <1 ppt. A Long Island Sound reference station will also be sampled for nutrients on the

same day the embayment stations are sampled.

Tier II Nutrients - Monitoring groups must collect the following data to be included in the UWS:

- For each water quality station
    - GPS coordinates of stations, recorded each sample date
    - Date and time
  - 0.5 m below the surface
    - Total Nitrogen
    - Total Dissolved Nitrogen
    - Dissolved Inorganic Nitrogen Species (nitrate, nitrite, ammonia)
    - Total Phosphorous
    - Orthophosphate (also known as dissolved inorganic phosphorus)
    - Salinity

Groups will submit data to the Unified Water Study according to methods provided in the UWS SOP Filtered Nutrients and UWS SOP Total Nitrogen and Total Phosphorous in Appendix A.

5) *Continuous* Dissolved Oxygen stations will be selected with consideration to representativeness and where access is granted for maintenance of the equipment. A minimum of one continuous dissolved oxygen station is required per embayment region. Logging will commence from May to October 31.

Continuous Dissolved Oxygen - Monitoring groups must collect the following data to be included in the UWS:

- for each continuous dissolved oxygen station
    - GPS coordinates of stations, recorded each sampling date
    - Date and time
    - Dissolved Oxygen
    - Conductivity (Salinity)
    - Barometric Pressure
    - Temperature

Groups will submit data to the Unified Water Study according to methods provided in the UWS SOP Continuous Dissolved Oxygen in Appendix A.

Roles of Project Participants

The Monitoring Program Coordinator and Monitoring Program Field Coordinator or designee will provide guidance and advisement to the groups participating in the UWS, conferring with the UWS Science Advisors as needed. They will conduct trainings, field audits, station selection guidance, ongoing technical support, and lab coordination among other activities. The full set of participants and their respective roles can be referenced in Table 1 of this document. Figure 1 outlines the lines of communications between project participants.

UWS Project Laboratory Manager has agreed to the UWS SOP Filtered Chlorophyll, UWS SOP Total Nitrogen and Total Phosphorous, and UWS SOP Filtered Nutrients for sample collection in the field. The project laboratory has provided their laboratory method SOPs which can be reviewed in Appendix C of this QAPP. The laboratory will adhere to both the UWS and their lab SOPs.

Participating Monitoring Groups will be responsible for conducting field work and analyses following the requirements presented in the UWS SOPs. Monitoring Group Leads or designated appointees will complete all required training. Monitoring Group members will complete all required data sheets and chain of custody forms. Any problems or deviance from this QAPP or SOPs will immediately be reported to the Monitoring Program Field Coordinator who will confer with the Monitoring Program Quality Assurance Officer on corrective course of action.

How the proposed sampling plan supports the Monitoring Program objectives

Data collected under this QAPP will be collected in a manner to allow the data to be used as part of the UWS. The UWS is a coordinated effort among groups monitoring Long Island Sound embayments with the goal of comparing water quality and macrophyte abundance within and among embayments.

Overview of data handling processes

Sampling event and field data will be collected on standardized field and instrument calibration sheets. These standardized datasheets are in Appendix B of this document.

If a field team is delivering samples to a centralized location for laboratory analysis by a member of the Monitoring Group, the field data sheet is sufficient as a chain of custody record. In this scenario a chain of custody form will not be required as sufficient information is contained on the sample event datasheet.

If a field team is delivering a sample for analysis by a lab external to the monitoring group, the UWS Chlorophyll a Chain of Custody Form or UWS Nutrient Chain of Custody Form is required. These forms are in Appendix B of this document.

A.6.a. Sampling Types Covered by this QAPP

The type of sample information that can be collected under this QAPP includes:

- GPS location to identify and track station locations
- Total water depth of the sample station; and depth of sample location
- Temperature

- Conductivity (Salinity)
- Dissolved oxygen concentration and percent saturation
- Chlorophyll a concentrations (filtered water sample)
- Chlorophyll a concentrations (*in situ* fluorescence)
- Turbidity
- Qualitative assessment of macrophytes
- Quantitative assessments of macrophytes
- Nitrogen forms to measure nutrient levels
- Phosphorous forms to measure nutrient levels

This section of the page intentionally left blank.

A.6.b. Maps of Study Area

Figure 2a-z. All UWS study sites. Reporting regions if present are clearly delineated. Red circles are water quality station locations. The maps are overlain by a hexagonal grid. The grid was used to select stations to represent the water quality of the entire embayment using a probability-based sampling design[2], as in the EPA National Coastal Assessment[3]. In some cases, hexagons have been joined to represent a local area considered similar or if a hexagon included large sections of land.

This section of the page intentionally left blank. Maps of study sites start below.

[2] Paul, J.F., J.L. Copeland, M. Charpentier, P.V. August, and J.W. Hollister. 2003, Overview of GIS applications in estuarine monitoring and assessment research. Marine Geodesy Journal 26: 63-72.

[3] EPA, U.S. 2001. National Coastal Assessment: Field Operations Manual. U. S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA 620/R-01/003. 72 p.

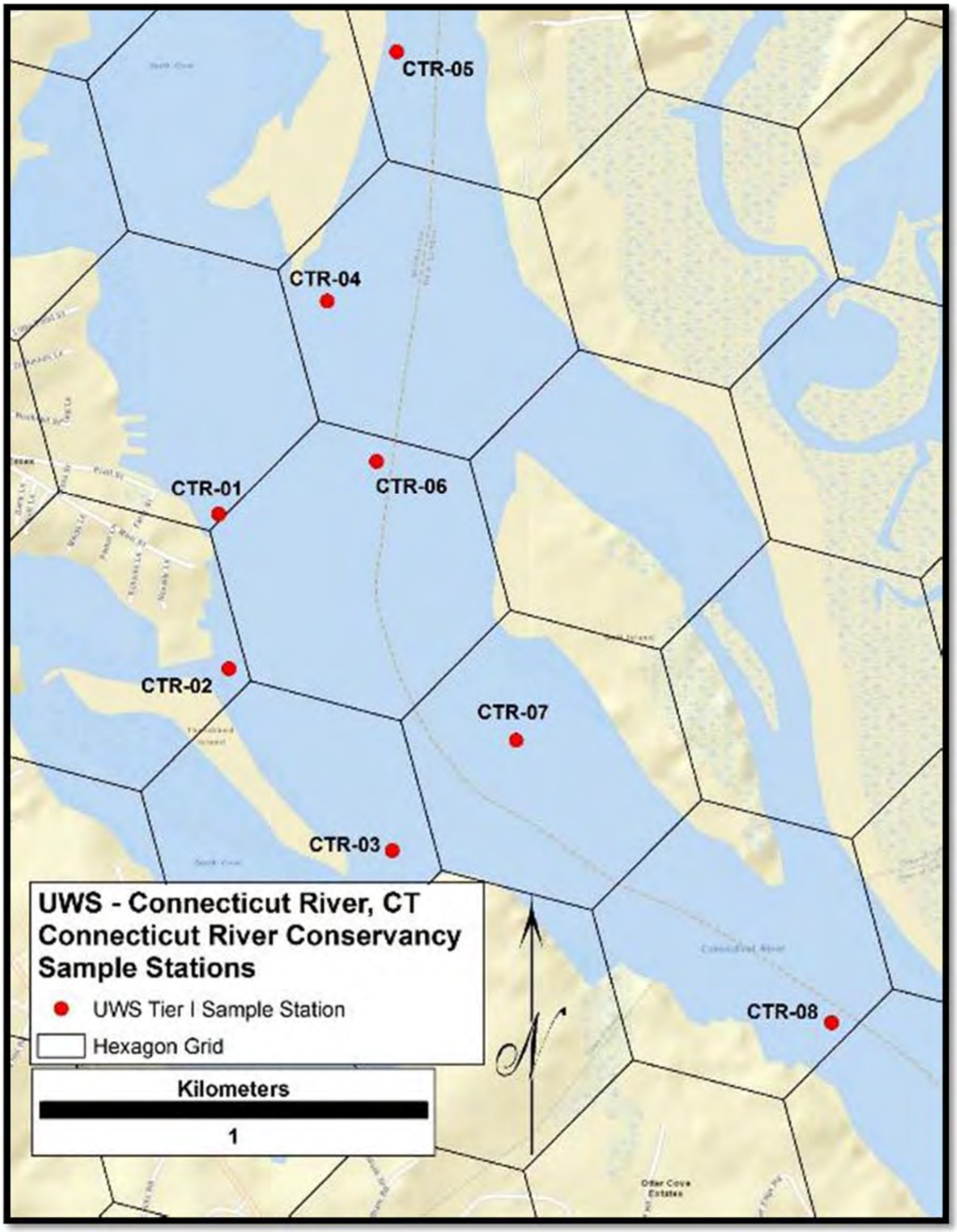

CTR-05
CTR-04
CTR-06
CTR-01
CTR-02
CTR-07
CTR-03
CTR-08
UWS - Connecticut River, CT
Connecticut River Conservancy
Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1
N

Figure 2a

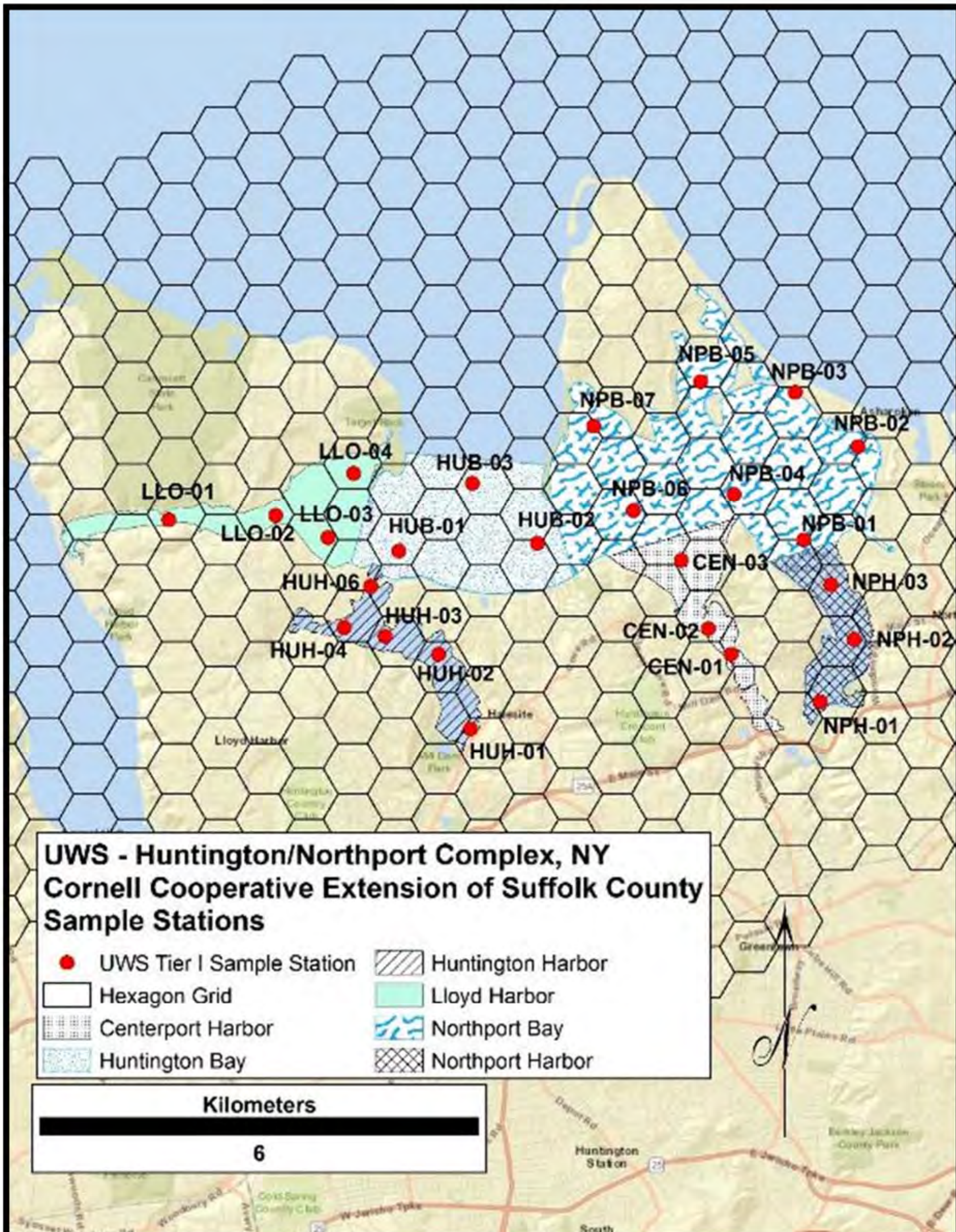

UWS - Huntington/Northport Complex, NY
Cornell Cooperative Extension of Suffolk County
Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Centerport Harbor
Huntington Bay
Huntington Harbor
Lloyd Harbor
Northport Bay
Northport Harbor
Kilometers
6
LLO-01
LLO-02
LLO-03
LLO-04
HUB-01
HUB-02
HUB-03
HUH-01
HUH-02
HUH-03
HUH-04
HUH-06
CEN-01
CEN-02
CEN-03
NPB-01
NPB-02
NPB-03
NPB-04
NPB-05
NPB-06
NPB-07
NPH-01
NPH-02
NPH-03
N

Figure 2b

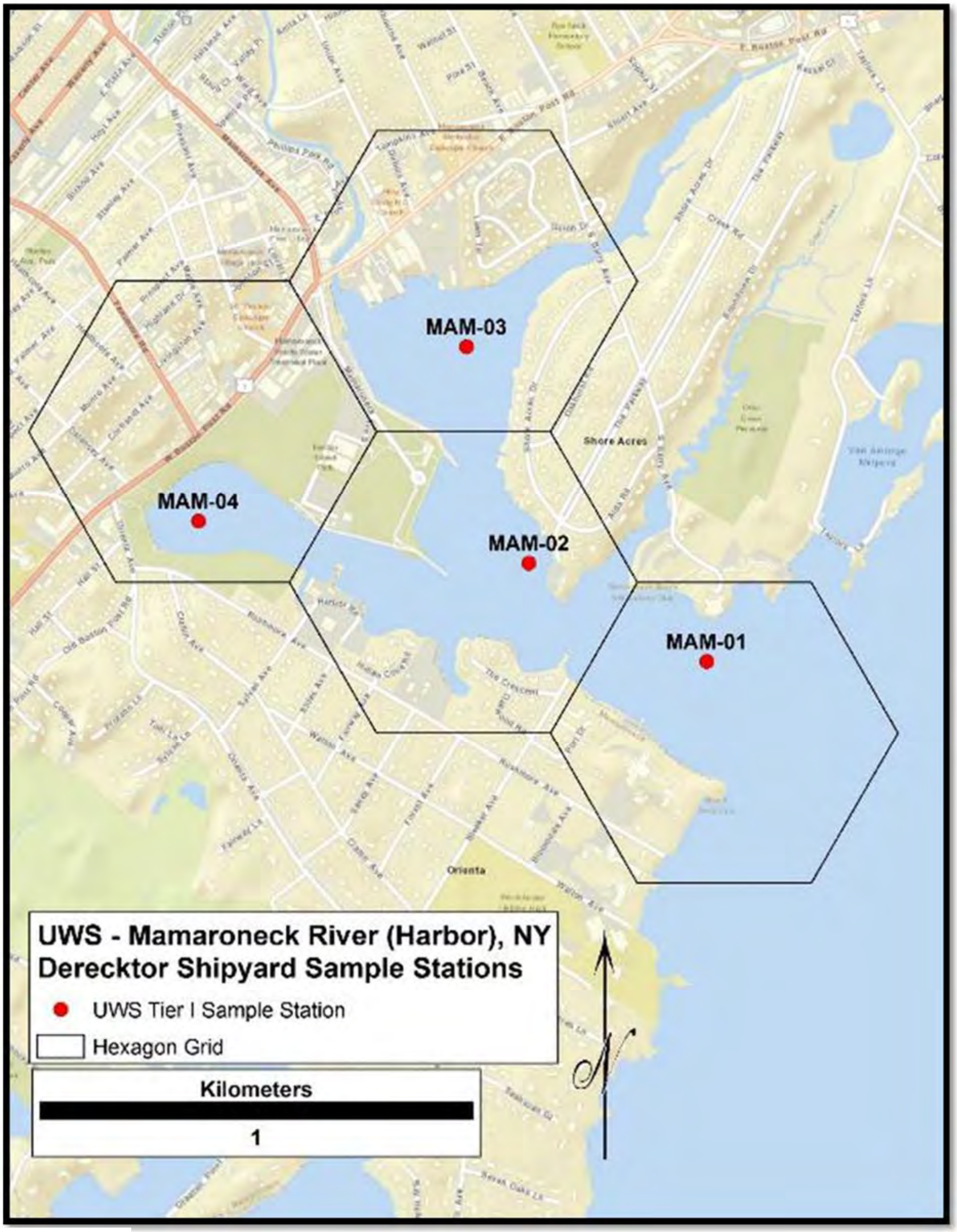

MAM-03
MAM-04
MAM-02
MAM-01
Shore Acres
Orienta
UWS - Mamaroneck River (Harbor), NY
Derecktor Shipyard Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1
N

Figure 2c


COL-O-07
OYB-02
MNC-03
MNC-02
MNC-01
OYB-01
COL-O-06
OYB-04
COL-O-05
OYB-03
COL-O-04
COL-I-03
COL-I-02
COL-I-01
UWS - Oyster Bay, Cold Spring Harbor,
Mill Neck Creek, NY
Friends of the Bay Sample Stations
UWS Tier I Sample Station
Mill Neck Creek
Hexagonal Grid
Outer Cold Spring Harbor
Oyster Bay
Inner Cold Spring Harbor
Kilometers
5
N

Figure 2d

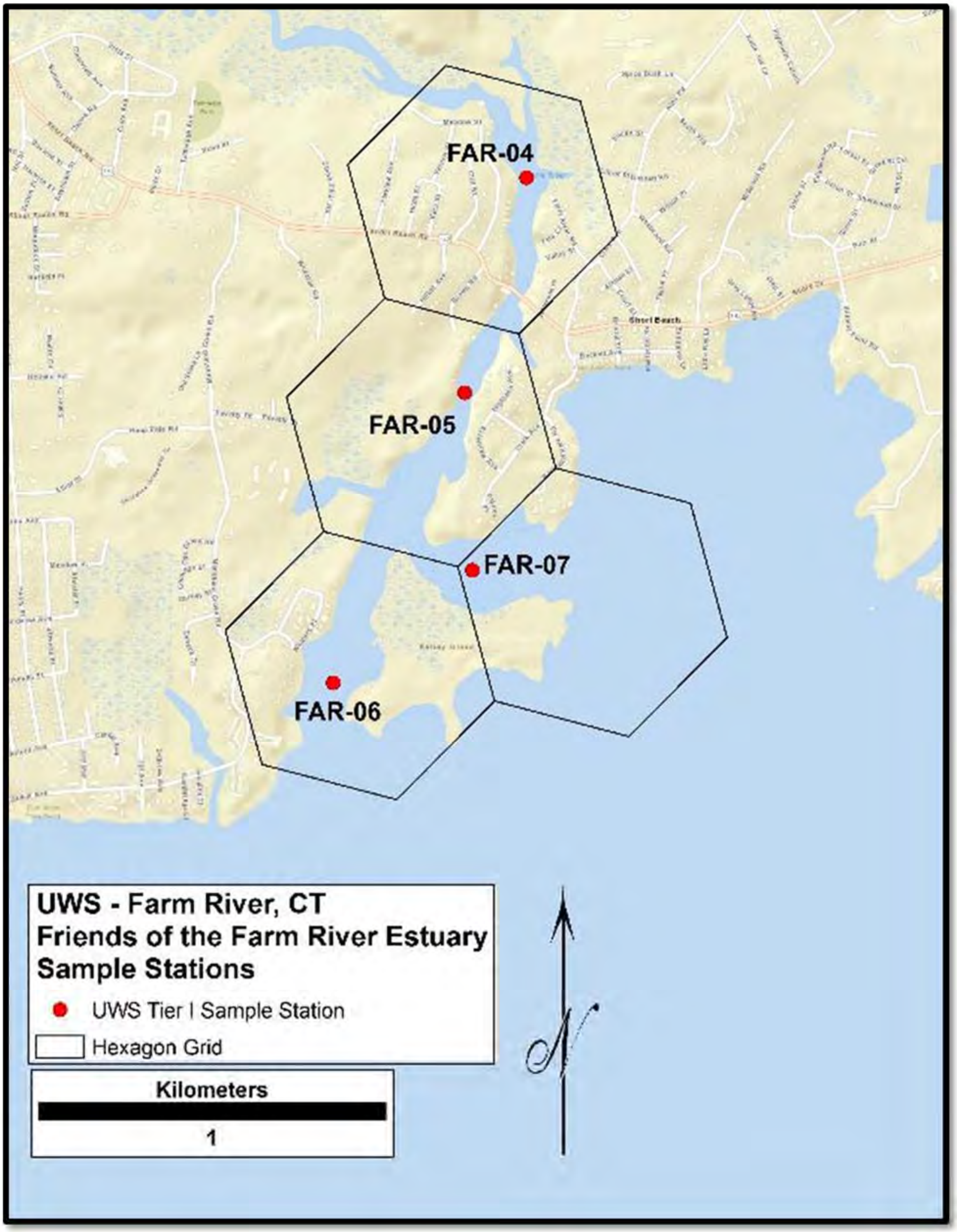

FAR-04
FAR-05
FAR-07
FAR-06
UWS - Farm River, CT
Friends of the Farm River Estuary
Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1
N

Figure 2e

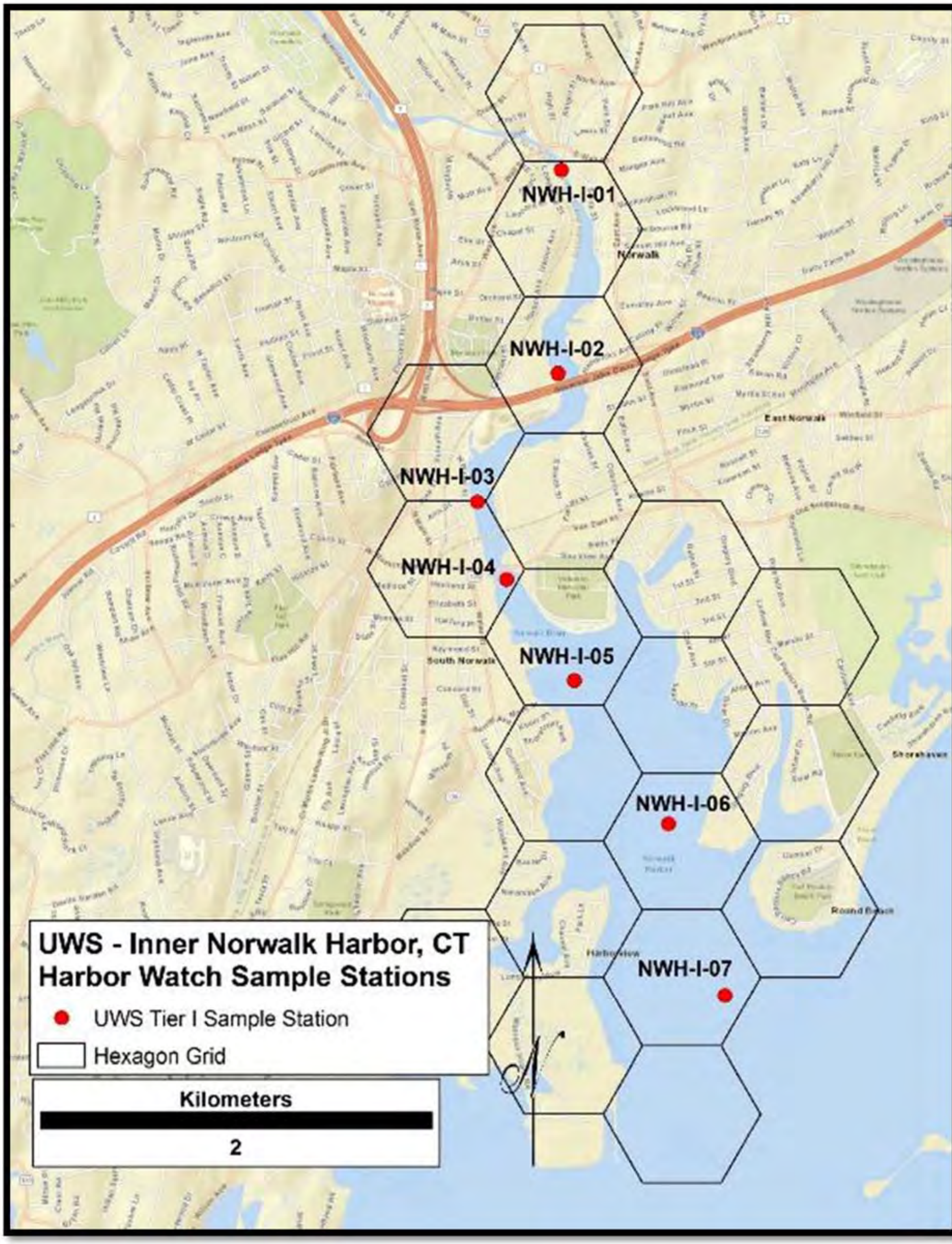

UWS - Inner Norwalk Harbor, CT
Harbor Watch Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
2
NWH-I-01
NWH-I-02
NWH-I-03
NWH-I-04
NWH-I-05
NWH-I-06
NWH-I-07

Figure 2f

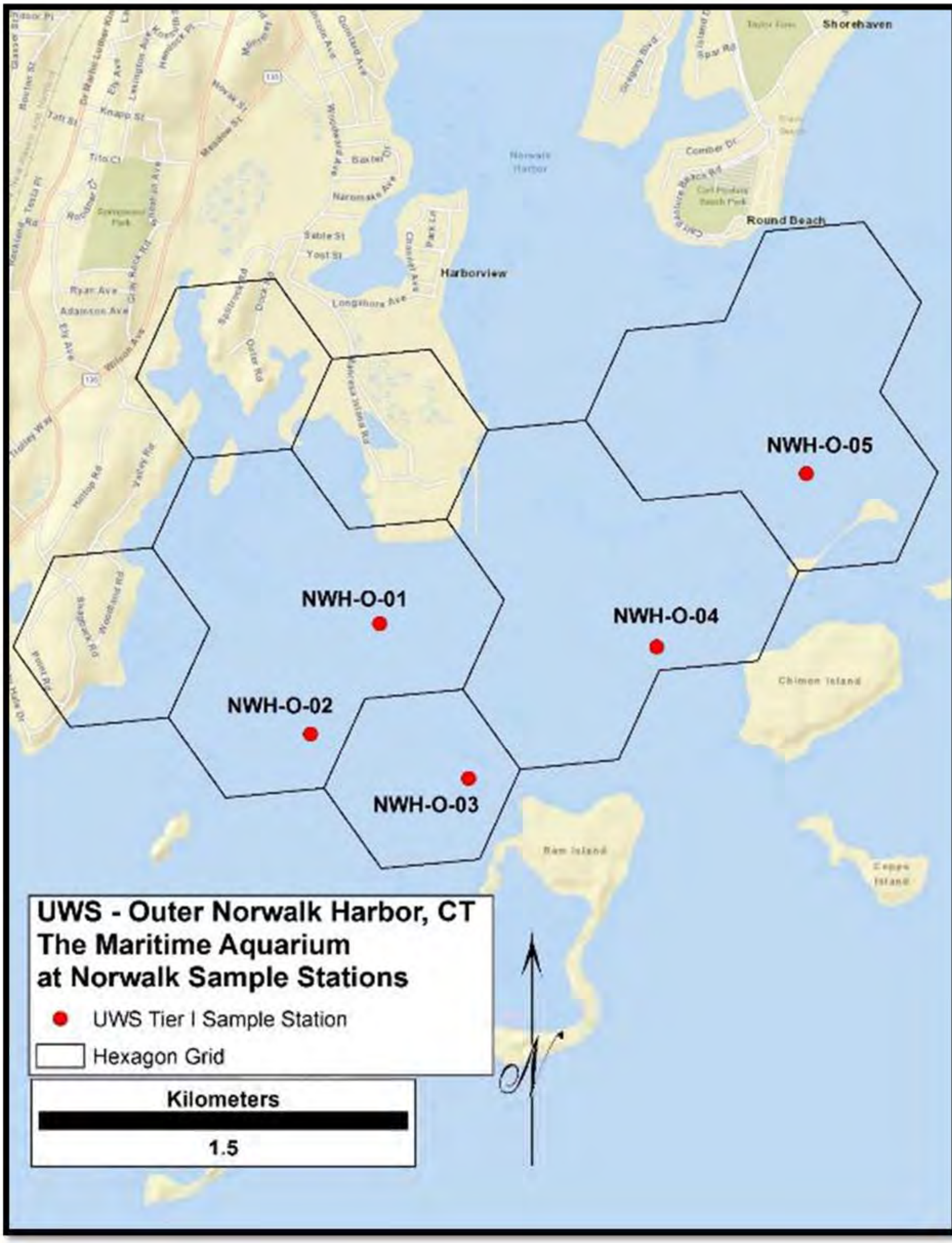

Shorehaven
Round Beach
Harborview
NWH-O-05
NWH-O-01
NWH-O-04
NWH-O-02
NWH-O-03
UWS - Outer Norwalk Harbor, CT
The Maritime Aquarium
at Norwalk Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1.5

Figure 2g

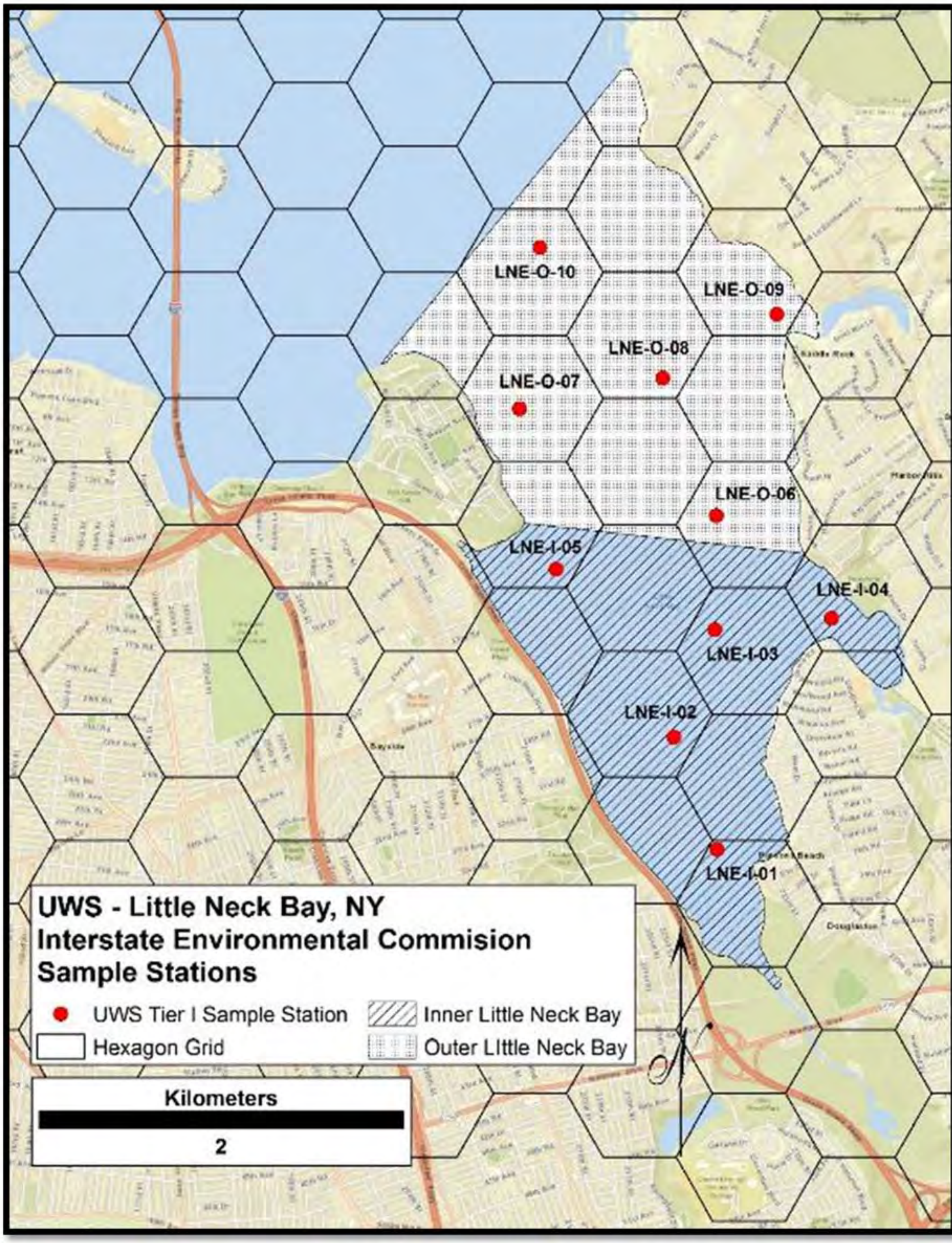

UWS - Little Neck Bay, NY
Interstate Environmental Commision
Sample Stations
UWS Tier I Sample Station
Inner Little Neck Bay
Hexagon Grid
Outer LIttle Neck Bay
Kilometers
2
LNE-O-10
LNE-O-09
LNE-O-08
LNE-O-07
LNE-O-06
LNE-I-05
LNE-I-04
LNE-I-03
LNE-I-02
LNE-I-01

Figure 2h

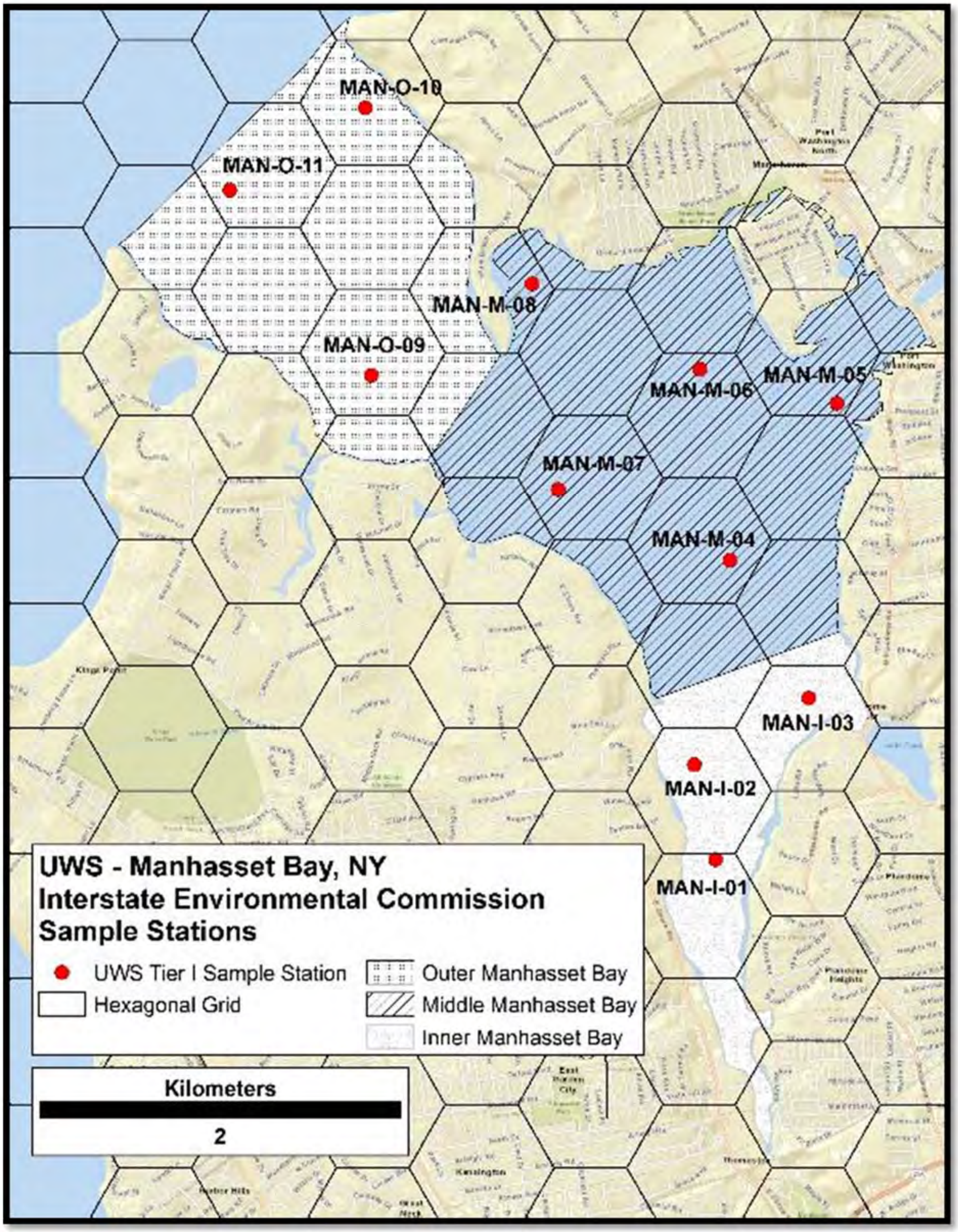

MAN-O-10
MAN-O-11
MAN-M-08
MAN-O-09
MAN-M-06
MAN-M-05
MAN-M-07
MAN-M-04
MAN-I-03
MAN-I-02
MAN-I-01
UWS - Manhasset Bay, NY
Interstate Environmental Commission
Sample Stations
UWS Tier I Sample Station
Hexagonal Grid
Outer Manhasset Bay
Middle Manhasset Bay
Inner Manhasset Bay
Kilometers
2

Figure 2i

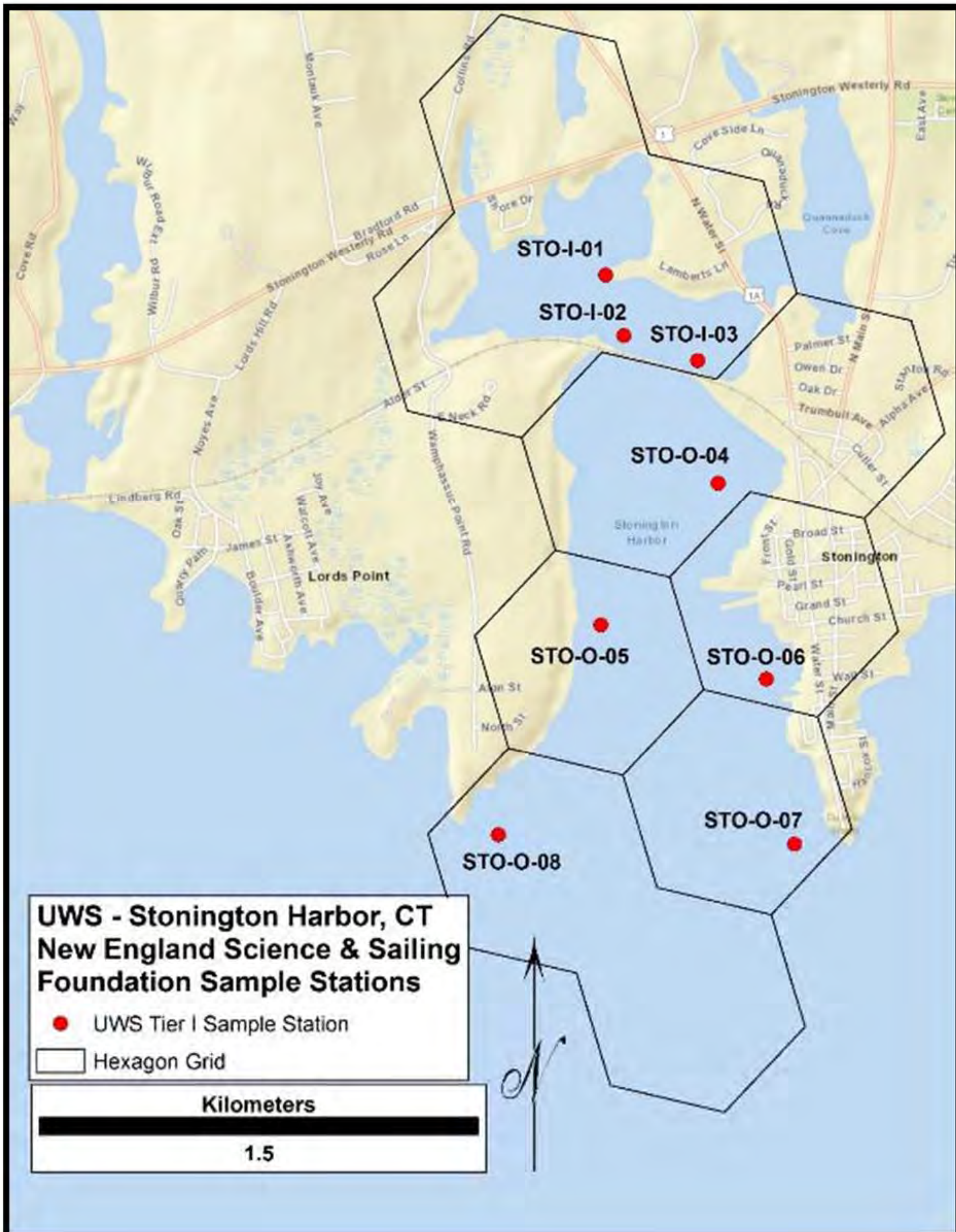

UWS - Stonington Harbor, CT
New England Science & Sailing
Foundation Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1.5
STO-I-01
STO-I-02
STO-I-03
STO-O-04
STO-O-05
STO-O-06
STO-O-07
STO-O-08
Lords Point
Stonington
Stonington Westerly Rd
Lords Hill Rd
Noyes Ave
Wamphassuc Point Rd
Montauk Ave
Lindberg Rd
Palmer St
Owen Dr
Oak Dr
Trumbull Ave
Broad St
Pearl St
Grand St
Church St
Water St
N Water St
Lamberts Ln
Cove Side Ln
Front St
Gold St
Wilbur Rd

Figure 2j

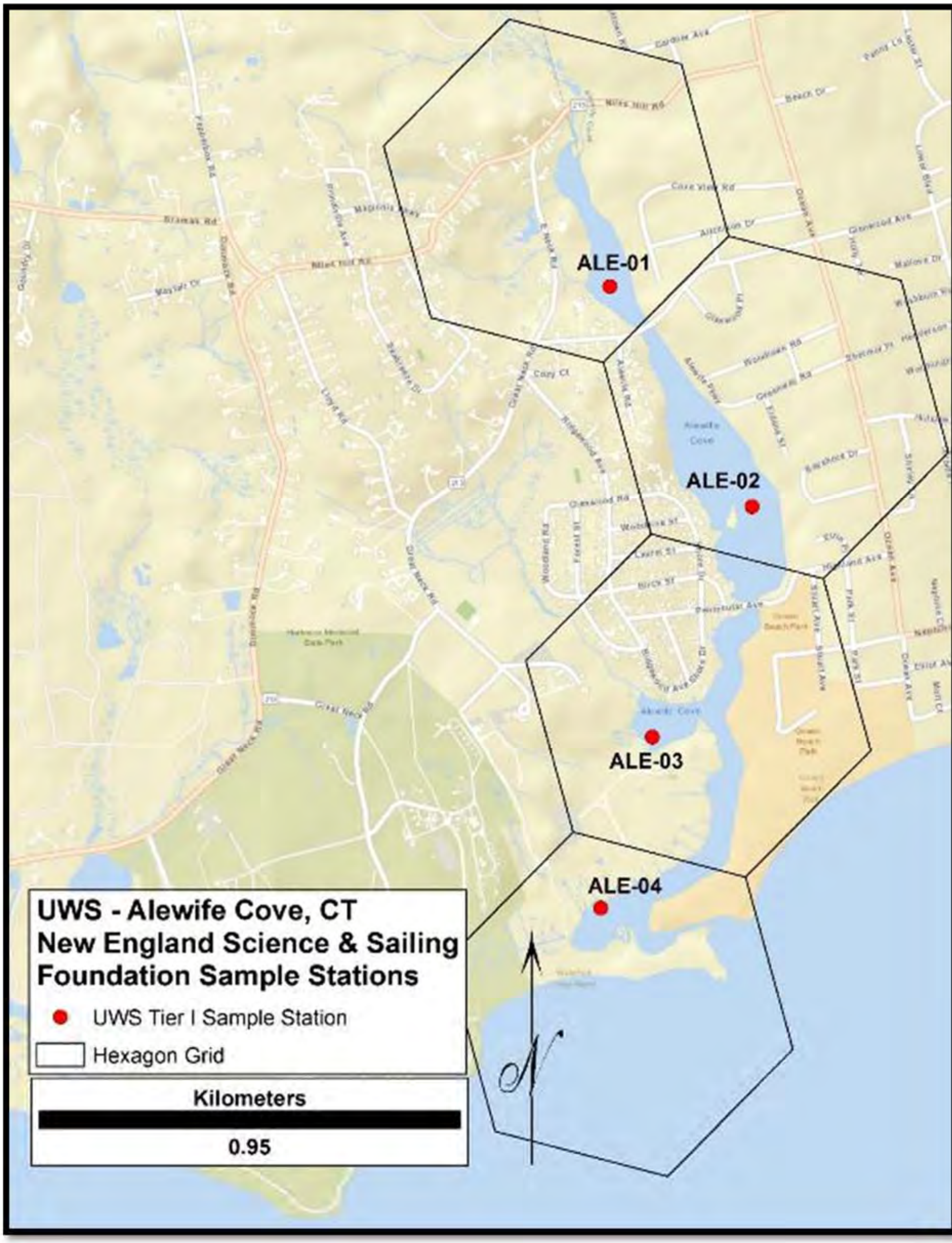

ALE-01
ALE-02
ALE-03
ALE-04
UWS - Alewife Cove, CT
New England Science & Sailing Foundation Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
0.95

Figure 2k

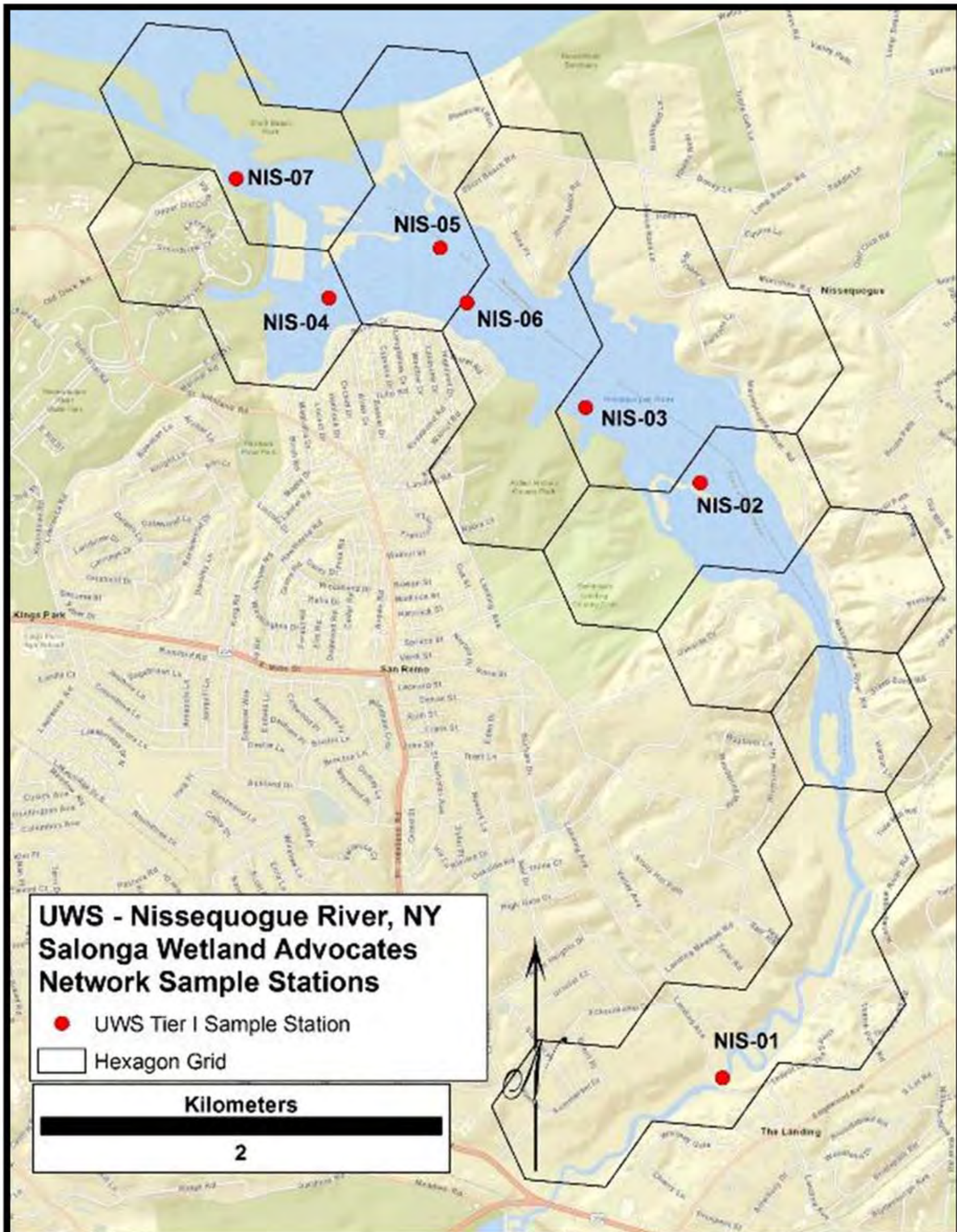

NIS-07
NIS-05
NIS-04
NIS-06
NIS-03
NIS-02
NIS-01
UWS - Nissequogue River, NY
Salonga Wetland Advocates
Network Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
2
Kings Park
San Remo
Nissequogue
The Landing

Figure 2l

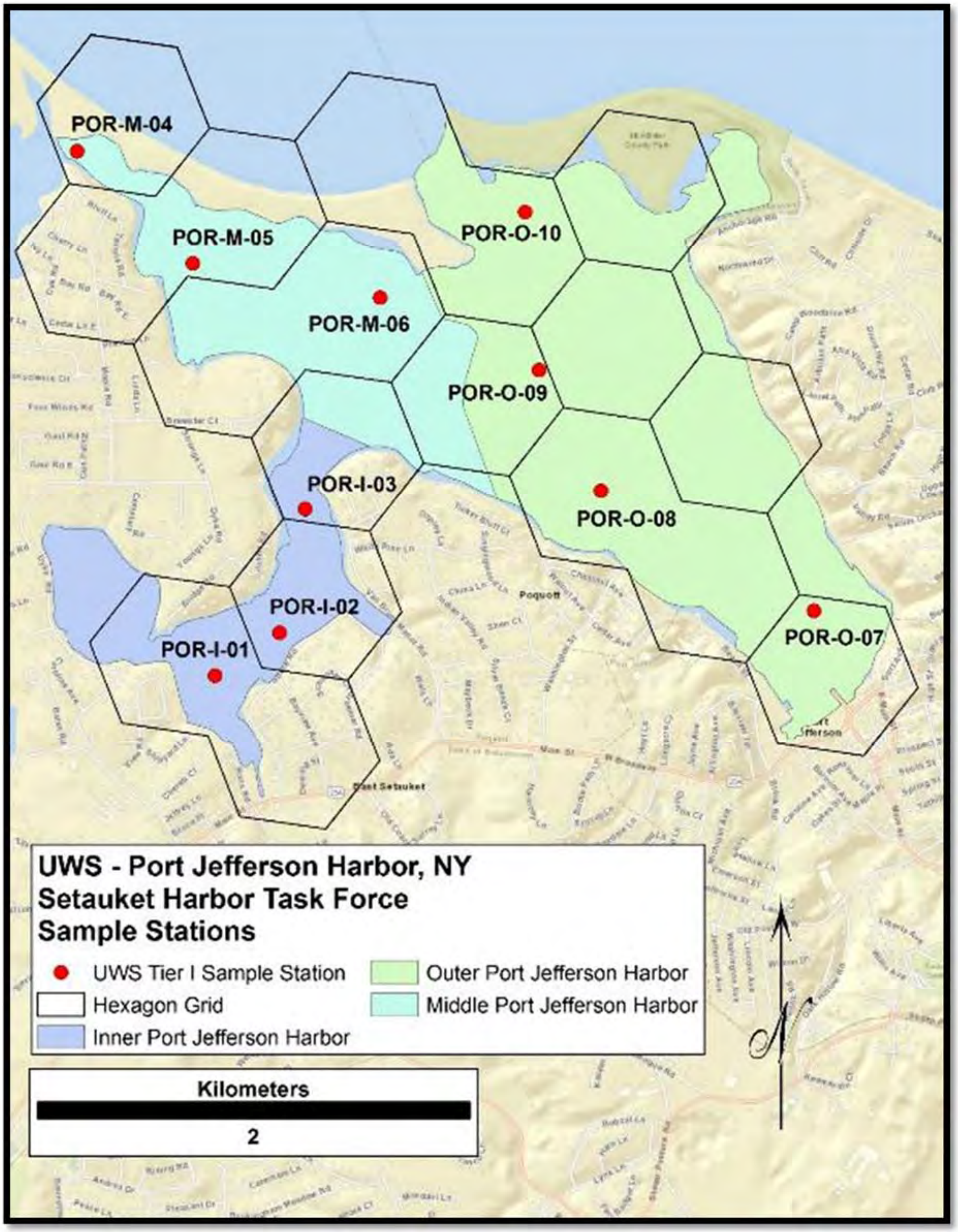

POR-M-04
POR-M-05
POR-M-06
POR-O-10
POR-O-09
POR-O-08
POR-O-07
POR-I-03
POR-I-02
POR-I-01
UWS - Port Jefferson Harbor, NY
Setauket Harbor Task Force
Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Inner Port Jefferson Harbor
Outer Port Jefferson Harbor
Middle Port Jefferson Harbor
Kilometers
2

Figure 2m

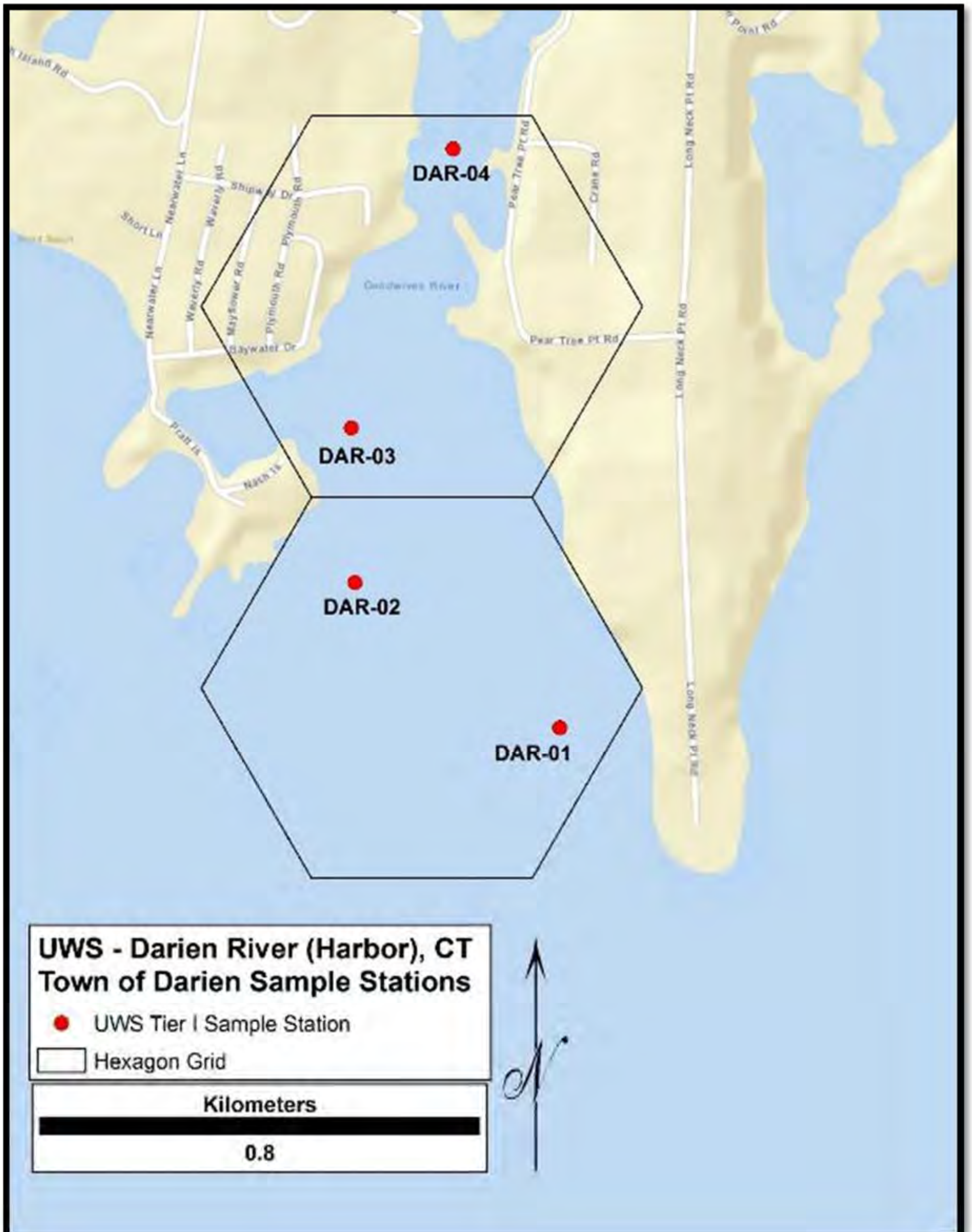

DAR-04
DAR-03
DAR-02
DAR-01
Pear Tree Pt Rd
Long Neck Pt Rd
Nearwater Ln
Plymouth Rd
Baywater Dr
UWS - Darien River (Harbor), CT
Town of Darien Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
0.8
N

Figure 2n

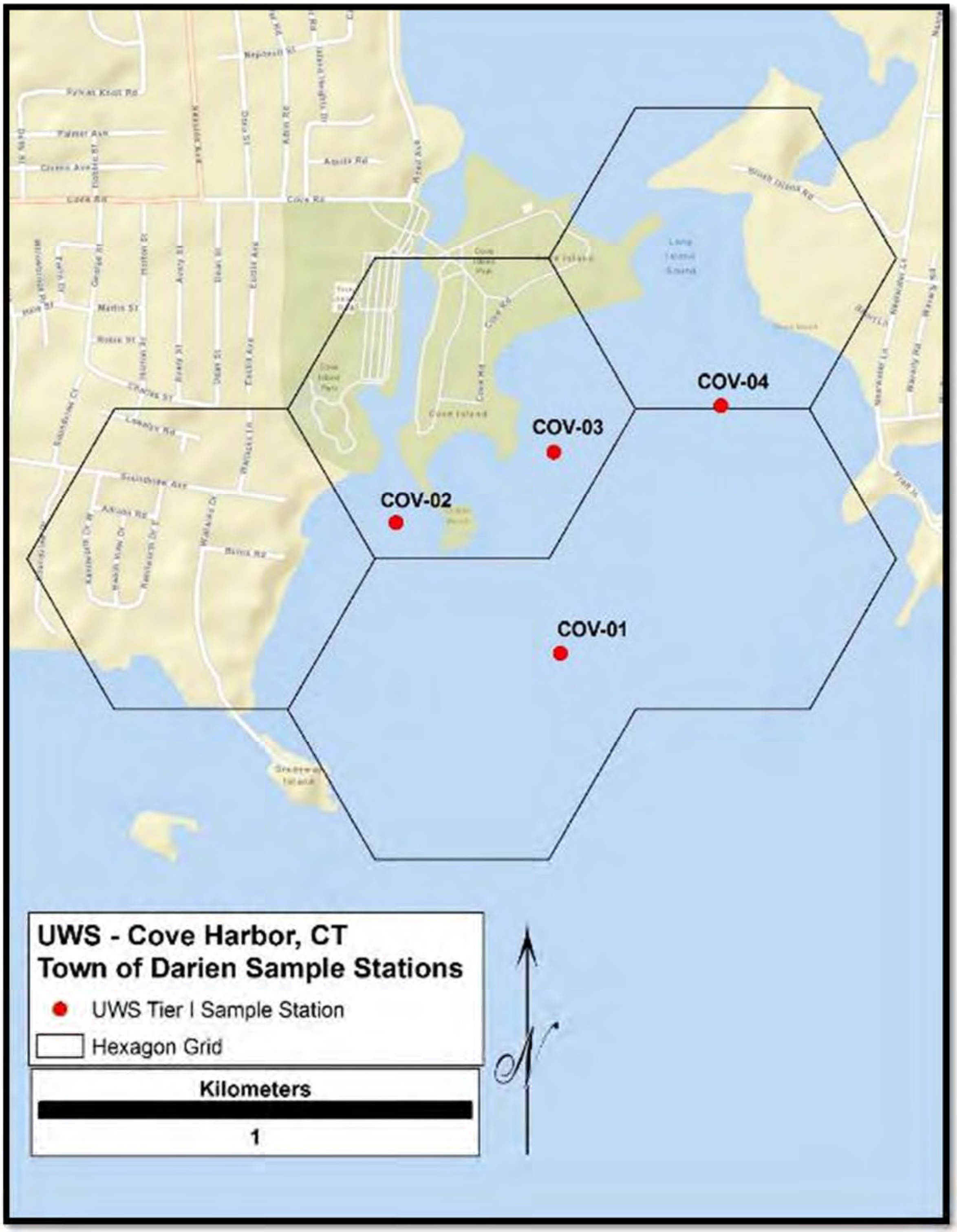

COV-01
COV-02
COV-03
COV-04
UWS - Cove Harbor, CT
Town of Darien Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1

Figure 2o

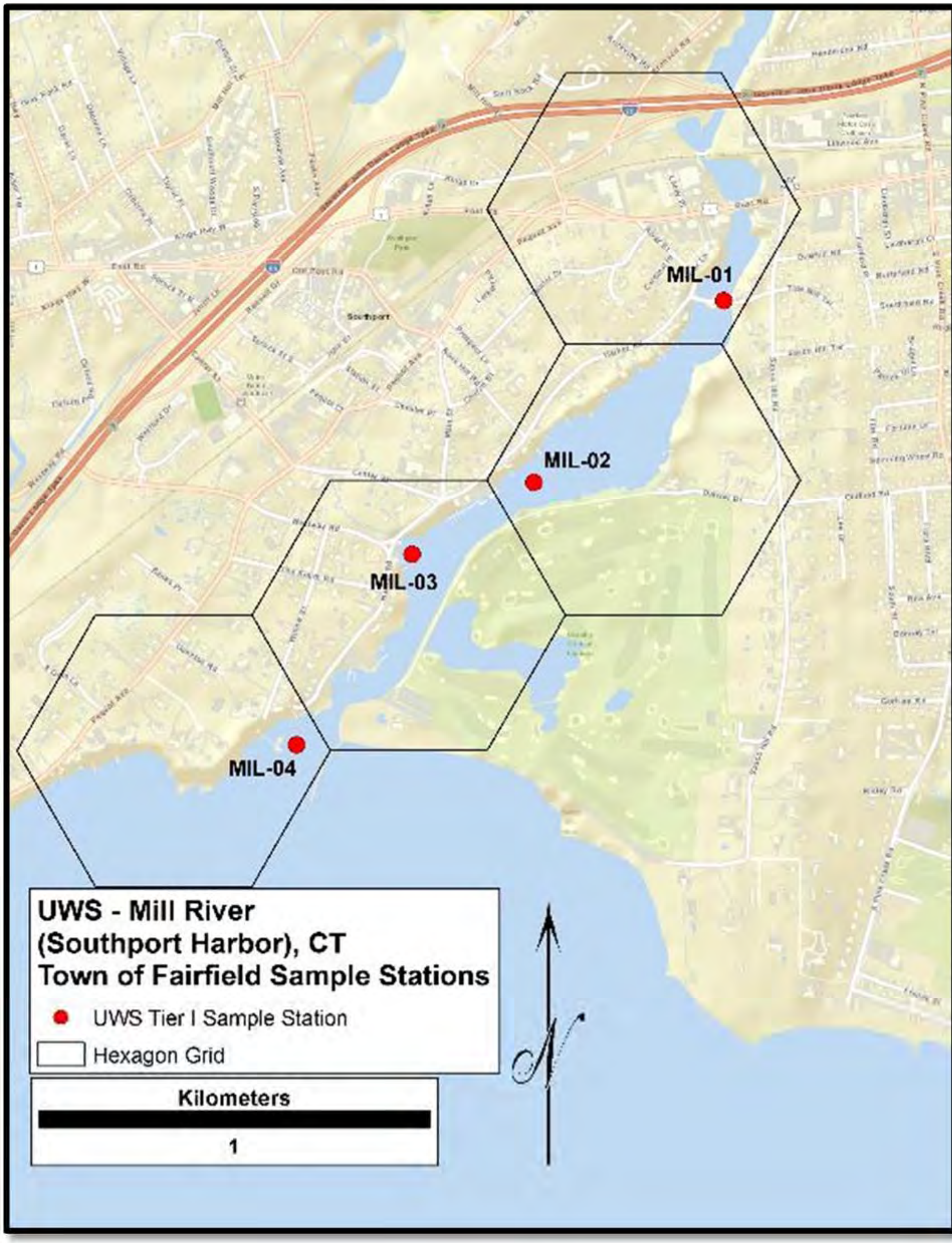
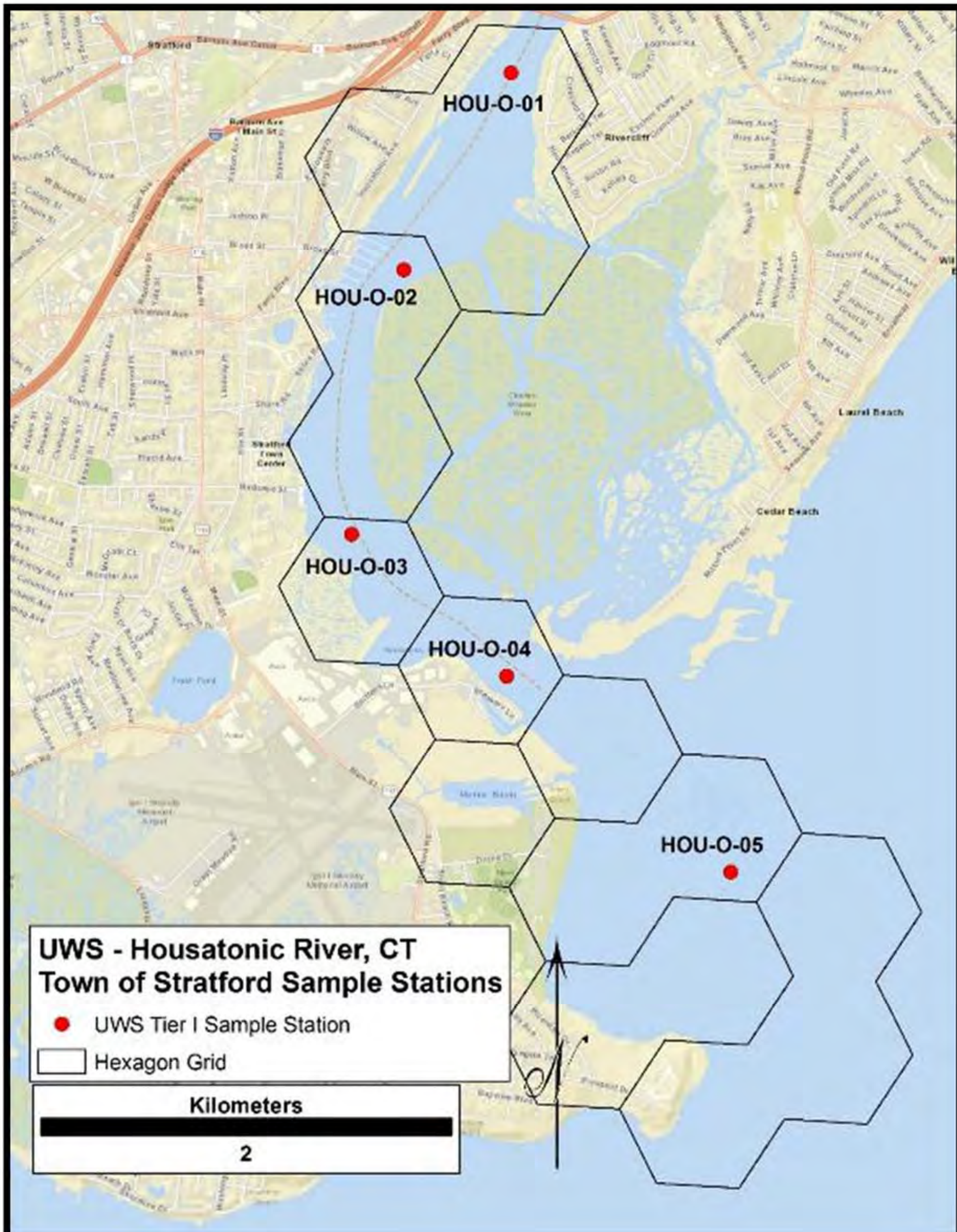

MIL-01
MIL-02
MIL-03
MIL-04
UWS - Mill River
(Southport Harbor), CT
Town of Fairfield Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1

Figure 2p


HOU-O-01
HOU-O-02
HOU-O-03
HOU-O-04
HOU-O-05
UWS - Housatonic River, CT
Town of Stratford Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
2
Laurel Beach
Cedar Beach

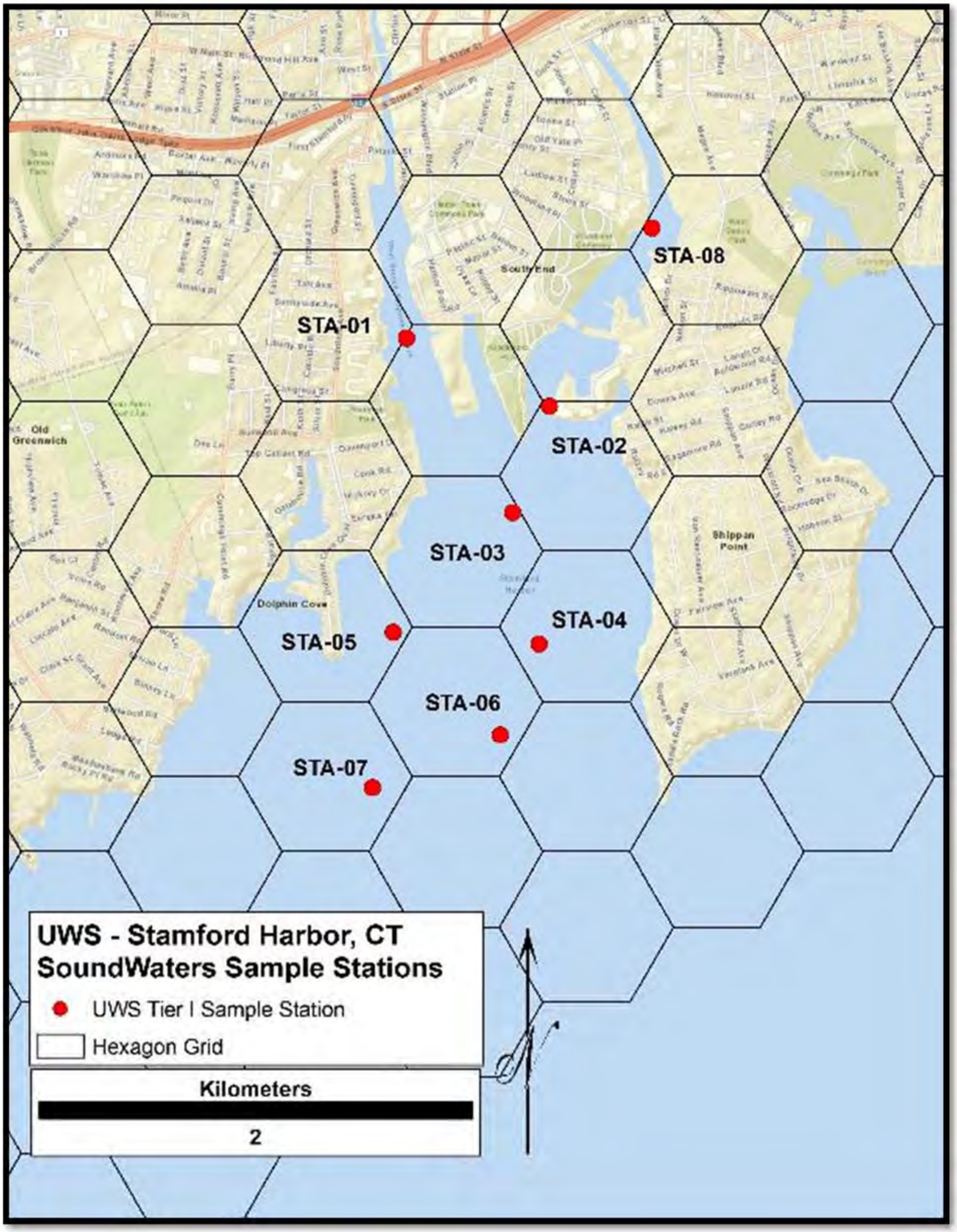

STA-01
STA-02
STA-03
STA-04
STA-05
STA-06
STA-07
STA-08
Old Greenwich
Dolphin Cove
Shippan Point
South End
UWS - Stamford Harbor, CT
SoundWaters Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
2

Figure 2r

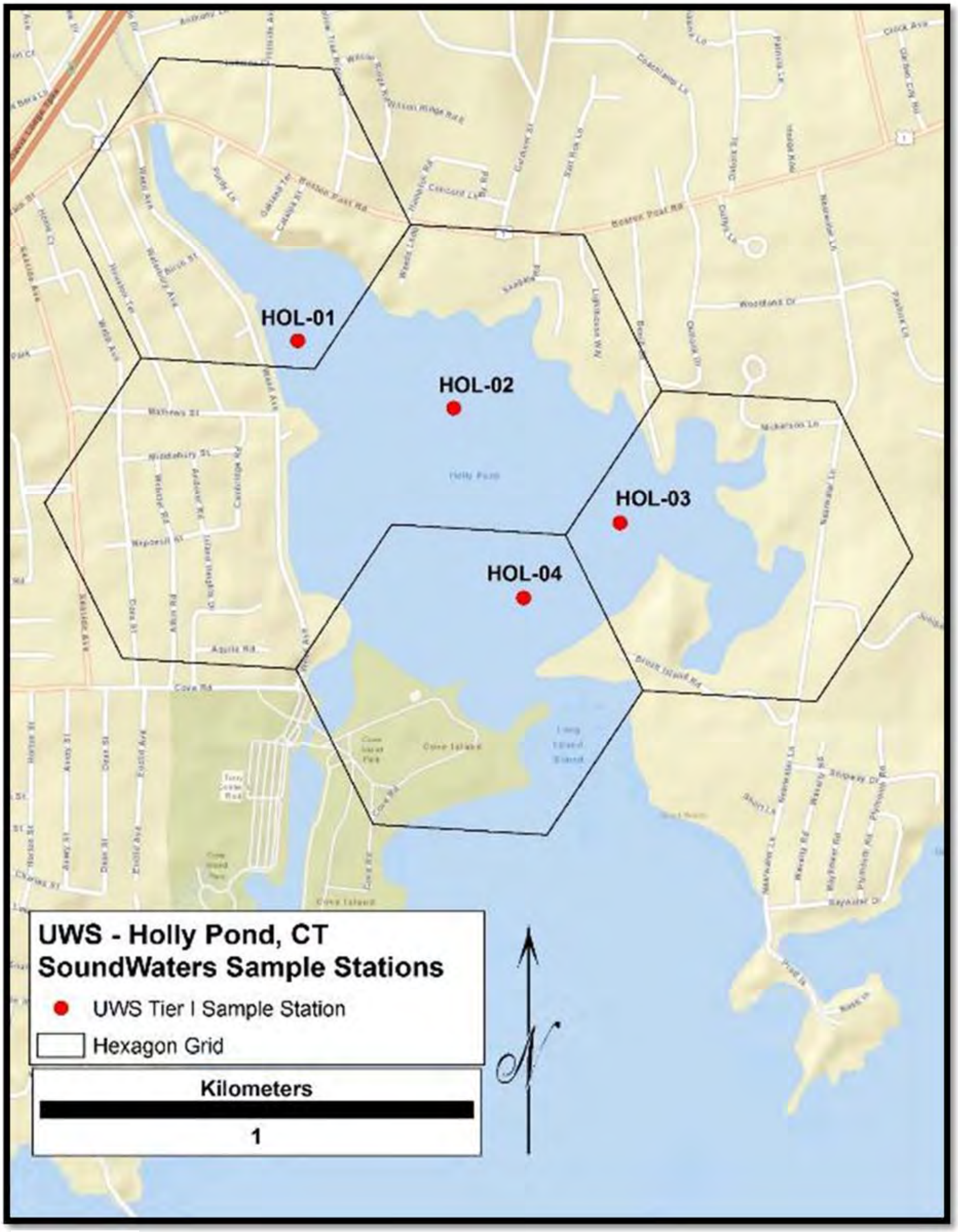

HOL-01
HOL-02
HOL-03
HOL-04
UWS - Holly Pond, CT
SoundWaters Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1

Figure 2s

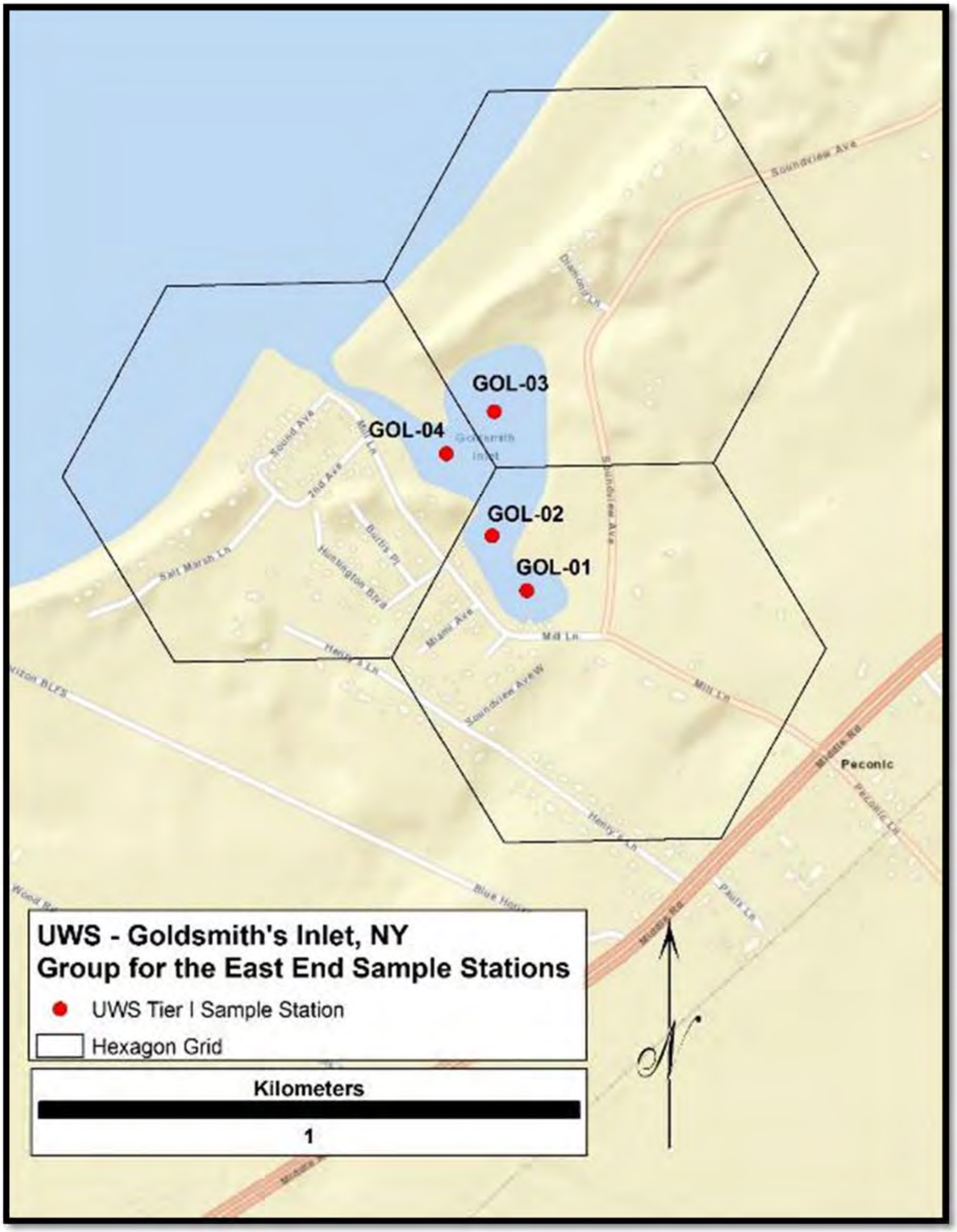

GOL-03
GOL-04
GOL-02
GOL-01
UWS - Goldsmith's Inlet, NY
Group for the East End Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1

Figure 2t

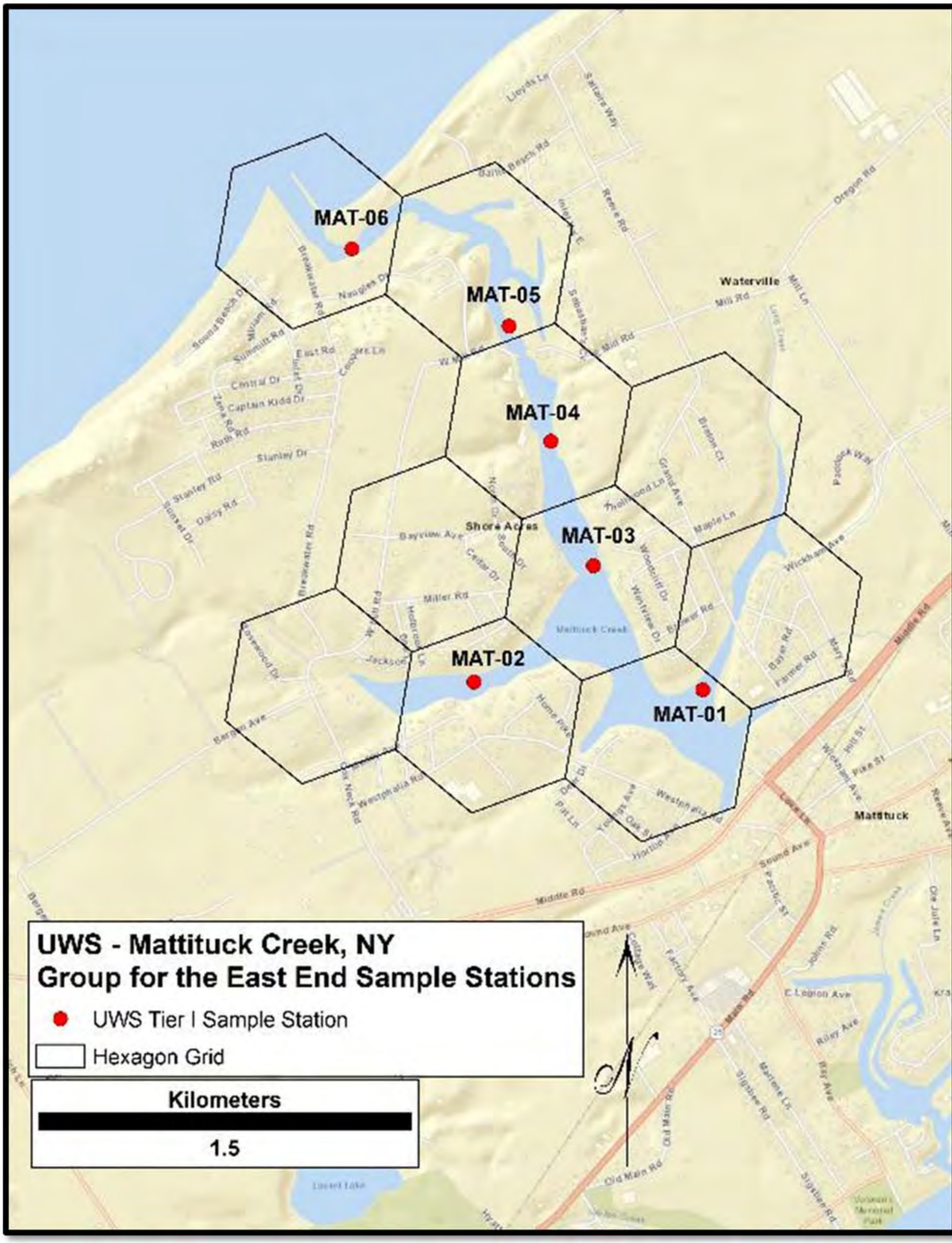

UWS - Mattituck Creek, NY
Group for the East End Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1.5
MAT-01
MAT-02
MAT-03
MAT-04
MAT-05
MAT-06
Waterville
Shore Acres
Mattituck

Figure 2u

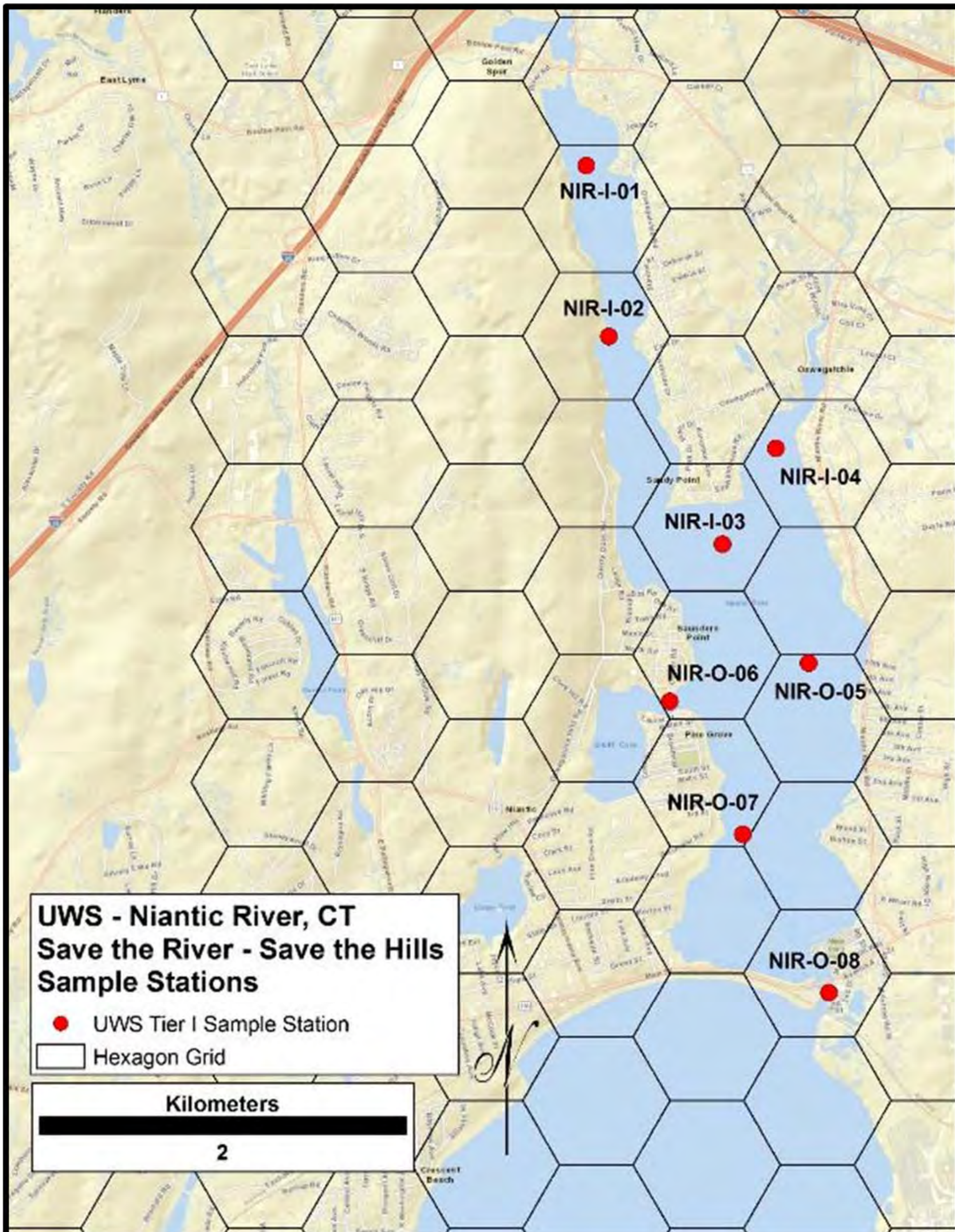

UWS - Niantic River, CT
Save the River - Save the Hills
Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
2
NIR-I-01
NIR-I-02
NIR-I-03
NIR-I-04
NIR-O-05
NIR-O-06
NIR-O-07
NIR-O-08

Figure 2v

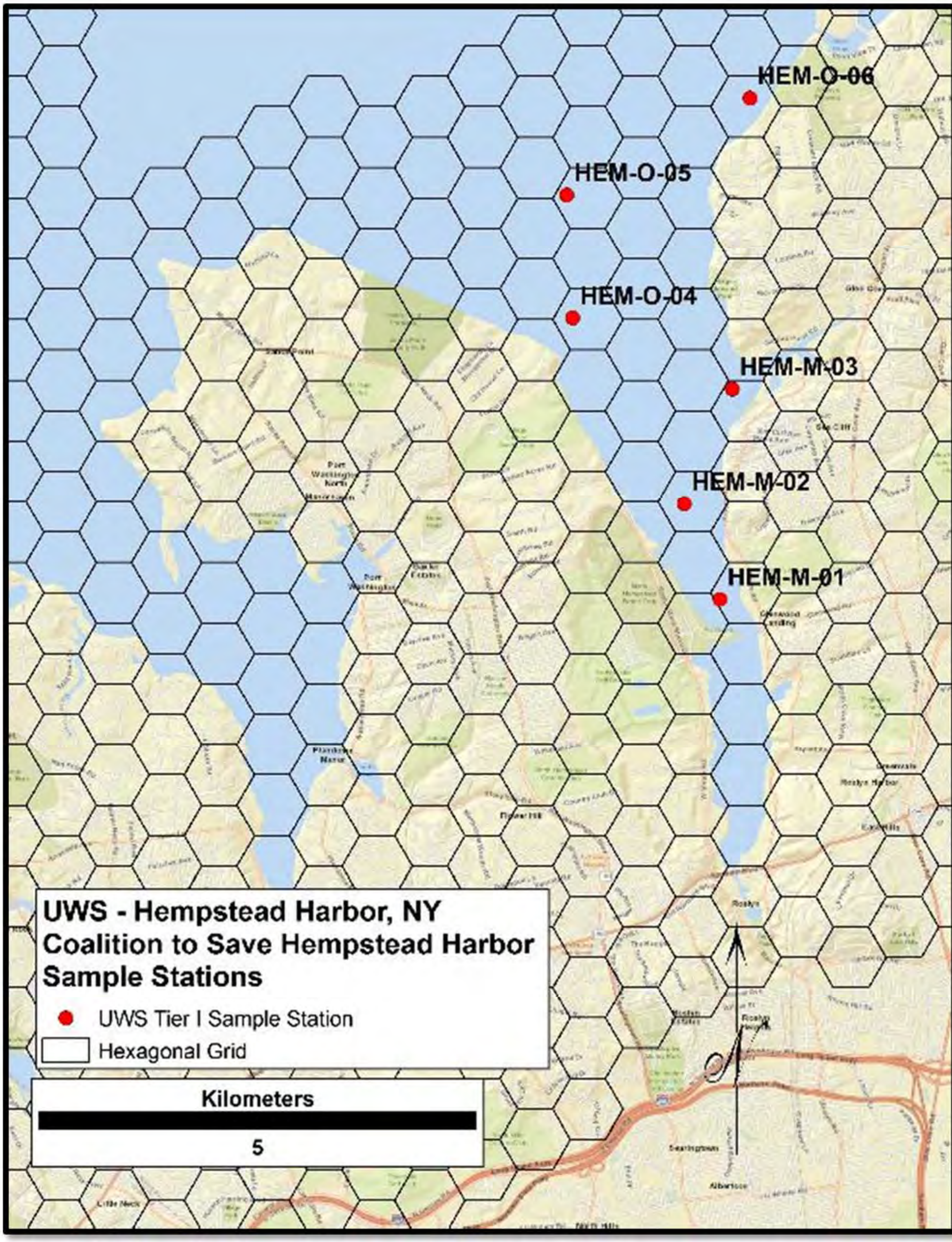

HEM-O-06
HEM-O-05
HEM-O-04
HEM-M-03
HEM-M-02
HEM-M-01
UWS - Hempstead Harbor, NY
Coalition to Save Hempstead Harbor
Sample Stations
UWS Tier I Sample Station
Hexagonal Grid
Kilometers
5

Figure 2w

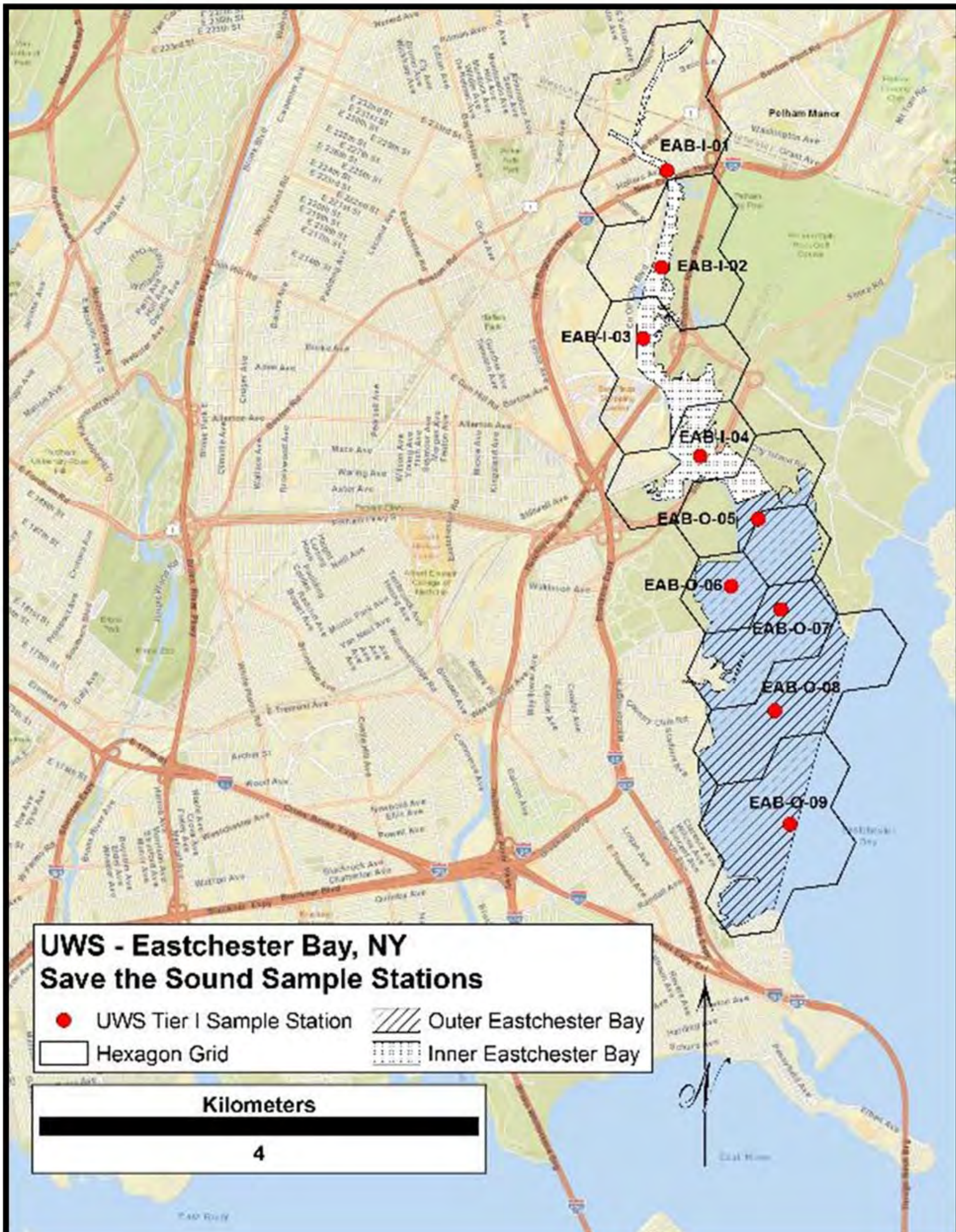

EAB-I-01
EAB-I-02
EAB-I-03
EAB-I-04
EAB-O-05
EAB-O-06
EAB-O-07
EAB-O-08
EAB-O-09
UWS - Eastchester Bay, NY
Save the Sound Sample Stations
UWS Tier I Sample Station
Outer Eastchester Bay
Hexagon Grid
Inner Eastchester Bay
Kilometers
4

Figure 2x

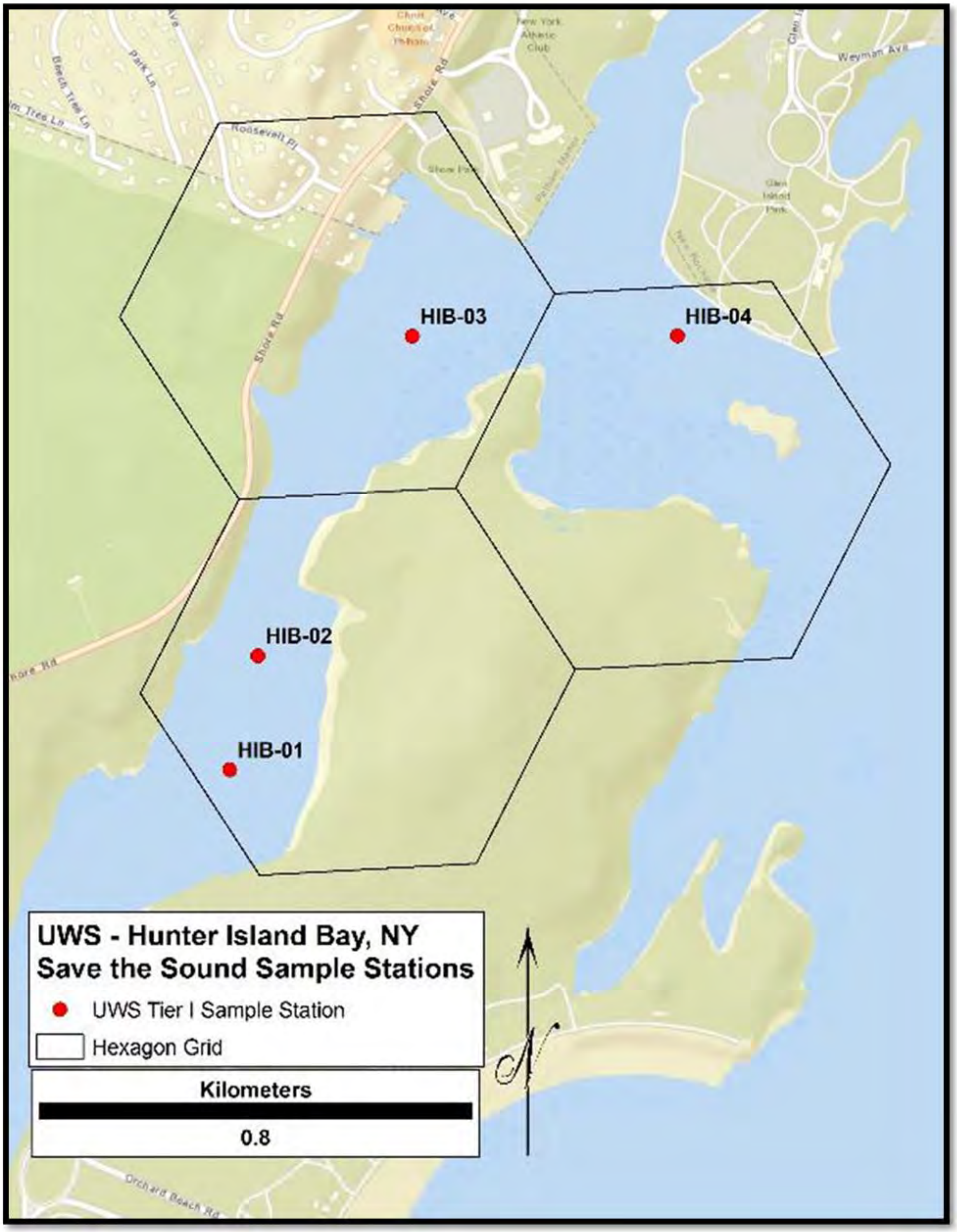

HIB-03
HIB-04
HIB-02
HIB-01
UWS - Hunter Island Bay, NY
Save the Sound Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
0.8
Shore Rd
Roosevelt Pl
Park Ln
Weyman Ave
Orchard Beach Rd

Figure 2y


UWS - New Rochelle Harbor, NY
Save the Sound Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1.5
NRH-01
NRH-02
NRH-03
NRH-04
Pelham Manor
Residence Park

Figure 2z

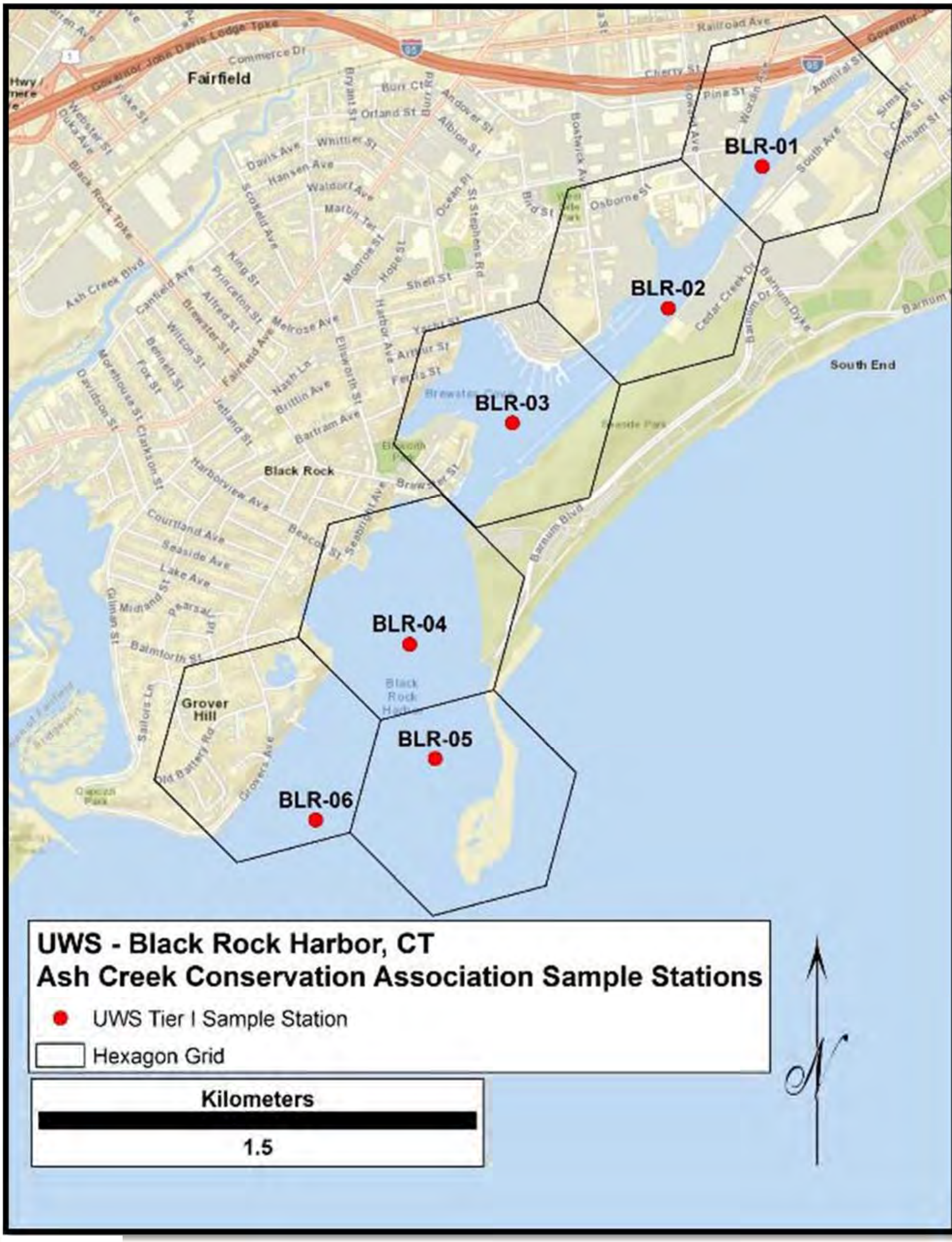

UWS - Black Rock Harbor, CT
Ash Creek Conservation Association Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1.5
BLR-01
BLR-02
BLR-03
BLR-04
BLR-05
BLR-06
Fairfield
Black Rock
Grover Hill
South End

Figure 2aa


UWS - Bronx River, NY
Bronx River Alliance Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1
BRR-01
BRR-02
BRR-03
BRR-04
BRR-05
BRR-06
Hunts Point
Bruckner Blvd
Bruckner Expy
Watson Ave
Story Ave
Lafayette Ave
Seward Ave
Randall Ave
Patterson Ave
Lacombe Ave
Seneca Ave
Spofford Ave
Oak Point Ave
E Bay Ave
Viele Ave
Ryawa Ave
Market St
Food Center Dr
Edgewater Rd
Metcalf Ave
Noble Ave
Rosedale Ave
Commonwealth Ave
St Lawrence Ave
Beach Ave
Taylor Ave
Thieriot Ave
Leland Ave
Underhill Ave
Bolton Ave
White Plains Rd
Stickball Blvd
Sound View Ave
Obrien Ave
Cornell Ave
Harding Park
Hunts Point Ave
Halleck St
Whittier St
Drake St
Longfellow Ave
Bryant Ave
Faile St
Coster St
Barretto St
Manida St
Casanova St
Irvine St
Farragut St
Sheridan Expy
Bronx River

Figure 2ab

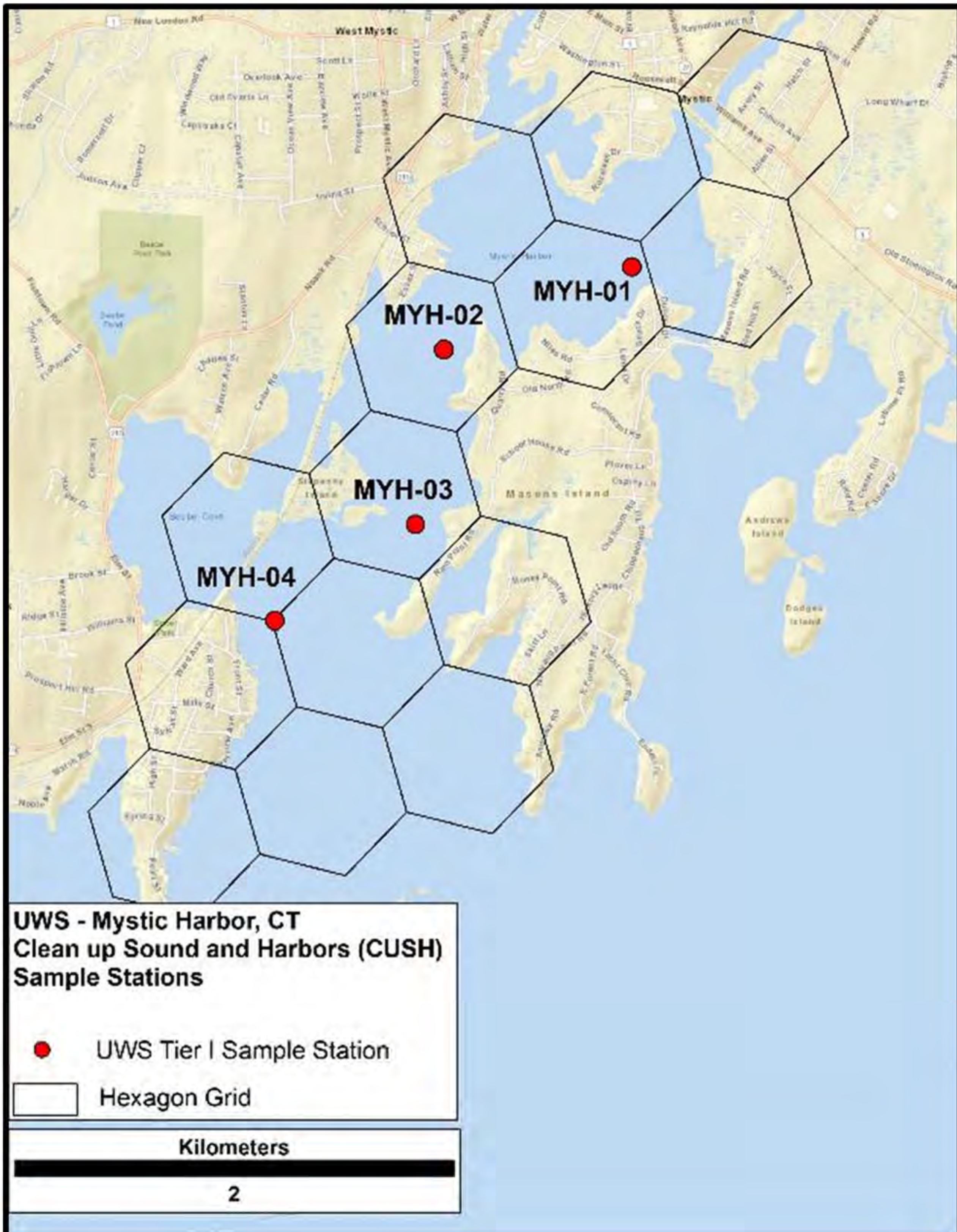

West Mystic
Mystic
Masons Island
MYH-01
MYH-02
MYH-03
MYH-04
UWS - Mystic Harbor, CT
Clean up Sound and Harbors (CUSH)
Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
2

Figure 2ac

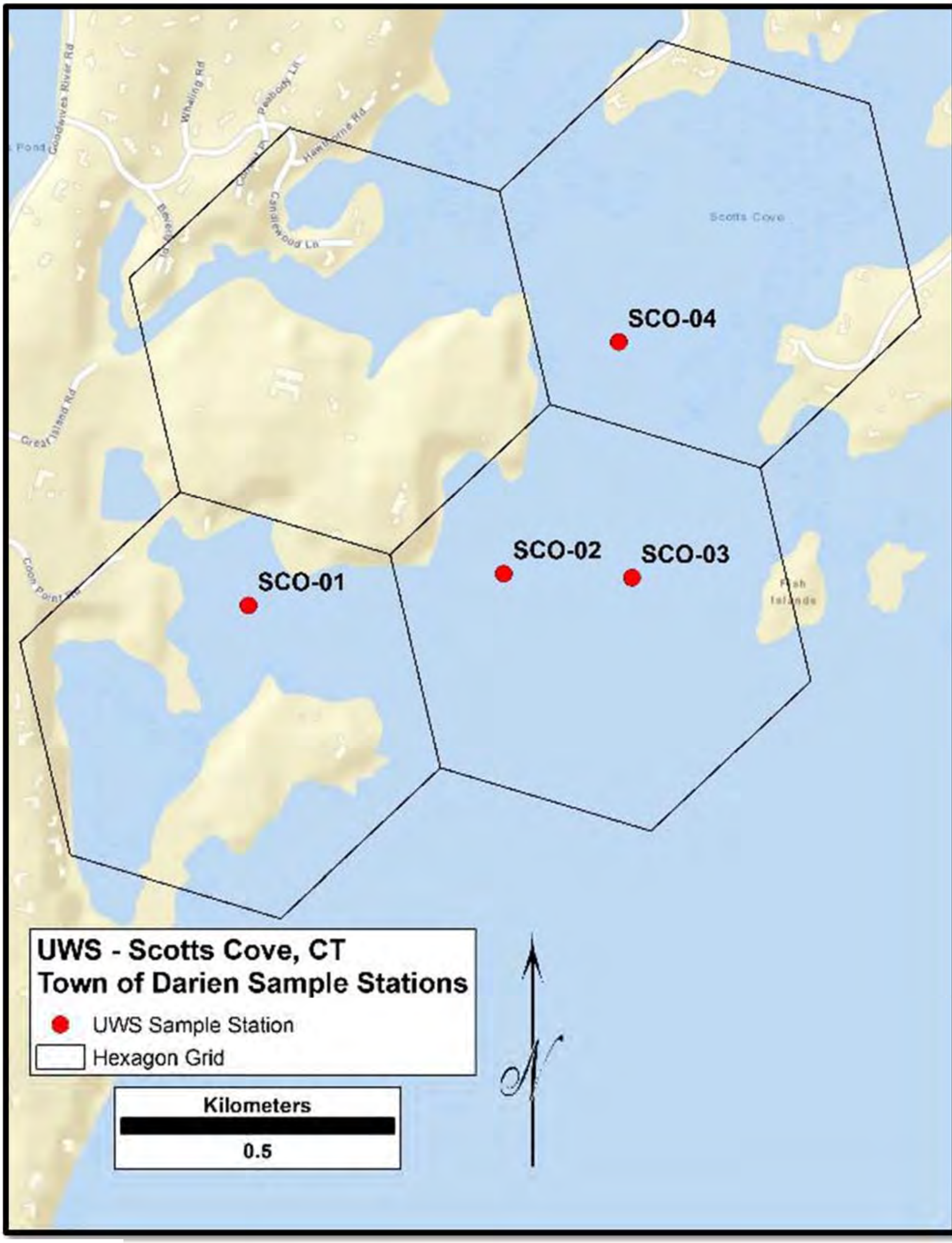

Goodwives River Rd
Whaling Rd
Peabody Ln
Hawthorne Rd
Candlewood Ln
Scotts Cove
SCO-04
Great Island Rd
SCO-02
SCO-03
SCO-01
Fish Islands
Coon Point Rd
UWS - Scotts Cove, CT
Town of Darien Sample Stations
UWS Sample Station
Hexagon Grid
Kilometers
0.5
N

Figure 2ad

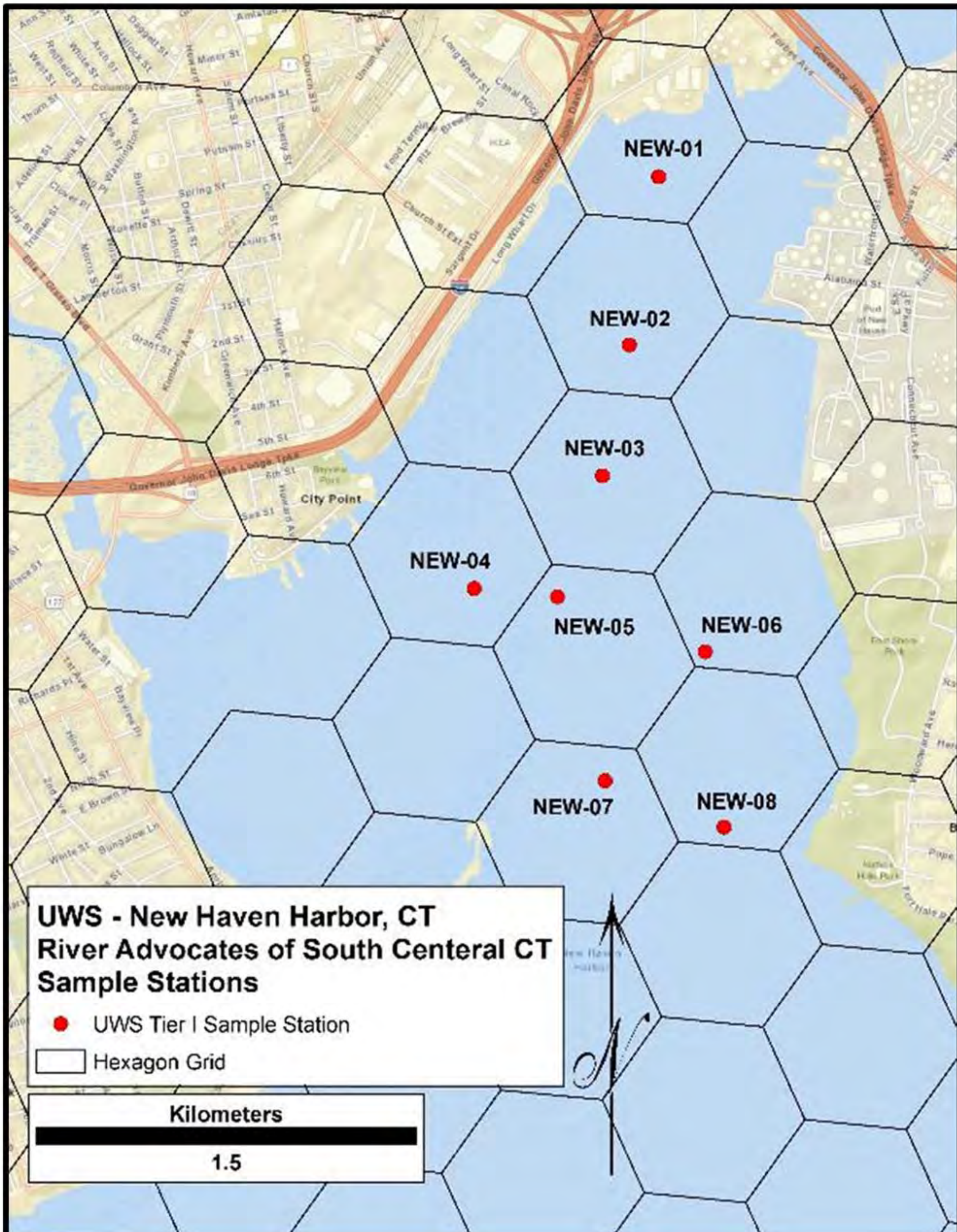

NEW-01
NEW-02
NEW-03
NEW-04
NEW-05
NEW-06
NEW-07
NEW-08
UWS - New Haven Harbor, CT
River Advocates of South Centeral CT
Sample Stations
UWS Tier I Sample Station
Hexagon Grid
Kilometers
1.5
City Point

Figure 2ac

Table 2: Station coordinates in NAD_83 for Tier I water quality and Tier II nutrients stations* in the UWS.

Station ID	Embayment	Longitude	Latitude
ALE-01	Alewife Cove, CT	-72.10449	41.31814
ALE-02	Alewife Cove, CT	-72.10069	41.31364
ALE-03	Alewife Cove, CT	-72.10343	41.30898
ALE-04	Alewife Cove, CT	-72.10485	41.3055
BLR-01	Black Rock Harbor, CT	-73.20513	41.16387
BLR-02	Black Rock Harbor, CT	-73.20895	41.15945
BLR-03	Black Rock Harbor, CT	-73.21531	41.15589
BLR-04	Black Rock Harbor, CT	-73.21946	41.14901
BLR-05	Black Rock Harbor, CT	-73.21839	41.14545
BLR-06	Black Rock Harbor, CT	-73.22326	41.14353
BRR-01	Bronx River, NY	-73.88403	40.82226
BRR-02	Bronx River, NY	-73.87916	40.81694
BRR-03	Bronx River, NY	-73.87346	40.81489
BRR-04	Bronx River, NY	-73.86939	40.81079
BRR-05	Bronx River, NY	-73.86751	40.80661
BRR-06	Bronx River, NY	-73.86299	40.80257
CEN-01*	Centerport Harbor, NY	-73.37583	40.89694
CEN-02	Centerport Harbor, NY	-73.37952	40.90007
CEN-03*	Centerport Harbor, NY	-73.38401	40.90849
COL-I-01	Cold Spring Harbor, NY	-73.46501	40.8625
COL-I-02	Cold Spring Harbor, NY	-73.46333	40.86667
COL-I-03	Cold Spring Harbor, NY	-73.46605	40.86898
COL-O-04	Cold Spring Harbor, NY	-73.47908	40.8796
COL-O-05	Cold Spring Harbor, NY	-73.48873	40.89025
COL-O-06	Cold Spring Harbor, NY	-73.48468	40.90344
COL-O-07	Cold Spring Harbor, NY	-73.50969	40.91512
CTR-01	Connecticut River, CT	-72.3842	41.352
CTR-02	Connecticut River, CT	-72.3839	41.34842

Station ID	Embayment	Longitude	Latitude
CTR-03	Connecticut River, CT	-72.37888	41.34416
CTR-04	Connecticut River, CT	-72.38082	41.35696
CTR-05	Connecticut River, CT	-72.37864	41.36275
CTR-06	Connecticut River, CT	-72.37932	41.35323
CTR-07	Connecticut River, CT	-72.37504	41.34672
CTR-08	Connecticut River, CT	-72.36533	41.34011
COV-01	Cove Harbor, CT	-73.49904	41.03958
COV-02	Cove Harbor, CT	-73.5036	41.04227
COV-03	Cove Harbor, CT	-73.49928	41.04377
COV-04	Cove Harbor, CT	-73.49468	41.04477
DAR-01	Darien River, CT	-73.4814	41.03846
DAR-02	Darien River, CT	-73.48587	41.04082
DAR-03	Darien River, CT	-73.48598	41.04336
DAR-04	Darien River, CT	-73.48382	41.04796
EAB-I-01*	Eastchester Bay, NY	-73.8207	40.88621
EAB-I-02	Eastchester Bay, NY	-73.82118	40.87824
EAB-I-03	Eastchester Bay, NY	-73.82306	40.8724
EAB-I-04*	Eastchester Bay, NY	-73.81672	40.8628
EAB-O-05*	Eastchester Bay, NY	-73.81038	40.85766
EAB-O-06	Eastchester Bay, NY	-73.81319	40.85211
EAB-O-07	Eastchester Bay, NY	-73.80781	40.85024
EAB-O-08	Eastchester Bay, NY	-73.80829	40.84192
EAB-O-09*	Eastchester Bay, NY	-73.80649	40.83259
FAR-04	Farm River, CT	-72.85192	41.26209
FAR-05	Farm River, CT	-72.85405	41.25649
FAR-06	Farm River, CT	-72.85857	41.24893
FAR-07	Farm River, CT	-72.85378	41.25186
GOL-01	Goldsmiths Inlet, NY	-72.46946	41.05073
GOL-02	Goldsmiths Inlet, NY	-72.47022	41.05165

Station ID	Embayment	Longitude	Latitude
GOL-03	Goldsmiths Inlet, NY	-72.47017	41.05373
GOL-04	Goldsmiths Inlet, NY	-72.47123	41.05303
HEM-M-01	Hempstead Harbor, NY	-73.65353	40.83189
HEM-M-02	Hempstead Harbor, NY	-73.65854	40.84172
HEM-M-03	Hempstead Harbor, NY	-73.65216	40.85365
HEM-O-04	Hempstead Harbor, NY	-73.67396	40.86077
HEM-O-05	Hempstead Harbor, NY	-73.67493	40.87349
HEM-O-06	Hempstead Harbor, NY	-73.65016	40.88365
HOL-01	Holly Pond, CT	-73.50337	41.05624
HOL-02	Holly Pond, CT	-73.49906	41.05487
HOL-03	Holly Pond, CT	-73.49446	41.0525
HOL-04	Holly Pond, CT	-73.4971	41.05092
HOU-O-01	Housatonic River, CT	-73.11245	41.1976
HOU-O-02	Housatonic River, CT	-73.11861	41.18895
HOU-O-03	Housatonic River, CT	-73.12158	41.17737
HOU-O-04	Housatonic River, CT	-73.11256	41.17121
HOU-O-05	Housatonic River, CT	-73.09952	41.16267
HIB-01	Hunter Island Bay, NY	-73.79606	40.87446
HIB-02	Hunter Island Bay, NY	-73.79547	40.87637
HIB-03	Hunter Island Bay, NY	-73.79217	40.88172
HIB-04	Hunter Island Bay, NY	-73.78636	40.88178
HUB-01*	Huntington Bay, NY	-73.42993	40.90936
HUB-02*	Huntington Bay, NY	-73.40746	40.91044
HUB-03	Huntington Bay, NY	-73.41805	40.91777
HUH-01*	Huntington Harbor, NY	-73.41805	40.88749
HUH-02	Huntington Harbor, NY	-73.42333	40.89666
HUH-03	Huntington Harbor, NY	-73.43205	40.89881
HUH-04	Huntington Harbor, NY	-73.43865	40.89988
HUH-06*	Huntington Harbor, NY	-73.43445	40.90499

Station ID	Embayment	Longitude	Latitude
LNE-I-01*	Little Neck Bay, NY	-73.75791	40.77224
LNE-I-02	Little Neck Bay, NY	-73.7608	40.7778
LNE-I-03	Little Neck Bay, NY	-73.75823	40.78314
LNE-I-04*	Little Neck Bay, NY	-73.75061	40.78377
LNE-I-05*	Little Neck Bay, NY	-73.76862	40.78606
LNE-O-06*	Little Neck Bay, NY	-73.7582	40.7888
LNE-O-07	Little Neck Bay, NY	-73.77112	40.794
LNE-O-08	Little Neck Bay, NY	-73.76179	40.79561
LNE-O-09	Little Neck Bay, NY	-73.75442	40.79884
LNE-O-10*	Little Neck Bay, NY	-73.76992	40.80202
LLO-01*	Lloyd Harbor, NY	-73.46734	40.91296
LLO-02	Lloyd Harbor, NY	-73.45	40.91361
LLO-03	Lloyd Harbor, NY	-73.44147	40.91093
LLO-04*	Lloyd Harbor, NY	-73.43738	40.91889
MAM-01*	Mamaroneck River, NY	-73.72225	40.94088
MAM-02	Mamaroneck River, NY	-73.72717	40.94288
MAM-03*	Mamaroneck River, NY	-73.72894	40.94737
MAM-04*	Mamaroneck River, NY	-73.73625	40.94367
MAN-I-01	Manhasset Bay, NY	-73.71316	40.80772
MAN-I-02	Manhasset Bay, NY	-73.71461	40.81244
MAN-I-03	Manhasset Bay, NY	-73.70714	40.81586
MAN-M-04	Manhasset Bay, NY	-73.71242	40.82271
MAN-M-05	Manhasset Bay, NY	-73.70551	40.83064
MAN-M-06	Manhasset Bay, NY	-73.71454	40.83228
MAN-M-07	Manhasset Bay, NY	-73.72375	40.82616
MAN-M-08	Manhasset Bay, NY	-73.72564	40.83644
MAN-O-09	Manhasset Bay, NY	-73.73613	40.83179
MAN-O-10	Manhasset Bay, NY	-73.73672	40.84517
MAN-O-11	Manhasset Bay, NY	-73.74556	40.84097

Station ID	Embayment	Longitude	Latitude
MAT-01	Mattituck Creek, NY	-72.53983	40.99671
MAT-02	Mattituck Creek, NY	-72.55082	40.99702
MAT-03	Mattituck Creek, NY	-72.54506	41.00124
MAT-04	Mattituck Creek, NY	-72.5471	41.0058
MAT-05	Mattituck Creek, NY	-72.5491	41.00997
MAT-06	Mattituck Creek, NY	-72.55664	41.01282
MNC-01	Mill Neck Creek, NY	-73.5675	40.89888
MNC-02	Mill Neck Creek, NY	-73.55809	40.90138
MNC-03	Mill Neck Creek, NY	-73.55167	40.90333
MIL-01	Mill River, CT	-73.27468	41.13761
MIL-02*	Mill River, CT	-73.28045	41.13339
MIL-03*	Mill River, CT	-73.28416	41.1317
MIL-04	Mill River, CT	-73.28766	41.12727
MYH-01	Mystic Harbor, CT	-71.96392	41.34344
MYH-02	Mystic Harbor, CT	-71.97418	41.34013
MYH-03	Mystic Harbor, CT	-71.97581	41.33295
MYH-04	Mystic Harbor, CT	-71.98351	41.32905
NRH-01	New Rochelle Harbor, NY	-73.77759	40.89548
NRH-02	New Rochelle Harbor, NY	-73.78096	40.89031
NRH-03	New Rochelle Harbor, NY	-73.78444	40.88806
NRH-04	New Rochelle Harbor, NY	-73.7881	40.88382
NIR-I-01*	Niantic River, CT	-72.19166	41.36423
NIR-I-02	Niantic River, CT	-72.19027	41.35582
NIR-I-03*	Niantic River, CT	-72.18295	41.34556
NIR-I-04*	Niantic River, CT	-72.17941	41.35027
NIR-O-05*	Niantic River, CT	-72.17737	41.3397
NIR-O-06	Niantic River, CT	-72.18646	41.33786
NIR-O-07	Niantic River, CT	-72.18174	41.33128
NIR-O-08*	Niantic River, CT	-72.1762	41.32346

Station ID	Embayment	Longitude	Latitude
NIS-01	Nissequogue River, NY	-73.20069	40.86397
NIS-02	Nissequogue River, NY	-73.20219	40.89071
NIS-03	Nissequogue River, NY	-73.20899	40.89408
NIS-04	Nissequogue River, NY	-73.22424	40.89892
NIS-05	Nissequogue River, NY	-73.21767	40.90121
NIS-06	Nissequogue River, NY	-73.21607	40.89874
NIS-07	Nissequogue River, NY	-73.22976	40.90427
NPB-01	Northport Bay, NY	-73.36417	40.91111
NPB-02*	Northport Bay, NY	-73.35544	40.92265
NPB-03	Northport Bay, NY	-73.36616	40.92906
NPB-04	Northport Bay, NY	-73.37555	40.91666
NPB-05*	Northport Bay, NY	-73.38112	40.93054
NPB-06*	Northport Bay, NY	-73.39183	40.91458
NPB-07	Northport Bay, NY	-73.39841	40.92496
NPH-01*	Northport Harbor, NY	-73.36131	40.89117
NPH-02	Northport Harbor, NY	-73.35583	40.89888
NPH-03*	Northport Harbor, NY	-73.35972	40.90561
NWH-I-01	Norwalk Harbor, CT	-73.41105	41.11738
NWH-I-02*	Norwalk Harbor, CT	-73.41117	41.10799
NWH-I-03*	Norwalk Harbor, CT	-73.416	41.10205
NWH-I-04	Norwalk Harbor, CT	-73.41419	41.09846
NWH-I-05*	Norwalk Harbor, CT	-73.41003	41.09385
NWH-I-06*	Norwalk Harbor, CT	-73.40425	41.08727
NWH-I-07	Norwalk Harbor, CT	-73.40073	41.07939
NWH-O-01	Norwalk Harbor, CT	-73.41195	41.06843
NWH-O-02*	Norwalk Harbor, CT	-73.41526	41.06435
NWH-O-03	Norwalk Harbor, CT	-73.40758	41.06275
NWH-O-04	Norwalk Harbor, CT	-73.39851	41.06764
NWH-O-05*	Norwalk Harbor, CT	-73.39131	41.07406

Station ID	Embayment	Longitude	Latitude
OYB-01	Oyster Bay, NY	-73.53963	40.89789
OYB-02	Oyster Bay, NY	-73.52878	40.91181
OYB-03	Oyster Bay, NY	-73.53113	40.88073
OYB-04	Oyster Bay, NY	-73.51553	40.89036
POR-I-01	Port Jefferson Harbor, NY	-73.10422	40.94861
POR-I-02	Port Jefferson Harbor, NY	-73.10069	40.9504
POR-I-03	Port Jefferson Harbor, NY	-73.09931	40.95557
POR-M-04	Port Jefferson Harbor, NY	-73.11192	40.97045
POR-M-05	Port Jefferson Harbor, NY	-73.10555	40.96579
POR-M-06	Port Jefferson Harbor, NY	-73.09524	40.9644
POR-O-07	Port Jefferson Harbor, NY	-73.07133	40.95141
POR-O-08	Port Jefferson Harbor, NY	-73.08307	40.95637
POR-O-09	Port Jefferson Harbor, NY	-73.08649	40.96139
POR-O-10	Port Jefferson Harbor, NY	-73.08729	40.968
STA-01	Stamford Harbor, CT	-73.54388	41.0363
STA-02	Stamford Harbor, CT	-73.53599	41.03353
STA-03	Stamford Harbor, CT	-73.53796	41.02906
STA-04	Stamford Harbor, CT	-73.53645	41.02362
STA-05	Stamford Harbor, CT	-73.54446	41.02405
STA-06	Stamford Harbor, CT	-73.53853	41.01981
STA-07	Stamford Harbor, CT	-73.54553	41.01754
STA-08	Stamford Harbor, CT	-73.53044	41.041
STO-I-01	Stonington Harbor, CT	-71.91511	41.34485
STO-I-02	Stonington Harbor, CT	-71.9144	41.34298
STO-I-03	Stonington Harbor, CT	-71.91138	41.3422
STO-O-04	Stonington Harbor, CT	-71.9106	41.33843
STO-O-05	Stonington Harbor, CT	-71.91545	41.33408
STO-O-06	Stonington Harbor, CT	-71.90871	41.33237
STO-O-07	Stonington Harbor, CT	-71.90762	41.32727

Station ID	Embayment	Longitude	Latitude
STO-O-08	Stonington Harbor, CT	-71.91973	41.32764
SCO-01	Scotts Cove, CT	-73.47318	41.04985
SCO-02	Scotts Cove, CT	-73.46762	41.05041
SCO-03	Scotts Cove, CT	-73.46483	41.05037
SCO-04	Scotts Cove, CT	-73.46516	41.05425
NEW-01	New Haven Harbor, CT	-72.91249	41.29462
NEW-02	New Haven Harbor, CT	-72.91387	41.28861
NEW-03	New Haven Harbor, CT	-72.91511	41.28396
NEW-04	New Haven Harbor, CT	-72.92115	41.27993
NEW-05	New Haven Harbor, CT	-72.91722	41.27964
NEW-06	New Haven Harbor, CT	-72.91025	41.27771
NEW-07	New Haven Harbor, CT	-72.91496	41.27309
NEW-08	New Haven Harbor, CT	-72.90936	41.27144

*These stations will be sampled for Tier II nutrients.

A.6.c. Annual Task Calendar

The annual task calendar describes when certain activities will occur.

Table 3: Annual Task Calendar
These tasks are repeated annually.

Activity	J	F	M	A	M	J	J	A	S	O	N	D
Kickoff meeting with UWS project team	x	x										
Develop draft QAPP and submit to UWS & EPA	x	x	x									
Finalize QAPP, responding to comments from EPA			x	x	x							
Application process and group admittance to UWS; includes station selection and funding	x	x	x	x			x					
Equipment inventory, purchase, inspection, and testing	x	x	x	x							x	X
Field training and database-related training session(s)			x	x								
Contact with analytical laboratory (for chlorophyll a and nutrient sampling samples)		x	x	x								
Field audits & midseason check in with Monitoring Group Leads or designated appointees					x	x		x				
Monthly check ins with Monitoring Groups					x	x	x	x	x	x	x	x

Activity	J	F	M	A	M	J	J	A	S	O	N	D
Technical support to Monitoring Groups				x	x	x	x	x	x	x	x	x
Sampling events					x	x	x	x	x	x		
Data entry					x	x	x	x	x	x	x	x
Data review and validation of data entry	o	o				x	x	x	x	x	x	x
Data uploads to STS-UWS website (must follow data review)			o									
Draft report		o										
Final annual report			o									
o indicates the year following sampling events												

A.7. Data Quality Objectives

Taken together, precision, accuracy and bias, representativeness, comparability, completeness, and sensitivity comprise the major data quality indicators used to assess the quality of the program's data. A summary of criteria are provided in Table 4.

Definitions of these data quality indicator terms:

- **Precision** is the degree of agreement among repeated field measurements of the same indicator and gives information about the consistency of methods. It is typically defined as relative percent difference, or RPD.

- **Accuracy** is a measure of confidence that describes how close a measurement is to its "true" or expected value; it includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations.

- **Bias** is the systematic or persistent distortion of a measurement process that causes errors in one direction.

- **Representativeness** is the extent to which measurements actually represent the true environmental condition. Parameters, station selection (including location of sampling point within the water column), time, and frequency of sample collection can all play a role in determining how representative a sample is.

- **Comparability** is the extent to which data can be compared between sample locations or periods of time within a project, or between different sites.

- **Completeness** is the comparison between the amount of valid or usable data the program originally intended to collect versus how much was actually collected.

- **Sensitivity** is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.

Table 4: Measurement Performance Criteria

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Criteria
Precision – overall	RPD ≤ value indicated in Table 5	field duplicates
Precision – analytical	RPD ≤ value indicated in Table 5	analytical duplicates
Accuracy / Bias	85% ≤ recovery ≤ 115%	certified reference material
Comparability	standard procedures followed	NA
Completeness	data from surface, mid (if applicable) and bottom at each station meet data quality objectives	data completeness check
Sensitivity	value ≥ MDL*	sample value check

* MDL = method detection limit. This is a reporting limit based on the lowest standard accurately analyzed in the analysis.

Precision - Precision objectives are listed in Table 5. Precision is evaluated in the field by participants taking replicate measurements for at least 5% of samples, where applicable.

For UWS Tier I water quality sample events, a replicate profile at one station per field day.

For water samples filtered and analyzed for extracted chlorophyll-*a*, two field replicates will be collected per sample day.

For estuary and tributary stations sampled for nutrients, a field replicate will be collected at each station.

For qualitative macrophyte stations, multiple pictures will be taken for rake toss sampling and beach sampling.

For quantitative macrophyte sampling, multiple analyses of the stills to determine percent coverage will be undertaken.

When a multiparameter sonde is used, standards will be read before and following a trip, within one day of the field day. Calibration of sondes will happen within one day of the sampling event. Multiparameter sondes can hold their calibrations for weeks. The pre and post sampling event readings can identify any potential drift outside of manufacturer recommendations for calibration. These values will be kept with all other data for review at the end of the project interval.

The Onset HOBO loggers (dissolved oxygen) and Star-Oddi loggers (temperature, conductivity, depth) will be deployed in a common water bath before deployment and following deployment. Conductivity, temperature and oxygen will be varied in the bath, allowing for multiple values for intercomparison. The temperature, conductivity, and oxygen of the bath will be determined with the instruments being used for conducting Tier I water quality profiles. These pre- and post-baths will serve to cross-calibrate all instruments and to determine if the deployed loggers exhibited any drift over the course of the deployment. The deployed loggers will be intercalibrated by applying a multiplicative correction if initial values differ by more than 10% from the reference value (as determined from the YSI EXO1 sonde or Eureka Manta +35).

The frequency of field replicate measurements for each parameter are described in Table 7.

Relative percent difference (RPD) of replicate samples is used as one index of precision; see Table 5. This is defined as the absolute difference between the replicates divided by the average of the replicates. The allowable RPDs for each parameter are provided in Table 7. A difference greater than the designated RPD requires further investigation of the sample run. If the difference is large enough, it indicates failure (unless the average of the two samples is less than 10 times the method detection limit), and results in potential disqualification or flagging of data from that station depth, unless there is a reasonable and supported explanation for the inconsistency. Replicate precision will be analyzed by calculating the RPD using the equation:

$$RPD (\%) = |x1 – x2| / ((x1 + x2)/2) * 100$$

where x1 is the original sample concentration and x2 is the replicate sample concentration.

The Microsoft Excel formula for calculating the RPD is:

= ABS(X1-X2) / ((X1+X2) / 2) * 100

where X1 is the original sample concentration and X2 is the replicate sample concentration. The RPD is automatically calculated in the UWS data entry template for replicate profiles and field samples.

Accuracy and Bias - Accuracy objectives are listed in Table 4. Procedures used to test or ensure accuracy are described in Table 11. While training and audits help to ensure measurement accuracy and precision, quantitative measures of accuracy for water quality monitoring are estimated using laboratory QC data (blank results, fortified matrix results, known QC samples, etc.). When a multiparameter sonde is used, standards will be read before and following a trip, within one day of the field day. Extracted chlorophyll a analysis will include a field replicate, laboratory blank and reference standards. Nutrient analysis will include a laboratory blank, field blank, and reference standards. Data loggers will be calibrated prior to and after deployment. Biweekly comparative readings between loggers and sonde will be recorded to keep a log of any drift occurring with loggers. These data will be evaluated with the log data in the final report and during the season.

Representativeness – Tier I water quality sample stations and quantitative Tier II macrophyte stations are selected to represent the entire embayment using a probability-based sampling design[4], as in the EPA National Coastal Assessment[5]. In this approach, a 0.42 km^2 hexagonal grid is overlain on the site map. Three random stations are generated in ArcGIS in each section of the embayment within a hexagon. Large embayments will have hexagons for random station generation selected with the UWS Science Advisors. A minimum of four stations will be sampled in each embayment, with larger sites having up to twelve stations. The location of the station in each hexagon will be randomly generated, with at least two alternate locations also randomly generated, in case the original location is deemed unusable (e.g. too shallow or in the middle of a navigation channel). If none of the three random stations are accessible, a station will be determined as close as possible to a randomly generated station unless bias circumstances are identified. The Monitoring Program Coordinator will oversee station selection, providing GIS-based maps and station coordinates to groups participating in the Unified Water Study. At least one Scientific Advisor affiliated with the UWS will also advise on the choice of station locations. Stations used previously by a group are evaluated for bias before inclusion in the UWS.

Tier II nutrient stations are a subset of the Tier I water quality stations selected in consultation with the UWS Science Advisors. A pilot test of nutrient sampling was conducted in Mamaroneck River, NY and Little Neck Bay, NY in 2017. In this pilot test, all Tier I water quality stations were sampled for nutrients. The approach to selecting a subset of stations (2-3) for Tier II nutrient analysis to yield a regional average was compared to the regional average using all stations in a region (3-5). The approach described below yields the most accurate regional average when sampling a subset of Tier I water quality stations for nutrients.

At a minimum, there will be two stations per embayment. In embayments with multiple regions, there will be a minimum of two stations per region. These stations are located at the boundaries of region delineations or the entire embayment, when regions are not identified.

Embayment size, salinity, and best judgment of the UWS Science Advisors determine if more stations may be needed in a region. Additional stations are required when the geometry of the embayment is not linear. For example, the Y shape of Mamaroneck River, NY requires three stations as seen in this QAPP. Salinity within a region that has a range greater than 2 ppt

---

[4] Paul, J.F., J.L. Copeland, M. Charpentier, P.V. August, and J.W. Hollister. 2003, Overview of GIS applications in estuarine monitoring and assessment research. Marine Geodesy Journal 26: 63-72.

[5] EPA, U.S. 2001. National Coastal Assessment: Field Operations Manual. U. S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA 620/R-01/003. 72 p.

triggers a closer inspection of available salinity data by the UWS Science Advisors, to insure selected stations are sufficient to characterize the region.

Stations that have salinity data of less than 5 ppt are not acceptable as representative embayment stations. In embayments with the minimum Tier I water quality stations (4 stations), a station where salinity is episodically below 5 ppt may be deemed acceptable if the UWS Science Advisors deem inclusion of the station as important to estimating the regional average. The next station downstream is evaluated for inclusion in cases where a station is rejected.

Tier II nutrients stations (tributary and Long Island Sound reference) are chosen based on access, location, and salinity values under 1 PPT.

Data logging stations are selected with at least one station per reporting region. Access to station is a strong consideration in the selection process. The final station locations will be conferred with UWS Science Advisors before deployment.

Qualitative macrophyte surveys are targeted qualitative assessments of areas in the embayment known to harbor macrophytes thus the random station generation does not apply to selecting these locations. Sample collection timing and frequency for water quality stations are selected to capture data that are representative of embayment conditions. While tidal stage will vary among sampling dates, the timing relative to dawn was considered of greatest importance when sampling Tier I water quality stations to evaluate hypoxia in embayments. These very shallow systems are typically dominated by benthic primary producers (macroalgae, benthic microalgae, and seagrass) versus pelagic primary producers (pelagic microalgae / phytoplankton). When the sun rises, these primary producers quickly replenish the dissolved oxygen in the water column. One of the goals of this study is to evaluate the incidence of hypoxia in embayments, thus sampling close to dawn is more important than sampling at a specific tidal stage. Time of high and low tide and precipitation volumes are recorded and will be considered in the analysis of results. Any abnormal or episodic conditions that may affect the representativeness of sample data are noted and maintained as metadata.

Comparability - The comparability of the data collected can be assured by using known protocols and documenting methods, analysis, sampling sites and stations, times and dates, sample storage and transfer, as well as laboratories and identification specialists; so that future surveys can produce comparable data by following similar procedures. Examples of project procedures are available in the collection of Standard Operating Procedures (SOPs) provided in Appendix A of this document.

Completeness –Minimum sample events for inclusion for Tier I and Tier II monitoring are included in section A.6 of this document.

Sensitivity – Sensitivity objectives are listed in Table 5. Sensitivity is the lowest detection limit of the method or instrument for each of the measurement parameters of interest. For analytical methods, these are the method detection limits (MDLs).

Table 5: Data Quality Objectives

Parameter	Units	Accuracy	Precision (allowable RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
Depth (calibrated line)	meters (m)	± 0.1 m	20%	0 – 50 m	0.1 m
Barometric Pressure (ONSET HOBO U20L-01)	Kilopascal (kPa)	0.62 kPa maximum error	10%	3.7 – 4.1 kPa	< 0.02 kPa
Depth (YSI EXO 1)	meters (m)	0 to 10 m ± 0.04% FS or ± 0.004 m 0 to 100 m ± 0.04% FS or ± 0.04 m 0 to 820 m ± 0.04% FS or ± 0.1 m	20%	0 – 50 m	0.001 m
Depth (Eureka Manta +35)	meters (m)	0 to 10 m ±0.02 (±0.2% of FS) 0 to 25 m ±0.05 (±0.2% of FS) 0 to 50 m ±0.1 (±0.2% of FS) 0 to 100 m ±0.2 (±0.2% of FS) 0 to 200 m ±0.4 (±0.2% of FS)	20%	0 – 50 m	0.01 m 0.01 m 0.1 m 0.1 m 0.1 m
GPS coordinates	decimal degrees (dec. deg.)	± 7.8 m http://www.gps.gov/systems/gps/performance/accuracy/	for reference point on land, within 10 m (=0.0001 dec. deg.)	NA	1.02 m
Temperature (YSI EXO 1)	degrees Celsius (°C)	-5 to 35 °C ± 0.5 °C 35 to 50 °C ± 0.05 °C	10%	4 – 26 °C	0.001 °C
Temperature (Eureka Manta +35)	degrees Celsius (°C)	± 0.1 °C	10%	4 – 26 °C	0.01 °C

Parameter	Units	Accuracy	Precision (allowable RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
Conductivity (YSI EXO 1)	millisiemens (mS/cm)	0 to 100 mS/cm ± 5% of reading or 0.0001 mS/cm; whichever is greater 100 to 200 mS/cm ± 5% of reading	10%	0 – 50 mS/cm	0.0001 to 0.001 mS/cm, range-dependant
Conductivity (Star-Oddi DST CT)	millisiemens (mS/cm)	13-50 mS/cm ± 1.5 mS/cm	10%	13-50 mS/cm	0.01 mS/cm within range
Specific Conductance (Eureka Manta +35)	millisiemens (mS/cm)	0 to 10 mS/cm ± 1% of reading or ± 0.001 mS/cm 10 to 100 mS/cm or ± 1% of reading	10%	0 – 50 mS/cm	0.001 mS/cm 0.01 mS/cm
Dissolved oxygen (YSI EXO 1)	milligrams per liter (mg/L) = parts per million (ppm); percent saturation (% sat.)	0 to 20 mg/l ± 1% of reading or 0.1 mg/L 20 to 50 mg/l ± 5% of reading 0 to 200% ± 1% reading or 1% air saturation, whichever is greater 200 to 500% ± 5% reading	20%	0 – 14 mg/L 0 – 120 %	0.01 mg/L 0.1 % sat.
Dissolved oxygen (Eureka Manta +35)	milligrams per liter (mg/L) = parts per million (ppm); percent saturation (% sat.)	0 to 20 mg/l ± 0.2 mg/l 20 to 50 mg/l ± 10% reading 0 to 200% sat. ±1% of reading or ±0.1 % sat. 200 to 500% sat. ±10% of reading	20%	0 – 14 mg/L 0 – 120 % sat.	0.1 mg/l 0.1 % sat.
Dissolved oxygen (ONSET HOBO U26)	milligrams per liter (mg/L) = parts per million (ppm)	0 to 8 mg/l ± 0.2 mg/l 8 to 20 mg/l ± 0.5 mg/l	20%	0 – 14 mg/L	0.02 mg/l

Parameter	Units	Accuracy	Precision (allowable RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
Chlorophyll a (as measured in lab)	microgram per liter (µg/L)	75 - 125 % recovery of a lab QC sample with known µg/L	15%	0 – 30 µg/L; though higher concentrations may occur	0.7 µg/L
Chlorophyll a (YSI EXO 1)	Relative Fluorescence Units (RFU), microgram per liter (µg/L)	Chl: R^2 > 0.999 for serial dilution of Rhodamine WT Solution from 0 to 400 µg/L PC equivalents	20%	0 – 30 µg/L; though higher concentrations may occur	0.01 RFU 0.01 µg/L
Chlorophyll a (Eureka Manta +35)	microgram per liter (µg/L)	0.03 to 500 µg/L ± 3% of full scale	20%	0 – 30 µg/L; though higher concentrations may occur	0.01 µg/L
Turbidity (YSI EXO 1)	FNU*	0 to 999 FNU ± 2% of reading or 0.3 FNU, whichever is greater 1000 to 4000 FNU 0.1 FNU	20%	0 – 30 FNU	0 – 999 FNU: 0.01 FNU 1000 – 9999 FNU: 0.1 FNU
Turbidity (Eureka Manta +35)	NTU	0 to 400 NTU ± 1% of reading ± 1 count 400 to 3000 NTU ± 3% of reading	20%	0 – 30 NTU	4 digits 4 digits
Dissolved ammonia - NH3 (as measured in lab)	mg/L NH_3 (= ppm = g/m3)	85% - 115% recovery of lab fortified matrix (LFM)	Field Replicate 30% Analytical Replicate 15%	0-1 mg/l	0.020 mg/l
Dissolved nitrate† - NO_{3-} (NO_x- NO_{2-})	mg/l NO_3 (= ppm = g/m3)	Value calculated from multiple N analyses	NA	0-2 mg/l	NA
Dissolved nitrite - NO2- (as measured in lab)	mg/L NO2 (= ppm = g/m3)	85% - 115% recovery of lab fortified matrix (LFM)	Field Replicate 30% Analytical Replicate 15%	0-0.7 mg/l	0.004 mg/l
Nitrate-nitrite – NO_X or NO_{3-} + NO_{2-} (as measured in lab)	mg/L NOx (= ppm = g/m3)	85% - 115% recovery of lab fortified matrix (LFM)	Field Replicate 30% Analytical Replicate 15%	0-2.5 mg/l	0.004 mg/l
Dissolved inorganic nitrogen† – DIN (NH3+NO_x)	mg/L DIN (= ppm = g/m3)	Value calculated from multiple N analyses	NA	0-4 mg/l	NA

Parameter	Units	Accuracy	Precision (allowable RPD)	Approx. Expected Range	Sensitivity (Resolution or MDL)
Total dissolved nitrogen – TDN (as measured in lab)	Mg/l TDN (= ppm = g/m3)	85% - 115% recovery of lab fortified matrix (LFM)	Field Replicate 30% Analytical Replicate 15%	0-5 mg/l	0.05 mg/l
Total Nitrogen (as measured in lab)	mg/l TDN (= ppm = g/m3)	85% - 115% recovery of lab fortified matrix (LFM)	Field Replicate 30% Analytical Replicate 15%	0-8 mg/l	0.05 mg/l
Total inorganic nitrogenǂ – TIN ($NH3+NO_x$)	mg/L TIN (= ppm = g/m3)	value calculated from multiple N analyses	NA	0-4 mg/l	NA
Total organic nitrogenǂ – TON (TN - TIN)	mg/L TON (= ppm = g/m3)	value calculated from multiple N analyses	NA	0-5 mg/l	NA
Dissolved organic nitrogenǂ - DON (TDN - DIN)	mg/L DON (= ppm = g/m3)	value calculated from multiple N analyses	NA	0-4.5 mg/l	NA
Particulate nitrogenǂ – PN (TN-TDN)	mg/L PN (= ppm = g/m3)	value calculated from multiple N analyses	NA	0-0.5 mg/l	NA
Total phosphorus – TP (as measured in lab)	mg/L TP (= ppm = g/m3)	85% - 115% recovery of lab fortified matrix (LFM)	Field Replicate 30% Analytical Replicate 15%	0-0.5 mg/l	0.334 mg/l
Dissolved organic nitrogenǂ - DON (TDN - DIN)	mg/L DON (= ppm = g/m3)	value calculated from multiple N analyses	NA	0-4.5 mg/l	NA
Dissolved orthophosphate – PO_4^{3-} or DIP (as measured in lab)	mg/L PO_4^{3-} mg/L DIP (= ppm = g/m3)	85% - 115% recovery of lab fortified matrix (LFM)	Field Replicate 30% Analytical Replicate 15%	0-0.3 mg/l	0.001 mg/l
Quantitative macrophyte amount	% coverage bare, macrophytes, and animals of bottom	Estimates from three analyses are compared. If the relative percent difference among the three estimates is greater than 5%, the Monitoring Group Lead examines the image and the three estimates, choosing the appropriate value. The three estimates will not be changed, values are retained to show the inconsistency. The Monitoring Group Lead decides on the final value for the estimate.			
Qualitative macrophyte amount	choice of: none, some, lots	This is a qualitative assessment, not quantitative. Photos are reviewed by a UWS Science Advisor or trained designee to confirm choice of amount.			

*: FNU and NTU are interchangeable in the UWS. All data reported as NTU.

ᵻ: This parameter is calculated rather than measured analytically, so MDL is not computed. RPD is also not relevant for this parameter.

A.8. SPECIAL TRAINING / CERTIFICATION

UWS trainings are hands on full day events*. They are designed for a wide range of experience in water quality monitoring; ranging from groups with an extensive existing water quality monitoring programs to groups with little to no water quality monitoring experience. The trainings help to ensure all groups are on the same understanding of project QAPP and SOPs. All Monitoring Groups are provided the SOPs and QAPP. They are required to read these documents. Monitoring Groups take notes on the project SOPs during training events to clarify any points that require extra attention. The objective of trainings is to have all Monitoring Groups, regardless of previous experience, following the project requirements in a unified manner.

The Monitoring Program Coordinator shall ensure that all UWS Monitoring Groups receive appropriate training by organizing and conducting training events. The trainings are mandatory for new and veteran groups and have hands on elements for sonde calibration and usage, filling in datasheets, macrophyte assessments, logger calibration and usage, nutrient sample collection, and filtering chlorophyll a. All topics are covered in guided step by step approach. Training will be assessed as described by checks in Section C.1 Assessment and Response Actions.

The Monitoring Program Coordinator enters training into the project database and records the following information: subject matter (i.e. what type of monitoring and procedures are covered), training course title, date and agenda, name and qualification of trainers, and names of participants trained with associated monitoring group name. The trainings and technical support offered through the Monitoring Program Coordinator, Monitoring Program Field Coordinator, and Science Advisors is in place for the duration of the project. This will ensure new and veteran groups have a reliable source for prompt answers to their inquiries. Groups are prompted to email or call the Monitoring Program Coordinator or Monitoring Program Field Coordinator with their questions. If needed, the Science Advisors will be consulted. This support is mentioned throughout the project duration and emphasized at the trainings. Trainers remind trainees to call at any hint of a question or issue so it can be resolved.

The Monitoring Program Coordinator worked closely with the Science Advisor signatories on this QAPP to confirm procedures are appropriate. He was part of the three person team leading UWS Tier I trainings around Long Island Sound in 2017. The Coordinator oversees Save the Sound's Water Quality Program which samples water for pathogen-indicator bacteria and participates in the UWS Tier I & II monitoring.

*: UWS trainings for the 2020 season will be held remotely due to concerns and timing in regard to spread of the Coronavirus (Covid-19).

The Coordinator holds a Bachelor of Science Degree in Environmental Studies from University California Santa Barbara and a Master's of Science Degree in Environmental Science and Management from Sacred Heart University.

Project training shall take place as specified in Table 6.

Table 6: Project-Specific Training

Training: Type & Description	Trainer(s)	Training Date(s)	Trainees	Location of Training Records
UWS Standard Operating Procedures and Methods, QAPP, and Data Entry Training - General water quality parameter information - Sonde calibration and field training - Chlorophyll a field collection, filtering, preservation, & transport - Nutrient sampling collection, filtering, preservation, & transport - Qualitative macrophyte assessment procedure - Quantitative macrophyte assessment procedure - Data logger calibration and field training - QAPP review and data entry	UWS Monitoring Program Coordinator, UWS Field Coordinator, UWS Science Advisor(s), and other personnel under the supervision of the listed trainer(s)	Annual; Spring before sampling season commences	All participating UWS groups will send 1-3 representatives	Office of the UWS Monitoring Program Coordinator; digital record of attendees and agenda stored on computer and backed up on Save the Sound S-Drive

A.9. Documents and Records

Calibration Datasheet, Sample Event Datasheet and Field Datasheet will be completed by Monitoring Groups before, during, and after Tier I water quality station sampling event.

Qualitative Macrophyte Field Datasheet will be completed upon every qualitative macrophyte survey. Photographs must accompany and be identified in this datasheet.

UWS Nutrient Sample Event Datasheet, Calibration Datasheet, Field Datasheet will be completed upon every Tier II nutrients sampling event. The calibration datasheet will only contain the parameters being recorded in the field: conductivity (salinity).

UWS Quantitative Macrophyte Field Datasheet will be completed upon every quantitative macrophyte survey.

UWS Logger Retrieval Sample Event Datasheet, Field Datasheet, and Calibration Datasheet will be completed upon every data retrieval of data loggers in the field. The calibration datasheet will only contain the parameters being recorded in the field: dissolved oxygen and conductivity.

Sample Labels will be put on all sample containers. Labels will include the station name, organization name, date, time, sample id, and type of sample. Samples needing containers with labels are filters for extracted chlorophyll a and nutrients. Detailed instructions for chlorophyll a filters and nutrient samples are provided in the UWS SOP Chlorophyll, UWS SOP Filtered Nutrients, and UWS SOP Total Nitrogen and Total Phosphorous SOP in Appendix A.

Chain of Custody (COC) forms will accompany samples from collection sites to laboratories. COC forms will be signed by collectors and all individuals who gain custody of the samples until they arrive at a lab. Information will agree with the label information on the sample containers and field datasheet. UWS Chain of Custody forms are in Appendix B.

Training records and field audit information will be kept by the Monitoring Program Coordinator.

The electronic project database shall be organized and protected from loss and damage through proper back-up of digital data on Save the Sound's S-Drive.

No scientific collecting permits or certificates of permission are required.

The specific forms to be used for this project are provided in Appendix B.

B. Data Generation and Acquisition

B.1. SAMPLING PROCESS DESIGN (EXPERIMENTAL DESIGN)

Tier I water quality sample stations, Tier II nutrients stations (estuary), and quantitative Tier II macrophyte stations were selected to represent the water quality of the entire embayment using a probability-based sampling design[6], as in the EPA National Coastal Assessment[7]. Monitoring Program Coordinator and a UWS Science Advisor advised on the choice of station locations. The UWS assigned unique ID codes for the embayments, reporting regions of the embayment, and stations. Water quality stations can be viewed in section A.6.b of this document.

Qualitative macrophyte stations are selected based on local knowledge and observation of the embayment during the course of the May and June sampling events. They are targeted to areas of macrophyte abundance. Monitoring Program Coordinator and a UWS Science Advisor advised on the choice of station locations. UWS SOP Qualitative Macrophytes describes the process for sampling locations for macrophytes. These stations are selected using an adaptive process that requires observations during May and June sampling events. These observations identify the best locations for high macrophyte abundance. The qualitative macrophyte sampling can be classified as judgmental design resulting in directed sampling information to complement the water quality station data. Macrophyte stations may change from year to year but records of locations are maintained by the UWS Monitoring Program Coordinator.

Data logging stations were selected with at least one station per reporting region. Access to station is a strong consideration in the selection process. The final station locations will be conferred with Monitoring Program Coordinator and the UWS Science Advisors before deployment.

Tier II nutrients stations (tributary) were selected based on access and salinity <1 ppt. Parameters, number and location of sampling sites, sampling time of day, frequency, and season are selected to meet the monitoring objectives referred to in Section A.6.a.

---

[6] Paul, J.F., J.L. Copeland, M. Charpentier, P.V. August, and J.W. Hollister. 2003, Overview of GIS applications in estuarine monitoring and assessment research. Marine Geodesy Journal 26: 63-72.

[7] EPA, U.S. 2001. National Coastal Assessment: Field Operations Manual. U. S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA 620/R-01/003. 72 p.

Sampling design components are described below:

Sampling Safety. Personal safety shall be a primary consideration in all activities, including selection of sampling stations, dates, and training programs. No sampling shall occur when personal safety is thought to be compromised. The Monitoring Group Lead of each participating group on this QAPP shall confer with their respective field teams before each sampling event to decide whether adverse weather or other conditions pose a threat to safety and will cancel/postpone sampling when necessary. Sampling shall take place in teams of two or more. Samplers shall wear life vests when required, in adverse conditions in boats, or wading in waters under difficult conditions. Samplers shall wear proper clothing to protect against the elements.

Design Considerations. A summary of design considerations incorporated into this project are included in Table 7. Specifics on the design approaches to the number of stations, depth of sampling, and frequency of sampling and time of day of sampling are included in the SOPs in Appendix A. A summary of general design approaches to the number of stations, depth of sampling, frequency of sampling, and time of day are included here:

There are 215 Tier I water quality stations and approximately 112 qualitative macrophyte station monitored across all the study sites. 16 data logging stations will be monitored. 83 quantitative macrophyte stations will be monitored. 57 Tier II nutrient stations will be monitored. The qualitative macrophyte stations are confirmed by the beginning of the macrophyte monitoring window described in UWS SOP Macrophytes. Sonde profiles for water quality parameters at water quality stations will be sampled 0.5 m below the surface, 0.5 m above bottom, mid-depth if total depth >10 m; if total depth is less than 1.5 m, only a mid-depth reading will be collected. Extracted chlorophyll a samples will be taken from a bucket. Two filters and a corresponding chlorophyll a sonde reading will be taken per sampling event. Land-based qualitative macrophyte stations will be photographed from land. Rake toss qualitative macrophyte stations will be photographed from land or boat. Quantitiative macrophyte stations are recorded from a boat. These are the same locations as the Tier I water quality stations in the respective embayments. Tier II nutrients stations are collected 0.5 below the surface. New Tier II nutrients tributary stations are confirmed by field work prior to collecting the first batch of nutrient samples for the season. Data logging stations are 0.5 m off the bottom and record data every 15 minutes. These stations are selected and confirmed with the Monitoring Program Coordinator and a UWS Science Advisor prior to commencement of the season.

Table 7: Sampling Approaches.
Assessment Type: Tier I water quality Stations.

<table>
<tr><th>Indicators</th><th>Number of sample locations</th><th>Frequency, duration, special conditions</th><th>Field survey QC</th></tr>
<tr><td>GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used</td><td rowspan="2">every station</td><td rowspan="8">Twice a month from May - October,

within 3 hours of sunrise,</td><td>repeat readings every time a station is sampled.
coordinates indicating a 100 m or greater discrepancy will be assessed and documented in final report.
reference land site, once per sampling event
once per field day,
take readings twice at the last station sampled</td></tr>
<tr><td>station depth</td><td rowspan="6">once per field day,
take readings twice for replicate at the last station sampled

calibration per SOPs</td></tr>
<tr><td>sample depth</td><td rowspan="4">every station:
if station depth < 1.5 m, mid-depth;
if station depth > 1.5 m & < 10 m, 0.5 m below surface and 0.5 m above bottom;
if station depth > 10 m, 0.5 m below surface, 0.5 m above bottom, and mid-depth</td></tr>
<tr><td>temperature</td></tr>
<tr><td>salinity</td></tr>
<tr><td>dissolved oxygen</td></tr>
<tr><td>turbidity</td><td rowspan="2">every station , 0.5 m below surface

once per sampling event from bucket at reference station</td></tr>
<tr><td>chlorophyll a</td><td>take readings twice for replicate at the last station sampled
calibration per SOPs

collect filter and sonde readings at reference station</td></tr>
</table>

Stations are representative, defined clearly in respective SOPs

Assessment Type: Qualitative Macrophyte Surveys.

Indicators	Number of sample locations	Frequency, duration, special conditions	Field survey QC
GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	Every station	Sample 3 days during the 3-week period starting July 15 and ending August 7. Try to sample once per week. If this is not possible, sample such that you maximize the days between sampling. All three days cannot be sampled in the same 7-day window. 2 sampling events or an event outside this time criteria may be accepted in unforeseeable circumstances. Consultation with Monitoring Program Coordinator and UWS Science Advisor is necessary for this decision. See UWS SOP Macrophytes for additional details.	repeat readings every time a station is sampled. coordinates indicating a 100 m or greater discrepancy will be assessed and documented in final report reference land site, once per sampling event
Macrophyte Abundance			Photos and assessment (none, some, lots) of each sample are reviewed by the Monitoring Program Coordinator and UWS Science Advisor

Stations are targeted, defined clearly in SOP

Assessment Type: Tier II nutrients Stations.

Indicators	Number of sample locations	Frequency, duration, special conditions	Field survey QC
GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	Every station	Each visit to sample station; at least monthly (May – October), with 14 days separation	Repeat readings every time the station is sampled to verify coordinates. Coordinates indicating a 100 m or greater discrepancy from documented coordinates will be assessed and documented in data notes.
Salinity	Every station	Each visit to sample station; at least monthly (May – October), with 14 days separation	Probe calibration prior to survey; post sampling event readings in standard
Nutrients	Every station	Each visit to sample station; at least monthly (May – October), with 14 days separation	At minimum one field replicate per sampling event

Station are representative.

Assessment Type: Data logging stations.

Indicators	Number of sample locations	Frequency, duration, special conditions	Field survey QC
GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	Every station	Each visit to sample station	Repeat readings every time the station is sampled to verify coordinates . Coordinates indicating a 100 m or greater discrepancy from documented coordinates will be assessed and documented in data notes.
Conductivity	Every station	Each visit to sample station	Probe calibration prior to survey; post sampling event readings in standard
Dissolved oxygen	Every station	Each visit to sample station	Probe calibration prior to survey; post sampling event readings in standard
Barometric pressure	Every station	Each visit to sample station	Not applicable

Stations are selected for access and other considerations addressed in this QAPP and UWS Data Logging SOP.

Assessment Type: Quantitative Macrophyte Surveys.

Indicators	Number of sample locations	Frequency, duration, special conditions	Field survey QC
GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	Every station	Each visit to sample station while conducting all camera descents to bottom. Obtained from GPS track	Not applicable
Bottom coverage (% macroalgae, % bare, % eelgrass)	Every station	Each visit to sample station with specifications in SOP on image count and analysis	Not applicable

B.2. Sampling Methods

Pre-coordination shall occur with the external lab to ensure that sample collection procedures meet lab needs. The project lab for this study is below:

> Interstate Environmental Commission Lab, contact: Evelyn Powers, epowers@iec-nynjct.org, 718-982-3792, c/o College of Staten Island-CUNY, 2800 Victory Blvd., Building 6S, Room 106, Staten Island, NY 10314

A laboratory of equal or higher certification than Interstate Environmental Commission can be considered if Interstate Environmental Commission is unable to complete project analyses. This surrogate laboratory must adhere to analytical methods in Table 10.

To comply with UWS program guidelines, all sample collections for this project shall follow detailed methods on how samples will be collected and preserved as stated in the standard operating procedures (SOPs) contained in Appendix A of this document. The lab has reviewed the UWS SOPs and confirms they are appropriate for the select analyses.

A summary overview of sample collection methods is provided in Table 8. A summary of field sampling considerations is provided in Table 9.

Any filters or nutrient sample bottles collected for analysis will be stored in a cooler, on ice during the sampling trip. The cooler designated for these samples will not be used for the storage of macrophytes.

All deviations from the Standard Operating Procedures of this QAPP will be documented and subsequently reviewed by the Monitoring Program Coordinator and the project UWS Science Advisors. This information will be available to all signatories at the completion of this project at which time acceptability of data will be determined.

Table 8: Overview of Sample Collection Methods
Assessment Type: Tier I water quality Parameters **(NA = not applicable)**

Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity per Sample Depth (unless otherwise noted)	Sample Preservation	Maximum Holding Time
GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	*in situ*	1 / station	transfer to digital format, maintain back-up copies of digital data	NA
Station depth	*in situ*	1 / station	transfer to digital format, maintain back-up copies of digital data	NA
Sample depth (metered line)	*in situ*	1, and for remainder of the sampling event if the intercomparison with project sonde and line is > 0.3 m	transfer to digital format, maintain back-up copies of digital data	NA
Multiparameter sonde: • depth • temperature • salinity • dissolved oxygen • turbidity • chlorophyll a	*in situ*	1 / sample depth and a second reading for each depth at the last station of the day	transfer to digital format, maintain back-up copies of digital data	NA
chlorophyll a (extracted, fluorometric analysis)	*Large bucket rinsed three times with surface water. Bucket volume must accommodate sonde for reading in situ*	Filtered sample volume must be sufficient to provide "color" on the filter pad; 10 mL to 180 mL. 2 filters collected and one sonde reading from bucket per sampling event	GF/F filter is blown dry with a 60mL syringe and stored in the dark (foil wrapped), on ice; transferred to -20°C freezer within 12 hours	28 days

Assessment Type: Qualitative Macrophyte Abundance **(NA = not applicable)**

Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation	Maximum Holding Time
GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	*in situ*	1 / station	transfer to digital format, maintain back-up copies of digital data	NA
Macrophyte abundance	digital photos	1 / sample (a sample is a single rake toss or required distance for soft shoreline photo)	transfer to a computer, upload to online datasheet	NA

Assessment Type: Tier II nutrients Parameters **(NA = not applicable)**

Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation	Maximum Holding Time
GPS: latitude & longitude in decimal degrees; NAD83 coordinate system or record system used	*in situ*	NA	transfer to digital format; maintain back-up copies of digital data	NA
Multiparameter sonde: • Salinity	*in situ*	NA	transfer to digital format; maintain back-up copies of digital data	NA
Inorganic nutrients	high density polyethylene (HDPE) polypropylene (new containers washed with ASTM Type 1 Ultrapure Water, used containers pre-acid-washed with 10% hydrochloric acid)	120 mL per station	ice or refrigerate filtered water samples at a temperature of <4 C while in the field, store at <-20 C	holding time of ~1 year once frozen
Total nutrients	high density polyethylene (HDPE) polypropylene (new containers washed with ASTM Type 1 Ultrapure Water, used containers pre-acid-washed with 10% hydrochloric acid)	120 mL per station	ice or refrigerate water samples at a temperature of <4 C while in the field, freeze at <-20 C	holding time of ~1 year once frozen

Assessment Type: Quantitative Macrophyte Abundance

Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation	Maximum Holding Time
Macrophyte abundance (% bare, % macroalgae, % eelgrass)	Field data sheets and computer storage	20 still images per station; more if heterogeneity is observed. Detailed procedure in SOP	maintain back-up copies of digital data	NA

Table 9: Overview of Field Sampling Considerations

Sample Type	Parameter(s)	Sampling Considerations
In-situ sampling	Station depth	Note the tidal stage and time of day. Depth varies greatly over the tidal cycle.
In-situ sampling, GPS	GPS: latitude & longitude in decimal degrees; NAD83 or WGS84 coordinate system, record system used	NAD83 or WGS84 coordinate system, record system used; check GPS accuracy relative to a known, fixed location
in-situ Tier I water quality sampling, multiparameter sonde	Depth Temperature Salinity Dissolved oxygen Turbidity Chlorophyll a fluorescence	Sample within 3 hours of sunrise. Inspection, maintenance, pre-calibration and post-checking of probes and instruments are critical to achieving accurate and precise measurements.
Data logging stations	Dissolved Oxygen, Conductivity (Salinity), Barometric Pressure	Inspection, maintenance as specified by manufacturer, and calibration of instruments are critical to achieving accurate and precise measurements, especially for DO. Loggers are rinsed and cleaned with freshwater after each retrieval and use.
Grab samples - i.e. collection of a water sample	Chlorophyll a	Keep careful and accurate track of volume of water passed through each filter pad, quantitation is impossible without this value.
Qualitative macrophyte abundance	Macrophyte abundance	Be sure to photograph all sites and samples. Record identifier for each photo on the datasheet.
Quantitative macrophyte abundance	Macrophyte abundance	Maintain low speed to minimize potential damage to camera. Monitoring Group Lead and two additional members of the sampling team, under Monitoring Group Lead supervision, will analyze the macrophyte videos as described in SOP

Sample Type	Parameter(s)	Sampling Considerations
Grab samples - i.e. collection of a water sample in bottle	Inorganic and total nutrients	Triple-rinse sample container in ambient water immediately prior to sample collection. Care must be taken to avoid contact between fingers and inside surfaces of containers, including bottle caps. New, pre-washed bottles preferred; if not, containers for nutrient samples should be acid-washed and rinsed with deionized water. This process is overseen by the Monitoring Coordinator. These bottles will be obtained by appropriate suppliers such as Fischer Scientific. Field filtration preferred for dissolved fractions. If filtering water, triple-rinse container with *filtered* water immediately prior to sample collection, not ambient water.

B.3. SAMPLE HANDLING AND CUSTODY

Sample handling and labeling procedures shall comply with project Standard Operating Procedures (SOPs). Chlorophyll a filters and nutrient samples will be transported on ice in a cooler to the freezer on the same day as sampling occurs. Filters and nutrient samples will always be transported on ice with no more than 24 hours out of freezer to avoid thawing.

Sample labels will be associated with: station name, date, time, volume filtered, sample id, type of sample, and organization name. These details may be written on the label. Information will also be filled in the field data sheet.

Chain of Custody shall be tracked as detailed in the SOPs. The project Chain of Custody forms are provided in in Appendix B.

The following steps shall be taken to avoid sample mislabeling:

Labels will be prepared in advance and cross checked with the field datasheet before sampling event. Field team will check data sheet versus sample filter labels before storing in the cooler for transport to a freezer. A white board with name of the embayment, site and station id, and date will be filmed prior to recording every station in the macrophyte video surveys.

B.4. ANALYTICAL METHODS

To comply with the requirements of the UWS Program, all analytical methods used in the Monitoring Program, including methods used by laboratories performing analyses for the project, shall be based on standardized laboratory methods.

All analytical methods used for this project are provided in Appendix C.

Table 10 provides an overview of the analytical methods utilized in this Monitoring Program. The SOPs associated with these methods are included in Appendix C.

Table 10: Overview of Analytical Methods.

Parameter	Method #	Source of Method	MDL	Alternative Applications Special Provisions
Chlorophyll a	EPA 445.0	EPA	0.7 µg/l	
Nitrite	EPA 353.2	EPA	0.004 mg/l	
Nitrate+Nitrite	EPA 353.2	EPA	0.004 mg/l	
Ammonia	EPA 350.1	EPA	0.020 mg/l	
Total Dissolved Nitrogen	EPA 353.2	EPA	0.05 mg/l	
Orthophosphate (DIP)	EPA 365.1	EPA	0.001 mg/l	
Total Nitrogen	EPA 353.2	EPA	0.05 mg/l	
Total Phosphorous	EPA 365.1	EPA	0.334 mg/L	

B.5. QUALITY CONTROL

Lab Quality Control (QC) protocols shall be discussed with the external lab facility or contractor analyzing chlorophyll a and nutrient samples prior to sampling to ensure acceptability.

Quality control shall be discussed and defined prior to sampling (e.g., during training).

Details on quality control procedures are provided in Table 11.

Table 11: Quality Control Measures

Note that 5% of field samples equates to one station per field day sampled as replicate.

Sample Type	Instrument/ Parameter	Accuracy Checks	Precision Checks	% Field QC Samples (blanks and field duplicates)
GPS coordinates	GPS or Smart Phone app / GPS coordinates	Compare location of reference site to Google Earth coordinates	Readings at a land-based reference point and duplicate readings at one station	1 / field day
Station depth	metered line / depth	re-measure line	replicate readings at one station	5%

Sample Type	Instrument/ Parameter	Accuracy Checks	Precision Checks	% Field QC Samples (blanks and field duplicates)
Multiparameter sonde and data loggers	Depth, temperature, conductivity, dissolved oxygen, turbidity, chlorophyll a	Pre-survey calibration and post-survey checks, including "zero" DO standard check	field duplicates or 3-5 minutes stable readings recorded	5% or verify repeatability in the field
Water samples - grab	Fluorometric determination of extracted chlorophyll a	Acetone blank, standard	QC check for multiparameter sonde	100%
Qualitative Macrophyte abundance	Observation / macrophyte abundance	Photos of all assessments	Photos of all assessments	100% photos are required for inclusion of the data in the UWS
Water samples – grab	TP, P fractions TN, N fractions	Field: blanks Lab: analysis of lab-fortified matrix (spiked samples) and/or lab QC standard	Field duplicates Lab duplicates	Minimum 5%
Quantitative Macrophyte abundance	% coverage bare, macrophytes, and animals of bottom	Still images of all assessments	Still images of all assessments	100% still images are required for inclusion of the data in the UWS

B.6. Instrument / Equipment Testing, Inspection and Maintenance

Maintenance of instruments and equipment shall occur as needed during the field season. Annual maintenance and intercalibration assurance will be conducted by Save the Sound.

Records of equipment inspection, maintenance, repair and replacement shall be kept in a logbook. A backup of the logbook will be kept in a separate location. If the logbook is digital, appropriate backups of the computer files will be maintained by Monitoring Program Coordinator.

Table 12: Instrument / Equipment Inspection and Testing Procedures

Equipment Type	Inspection Frequency	Type Inspection	Maintenance, Corrective Action
GPS unit	before each sampling date	battery life	charge batteries

Equipment Type	Inspection Frequency	Type Inspection	Maintenance, Corrective Action
Depth line	Annually, or when a potential problem is noted	Check the calibrated line against a meter tape	Wipe tape after each use, if line has stretched or is damaged, replace immediately and note recent data as questionable
Multiparameter sonde	Before each sampling date	Battery life, electrical connections, sensor condition	Charge batteries, spare sensors as appropriate, batteries
Filtering apparatus (chlorophyll a)	Before each use	Proper functioning, clean storage	Spare filters and syringe
Collection rake, rope	Before each collection	Visually for integrity	Repair, replace keep spares on hand
Filtering apparatus (nutrients)	Before each use	Poper functioning, clean storage	Spare syringe, spare filters, spare pump tubing
Logging sensors	Every 7-10 days or as needed	Biofouling and battery check	Clean off fouling organisms, check battery life from data log
Underwater camera and equipment	Before each use	Battery life, test video	Recharge/replace batteries and clean lens if required

B.7. Instrument / Equipment Calibration and Frequency

Calibration shall occur within a day prior to a sampling trip.

Records of calibration shall be kept in a logbook (hard copy or digital, with back-ups). Calibration records shall be maintained for a minimum of four years, ideally longer. Monitoring Groups will deliver calibration records to the Monitoring Program Coordinator. These records and digital backups will be saved on Save the Sound's S-Drive for duration of the project.

A summary of calibration procedures for instruments and equipment is provided in Table 13.

Detailed calibration procedures are described in SOPs contained in Appendices A.

Table 13: Instrument / Equipment Calibration Procedures

Instrument	Inspection and Calibration Frequency	Standard of Calibration Instrument Used	Calibration Acceptance Criteria	Corrective Action
Calibrated lines (for depth)	Annually	Tape measure	Within 0.1 m of tape measure	Recalibrate or replace with calibrated line
Multiparameter sonde	Before each sampling run	Standard solutions	According to manufacturer's instruction or when not provided a maximum difference of %10 of the calibration standard value	According to UWS and manufacturer's instruction

Instrument	Inspection and Calibration Frequency	Standard of Calibration Instrument Used	Calibration Acceptance Criteria	Corrective Action
Logging sensors	Before and after deployment	Standard solutions, according to manufacturer's recommendations	According to manufacturer's instruction or when not provided a maximum difference of %10 of the calibration standard value	According to UWS and manufacturer's instruction

B.8. Inspection / Acceptance of Supplies and Consumables

The procedures for inspection and acceptance of supplies and consumables listed in Table 14 shall be followed by the Monitoring Groups.

Table 14: Supplies Inspection and Acceptance Procedures

Supplies	Inspection Frequency	Type of Inspection	Available Parts	Maintenance
Calibration standards	Before each sampling date	Visual inspection of quantity and expiration date	Spare, fresh solutions	Storage according to manufacturer's recommendations, annual replacement at beginning of sampling season
Sonde sensors, filters	Before each sampling date	Visual inspection of quantity, integrity	Spares	Storage according to manufacturer's recommendations
Field and lab sample sheets	Before each sampling date	Visual	Additional copies	
Cooler	Before each sampling date	Cleanness, ice packs		Annually or as needed
Sample bottles	Before each sampling date	Integrity, cleanness and seal for nutrient bottles, verified sterility of bacterial sample bottles	One set of spare bottles	Clean after use (note that nutrient bottles require acid washing before reuse)

B.9. Non-direct Measurements

To provide high-quality data to enhance the interpretation of data collected as part of this Monitoring Program, data may be acquired from qualified sources approved by Monitoring Program Coordinator. NOAA tide gauges will be used for tide information. Precipitation will be acquired from local weather stations that log reasonable (in respect to northeastern USA conditions) volumes. Precipitation data out of the expected annual volumes and the observed conditions will be flagged and discussed with Monitoring Program Coordinator and shared with quality assurance personnel for review and potential disqualification. External data sources are described in Table 15.

Table 15: Non-Project Data Validity

The following data will be used as part of the Monitoring Program. This is a secondary use of data.

Title or descriptive name of data document.	Source of data.	QAPP written? Y/N	Notes on quality of data.	Planned restrictions in use of the data due to questions about data quality.
Time of low and high tide	NOAA tide gauges recorded on field data sheet	N	NOAA has internal requirements for data suitability.. High and low tide data are not generally available at the embayment. Data from NOAA tide gauges are acceptable; data are used in broad scale, to determine the potential impact of stage in tidal cycle on the day of sampling.	Data quality is acceptable. However, local tidal stage will differ from the nearest NOAA gauge even when corrected for difference in location. These data are rough predictors only.
High and low temperature and precipitation within the 24 hours prior to the field trip	Local weather station recorded on field data sheet	N	Air temperature within the last 24 hours are not generally available at the embayment. Data from nearby weather stations are acceptable; data are used in broad scale, to determine the potential impact of weather on the day of sampling.	Data will be used in comparing among embayments or among dates, as a general indication of weather during the day prior to sampling.

B.10. Data Management

Field teams shall record data on field sheets, review them, and turn over to respective Monitoring Group Lead or designated appointee.

Monitoring Group Leads or designated appointees shall review sheets and confer with field teams on any needed corrective action.

The designated person shall fill out the chain-of-custody form for forwarding samples to the external laboratory. Each person who handles or transports samples shall also sign the custody form upon receipt of the samples. Chain of custody forms will follow samples to the lab and back to Monitoring Program Lab Coordinator by mail or pickup after each analysis run is completed. Alternatively, scanned copies may be emailed or faxed. These copies will be sent to Monitoring Group Leads or designated appointees.

Once laboratory analyses are complete, the laboratory personnel shall deliver (digital or hard copy) lab results to the Monitoring Program Lab Coordinator or arrange for pickup. These results will be sent to all Monitoring Group Leads or designated appointees.

The Monitoring Group Lead or other trained designee will enter raw field and lab data into the project computer system.

Computer-entered data shall be compared with field sheets for accuracy.

Original data sheets will be stored by the Monitoring Group Leads or designated appointees, following data entry into the UWS data entry template.

Digital back-ups and copies of the non-digitized data will be made and stored in a separate location designated by the Monitoring Group Lead or designated appointees and delivered to the Monitoring Program Coordinator.

Documentation of data recording and handling, including all problems and corrective actions, shall be included in all preliminary and final reports.

Table 16 in this document accurately represents the procedures utilized by the UWS for data management, review, validation, and verification.

Table 16: Data Management, Review, Validation, Verification Process Summary
The term "Field sampler" refers to the person conducting the sampling in the field.

Activity	By whom	Corrective action, if needed
Conduct field audits of Monitoring Groups performing calibrations and demonstrating field procedures.	Monitoring Program Field Coordinator or appointed designee	Correct any discrepancies with this QAPP or SOPs
Check labels just prior to sampling, to ensure correct labeling of container.	Field sampler	Correct label
At time of sampling, record data, sign field sheets.	Field sampler	Remind samplers of proper procedures; retrain if needed.
Fill out, sign chain of custody (COC) forms for any samples going to lab.	Field sampler or designated person	Remind person of proper procedures; retrain if needed.
Before turning field sheets over to Monitoring Group Lead or designated appointee, check for reasonableness to expected range, completeness.	Field sampler	Resample if feasible; otherwise, flag suspect data.
Upon receipt of field sheets, recheck for reasonableness to expected range, completeness, accuracy, and legibility.	Monitoring Group Lead or designated appointee	Confer with field sampler(s) immediately or within 24 hours. Resample if feasible; otherwise, flag suspect data.
Upon receipt of samples, field sheets and COC forms, check to see that sheets and forms correspond to number of samples, condition of samples as stated on COC forms. Sign COC forms. Copies of field sheets and COC forms are made, given to Monitoring Program Coordinator.	Monitoring Group Lead or designated appointee	Contact field samplers as needed to locate missing samples, data records. In case of missing/spoiled samples or data records, authorize resampling as needed and feasible. If resampling is not feasible, flag all suspect data.
Upon completion of laboratory analyses, fill out lab sheets, including data on QC tests.	External Lab	Re-analyze if possible. If not, confer with Monitoring Program Laboratory Coordinator. Flag all suspect data.
Upon receipt of lab data, review for completeness and legibility.	Monitoring Group Lead or designated appointee	Confer with Monitoring Program Laboratory Coordinator.

Activity	By whom	Corrective action, if needed
Upon completion of data entry, compare with field/lab sheets for accuracy.	Monitoring Group Lead or other volunteer. Data entry personnel may review their own work, but it cannot be on the same day as data entry.	Re-enter or correct data.
Translate data into preliminary data reports: run statistical analyses and/or prepare graphical summaries of data. Check for agreement with QC objectives for completeness.	Monitoring Program Coordinator	Confer with QA Officers and UWS Science Advisor(s). Flag or discard suspect data.
In-season (at least once) and end of season review of collected data sets (individual sample runs and season-total compilations); review for completeness and agreement with QC objectives and DQOs.	Monitoring Group Lead or designated appointee	Flag suspect data. Confer with Monitoring Program Quality Assurance Officer.

Data Management Systems – spreadsheets, databases, statistical or graphical software packages, location of data records (paper and electronic), are described here:

All data will be entered from field data sheets to an Excel spreadsheet for storage and retrieval by Monitoring Group Leads and appointed individuals. Digital copies of all datasheets will be kept on file on the S-Drive server in Save the Sound office for at least 4 years with a plan to keep records for duration of the project and beyond. The S-Drive is backed up weekly.

C. Assessment and Oversight

C.1. Assessment and Response Actions

The Monitoring Program Coordinator and UWS Science Advisors will identify and effectively address any issues that affect data quality, personal safety, and other important project components. The progress and quality of the monitoring program shall be assessed to ensure the objectives are being accomplished. The Monitoring Program Coordinator or appointed designees will check at the end of every month from May - October to confirm the following:

a. Monitoring is occurring as planned.
b. Sufficient written commentary and supporting photographs exist.
c. Sufficient field members are available for all sampling groups.
d. Samplers are collecting in accordance with project schedules.
e. Datasheets and custody control sheets are being properly completed and signed.

f. Retraining or other corrective action is implemented at the first hint of non-compliance with the QAPP or SOPs.
g. Labs are adhering to the requirements of this QAPP in terms of work performed, accuracy, acceptable holding times, timely and understandable results and delivery process.
h. Data management is being handled properly, i.e. data are entered on a timely basis, is properly backed up, is easily accessed, and raw data are properly stored in a safe place.
i. Procedure for developing and reporting the results exists.

Monitoring Groups will be assessed on their ability to follow UWS procedures during field audits overseen by the Monitoring Program Quality Assurance Officer and Field Coordinator. The Monitoring Program Field Coordinator or designee will observe each monitoring group undertaking calibrations and field procedures once in May-June and follow up calls with Monitoring Groups will be scheduled after initial field audits. Field procedures will be reviewed from a set location on the water that does not need to be a UWS monitoring station. A dock or boat in a slip will be appropriate for these field audits. The CTDEEP and NYSDEC representative on this QAPP distribution list will be provided dates for field audits being held in embayments within their respective management areas. CTDEEP and NYSDEC staff have the option to attend the field audits as observers. The Monitoring Program Quality Assurance Officer or designee will conduct a midseason check in call in August to all Monitoring Groups.

The Monitoring Program Coordinator shall confer with the UWS Science Advisors as necessary to discuss any problems that occur and what corrective actions are needed to maintain program integrity. In addition, the Monitoring Program Coordinator and UWS Science Advisors shall meet at the end of the sampling season, to review the draft report and discuss all aspects of the program and identify necessary program modifications for future sampling activities. All problems discovered and program modifications made shall be documented in the final version of the project report. If modifications require changes in the Quality Assurance Project Plan, these changes shall be submitted to the QAPP distribution list for review.

If data are found to be consistently outside the Data Quality Objectives as defined in section A.7. of this documents the Monitoring Program Coordinator shall review the program and correct problems as needed. Corrections may include retraining groups; rewriting sampling instructions; replacement of staff/Monitoring Group(s); alteration of sampling schedules, sites, stations or methods; or other actions deemed necessary. This information will be logged and maintained by the Monitoring Program Quality Assurance Officer. It will also be included in the QAPP Final Report.

C.2. Reports to Management

Data that have passed the project quality assurance may be posted on the organization's web site, shared with the local media or at other venues (e.g. kiosks at recreation access sites), and submitted to the Long Island Sound Study, New England Interstate Water Pollution Control

Commission, Interstate Environmental Commission, New York State Department of Environmental Conservation, New York City Department of Environmental Protection and/or Connecticut Department of Energy and Environmental Protection. A caveat will accompany these or any data released on a preliminary basis, explaining that they are for review purposes only and subject to correction after completion of a full data review occurring at the end of the sampling season.

The Monitoring Program Coordinator will write a final report. This will be sent to the distribution list on this QAPP. A final workbook of data from all embayments will accompany the report. The final report will also include (updated as necessary) any tables and graphs that were developed for initial data distribution efforts (i.e. the web site and media), and it will describe the program's goals, methods, quality control results, and recommendations. This report may also be used in public presentations.

All reports, preliminary or final, will include discussion of steps taken to assure data quality, findings on data quality, and decisions made on use, censorship, or flagging of questionable data. Any data that are censored in reports will be either referred to in this discussion, or presented but noted as censored.

In short, the final report will include:

- Raw data
- QC data
- Associated metadata
- Questionable data, flagged
- Identification of status as “preliminary” or “final” report

Table 17: Report Mechanisms, Responsibilities, and Distribution

Reporting Mechanism	Person Responsible for writing report	Distribution list
Monitoring Group Master Data Entry Template	Monitoring Group Lead or designated appointee	Monitoring Program Coordinator
Final Monitoring Report	Monitoring Program Coordinator	All signatories of this QAPP
Final Monitoring Data	Monitoring Program Coordinator	Signatories on this QAPP, EPA, NYS DEC, CTDEEP, NYCDEP, and other management groups

D. Data Validation and Usability

D.1. Data Review, Verification, and Validation

All project data, metadata, and quality control data shall be critically reviewed to look for problems that may compromise data usability.

Data collected before the 2018 season will be flagged as not being conducted under this QAPP when distributed. Save the Sound – Connecticut Fund for the Environment will be tasked with maintaining this QAPP in all aspects for the duration of the Unified Water Study.

The Monitoring Group Lead or designated appointee will review field data after each sampling run and take corrective actions as described in Table 16 of this document. At least once during the season, at the end of the season and if questions arise, the Monitoring Group Lead or designated appointee will share the data with the UWS Quality Assurance Officer to determine if the data appear to meet the objectives of the QAPP. Together, they will decide on any actions to take if problems are found.

D.2. Verification and Validation Methods

All project data and metadata are reviewed and approved as usable data, or as un-usable data.

Data verification and validation will occur as described in Table 16, and will include checks on:

- Completion of all fields on data sheets; missing data sheets

- Completeness of sampling runs (e.g. number of stations visited / samples taken vs. number proposed, were all parameters sampled / analyzed)
- Completeness of QC checks (e.g. number and type of QC checks performed vs. number or type proposed)
- Number of samples exceeding QC limits for accuracy and precision and how far limits were exceeded.

D.3. Reconciliation with User Requirements

At the conclusion of the sampling season, after all in-season quality control checks, assessment actions, validation and verification checks and corrective actions have been taken, the resulting data set will be compared with the program's data quality objectives (DQOs) as defined in section A.7. This review will include, for each parameter, calculation of the following:

- Completeness goals: overall % of samples passing QC tests vs. number proposed.
- Percent of samples exceeding accuracy and precision limits.
- Average departure from accuracy and precision targets.

After reviewing these calculations, and taking into consideration such factors as clusters of unacceptable data (e.g. whether certain parameters, stations, dates, monitoring groups, etc. produced poor results), the Monitoring Program Coordinator, Quality Assurance Officer, and respective Monitor Group Lead will evaluate overall program attainment of DQOs and determine what limitations to place on the use of the data, or if a revision of the DQOs is allowable.

E. Appendices

Appendix A. Standard Operation Procedures

Appendix B. Data Forms, Checklists, and Chain of Custody Forms

Appendix C. External Labs - Analytical Method

ATTACHMENT 4

Niantic River Estuary/Bay Monitoring Map

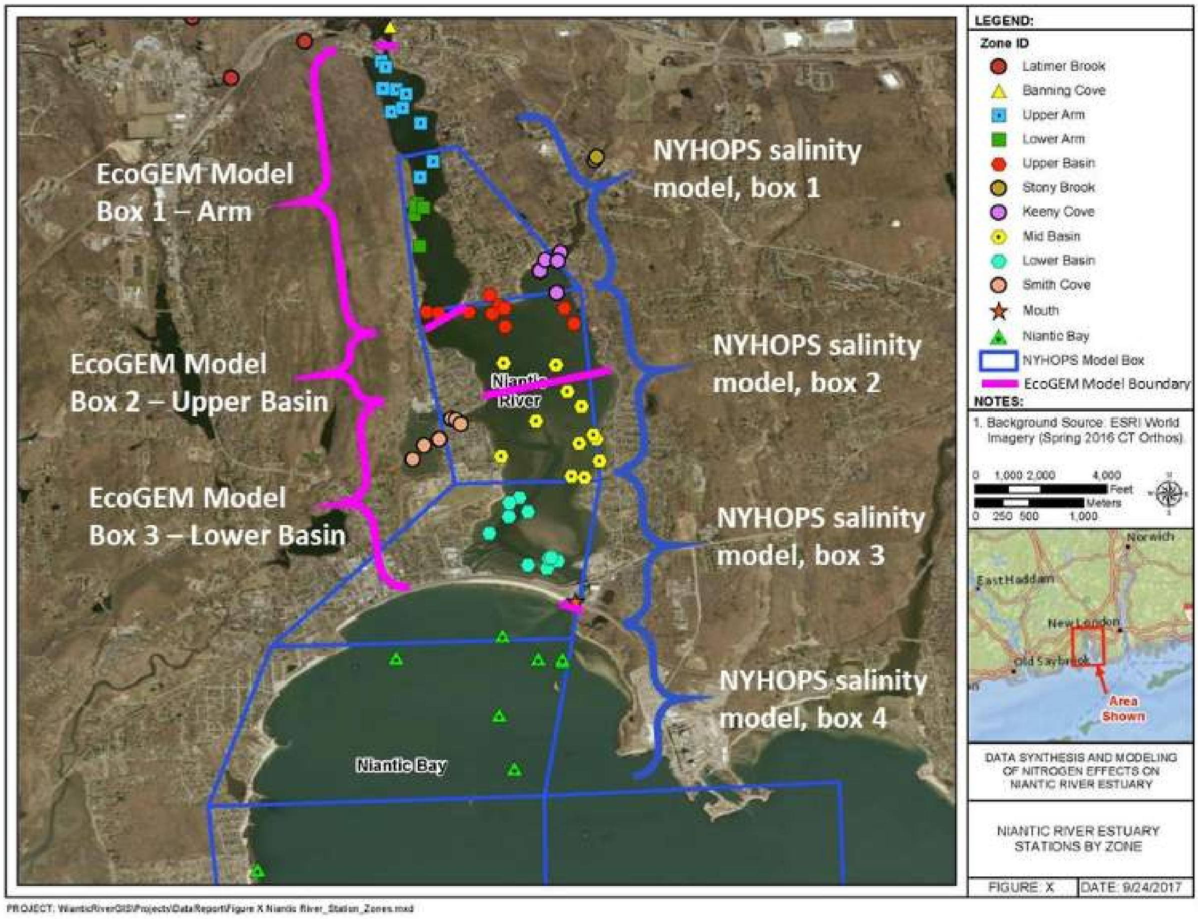
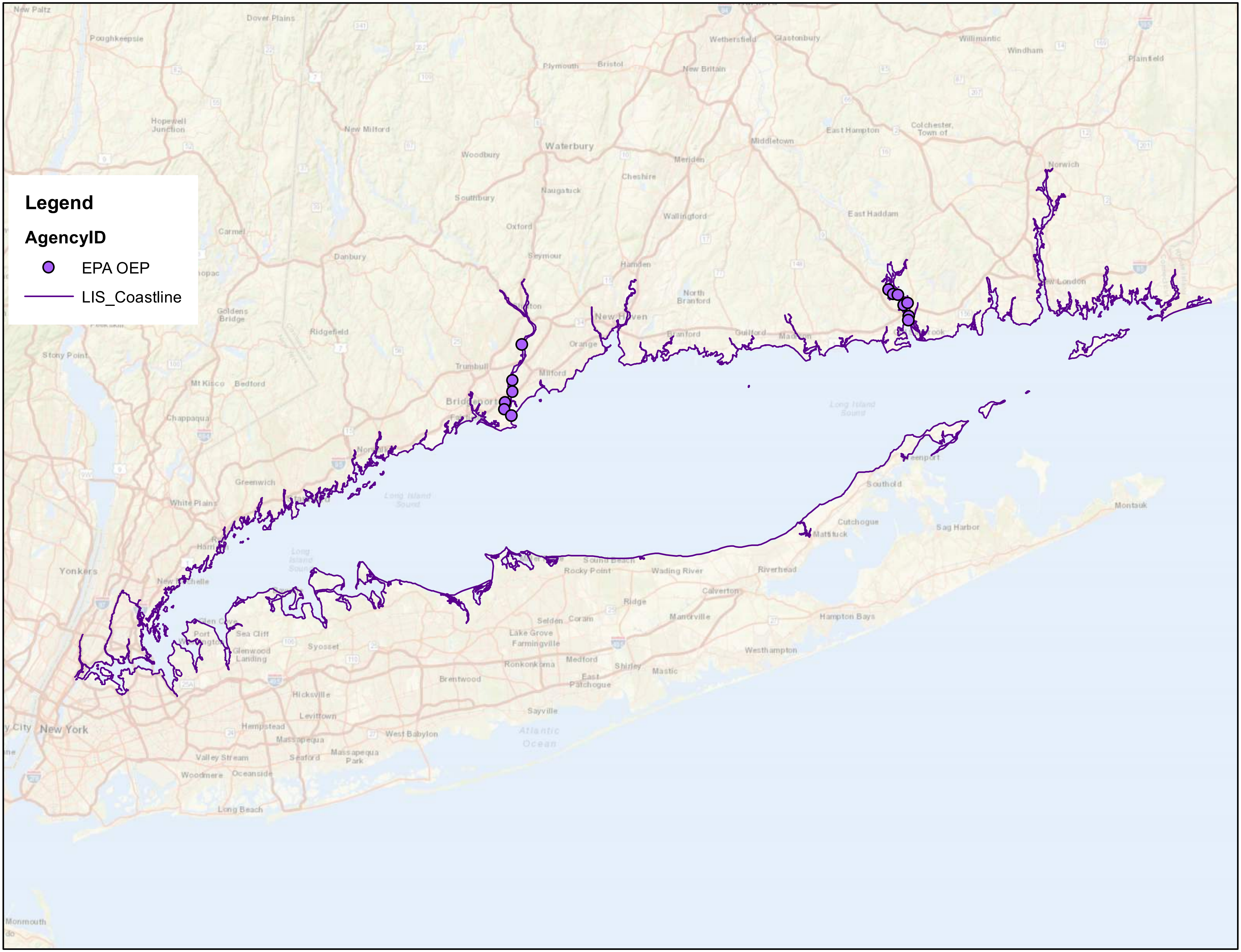
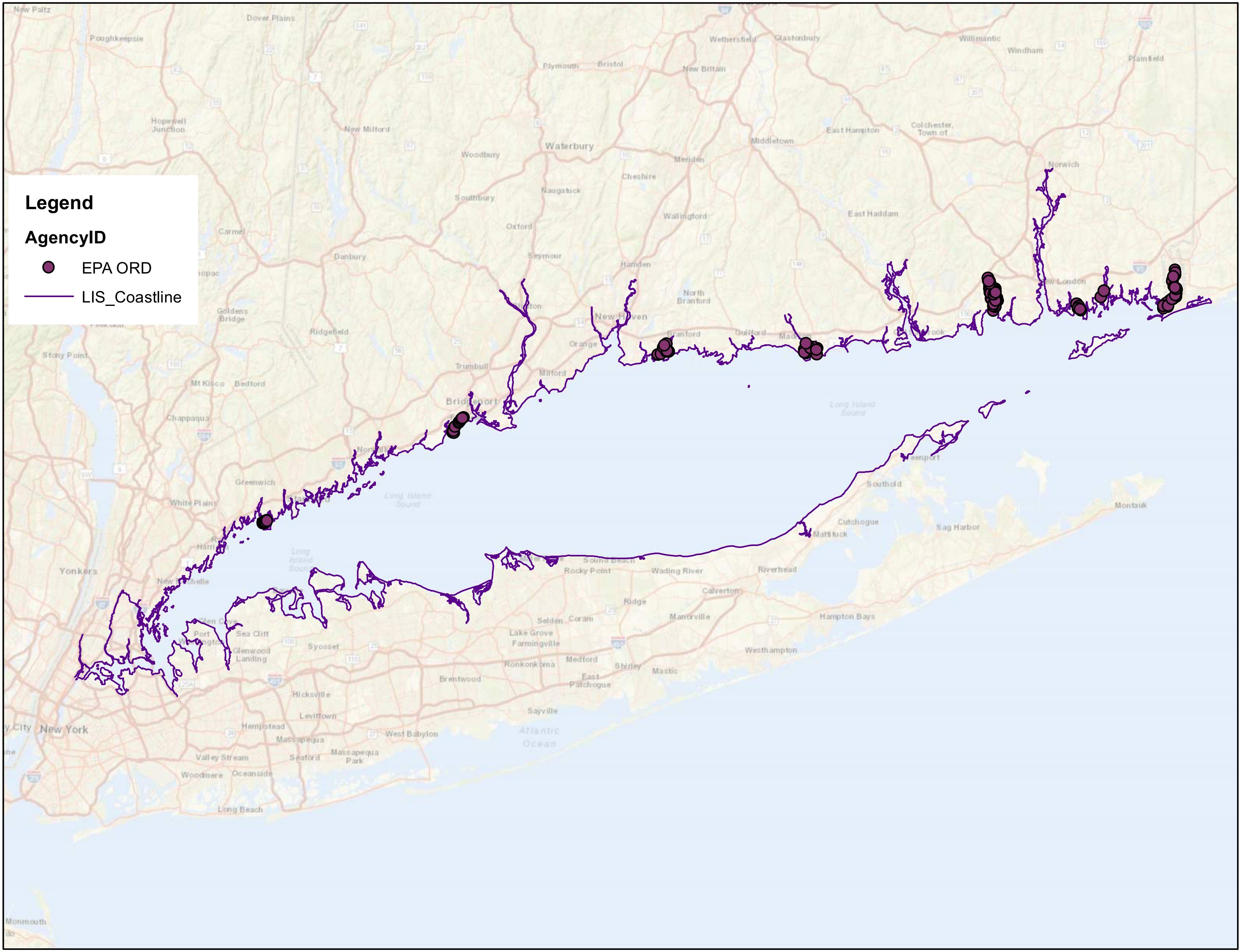


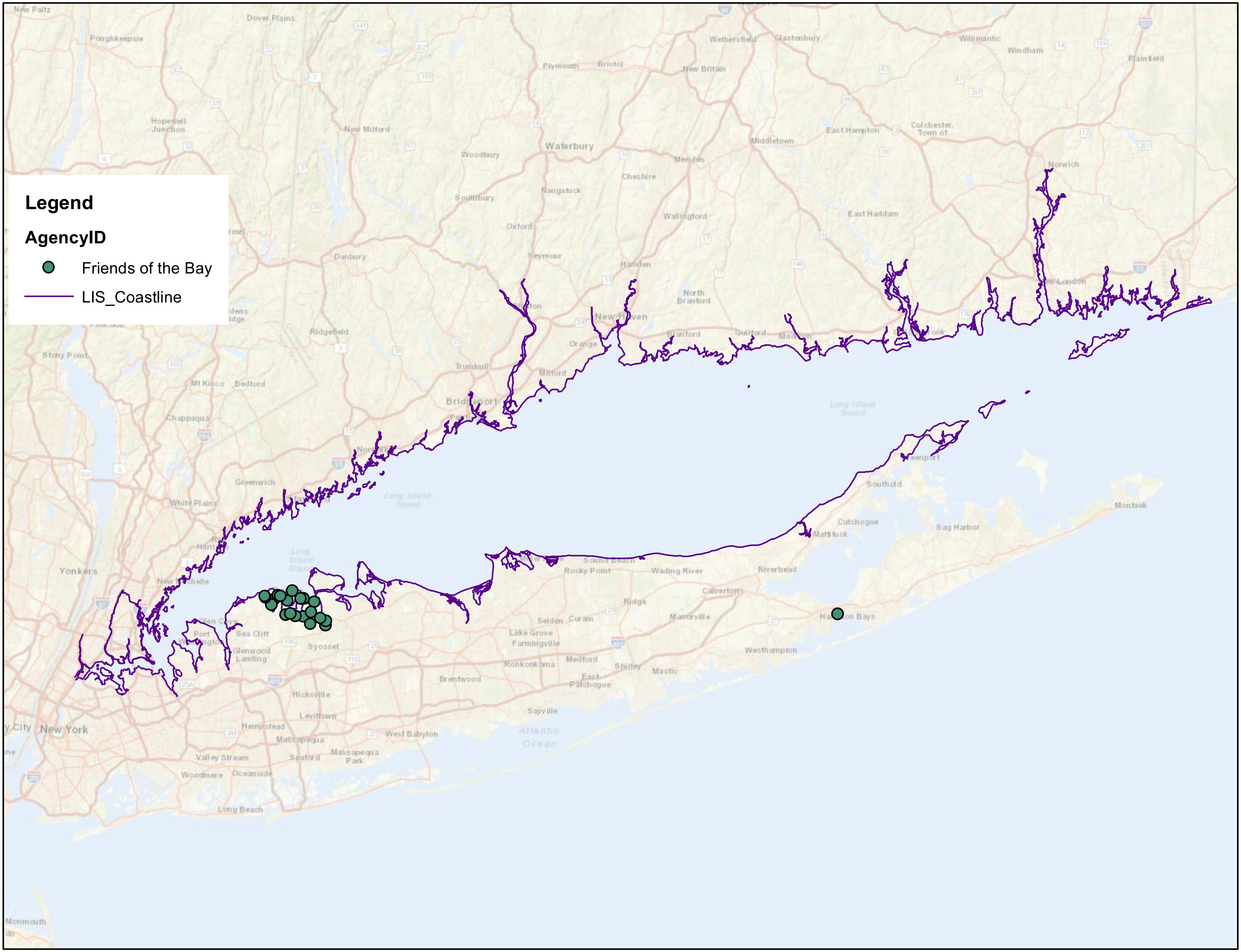
Figure 10: Station Locations and Grouping for Analysis in Niantic River and Niantic Bay.
The blue lines represent the boundaries of the NYHOPS model boxes, the source of salinity data for modeling the hydrodynamics for the ecological model. The bold pink lines indicate the boundaries of the ecological model. Stations within these boxes are used to compare the NYHOPS salinity to the field determined salinity and to determine is water quality parameters are similar enough within an ecological box to justify the demarcations.

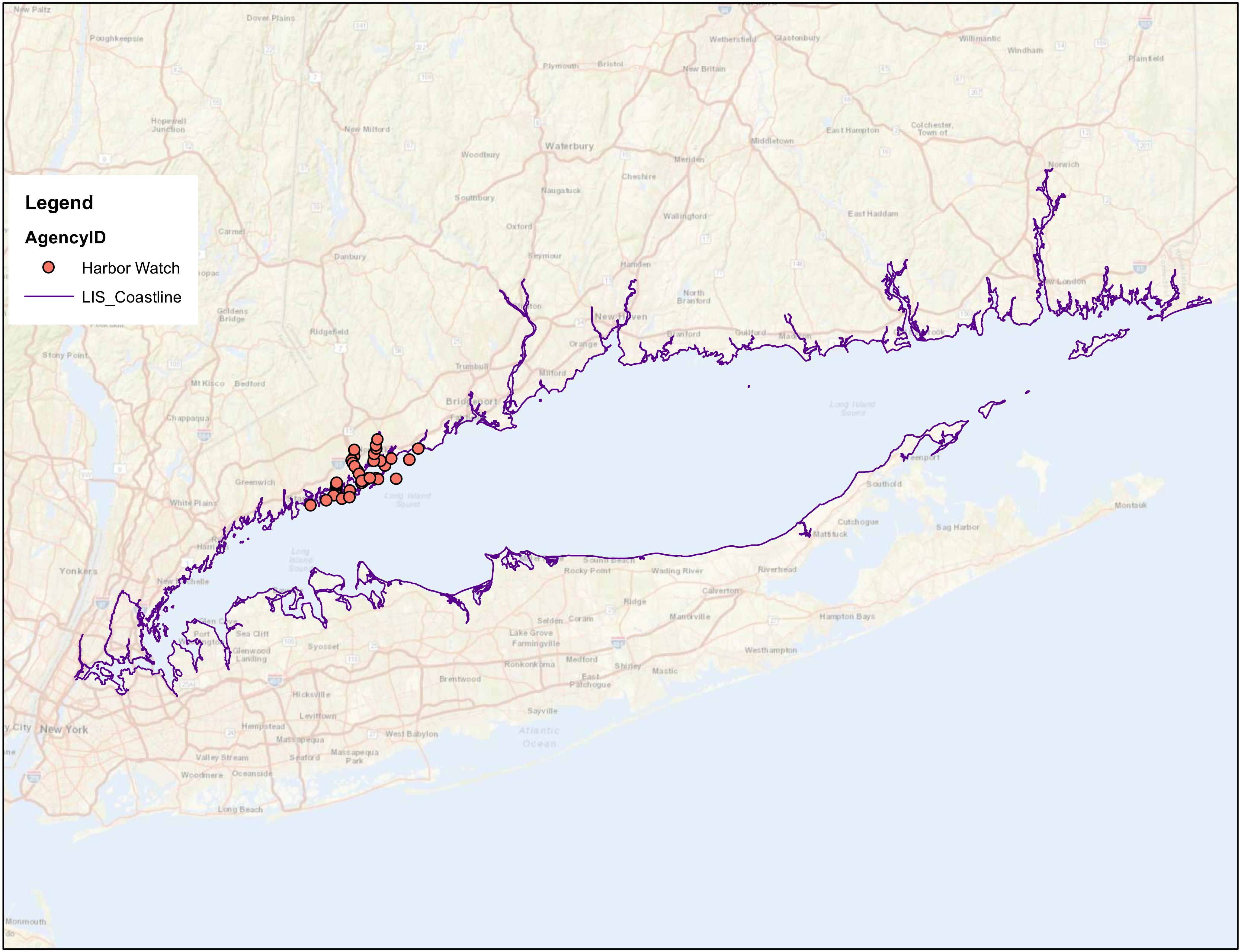
ATTACHMENT 5

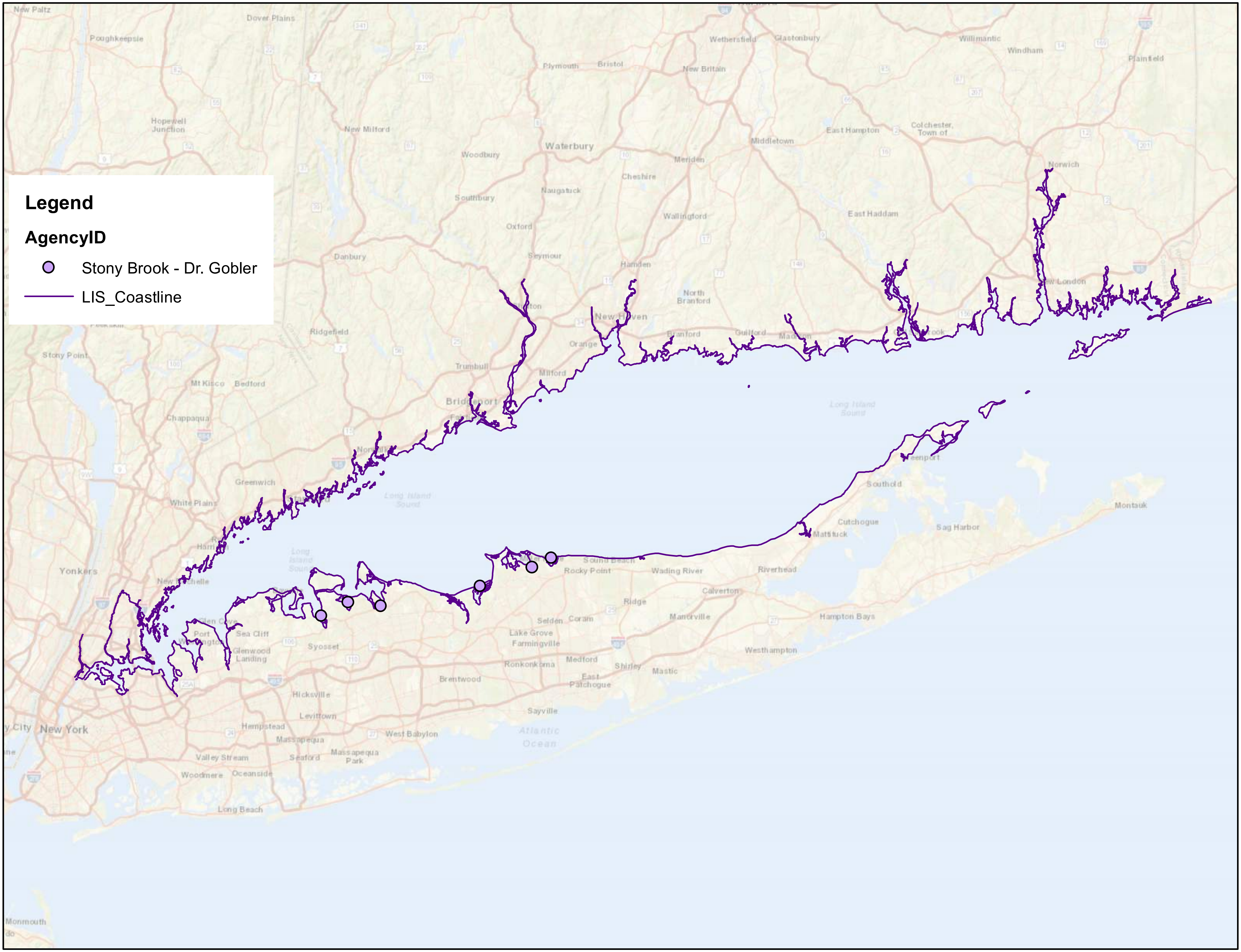
Embayment Monitoring Maps

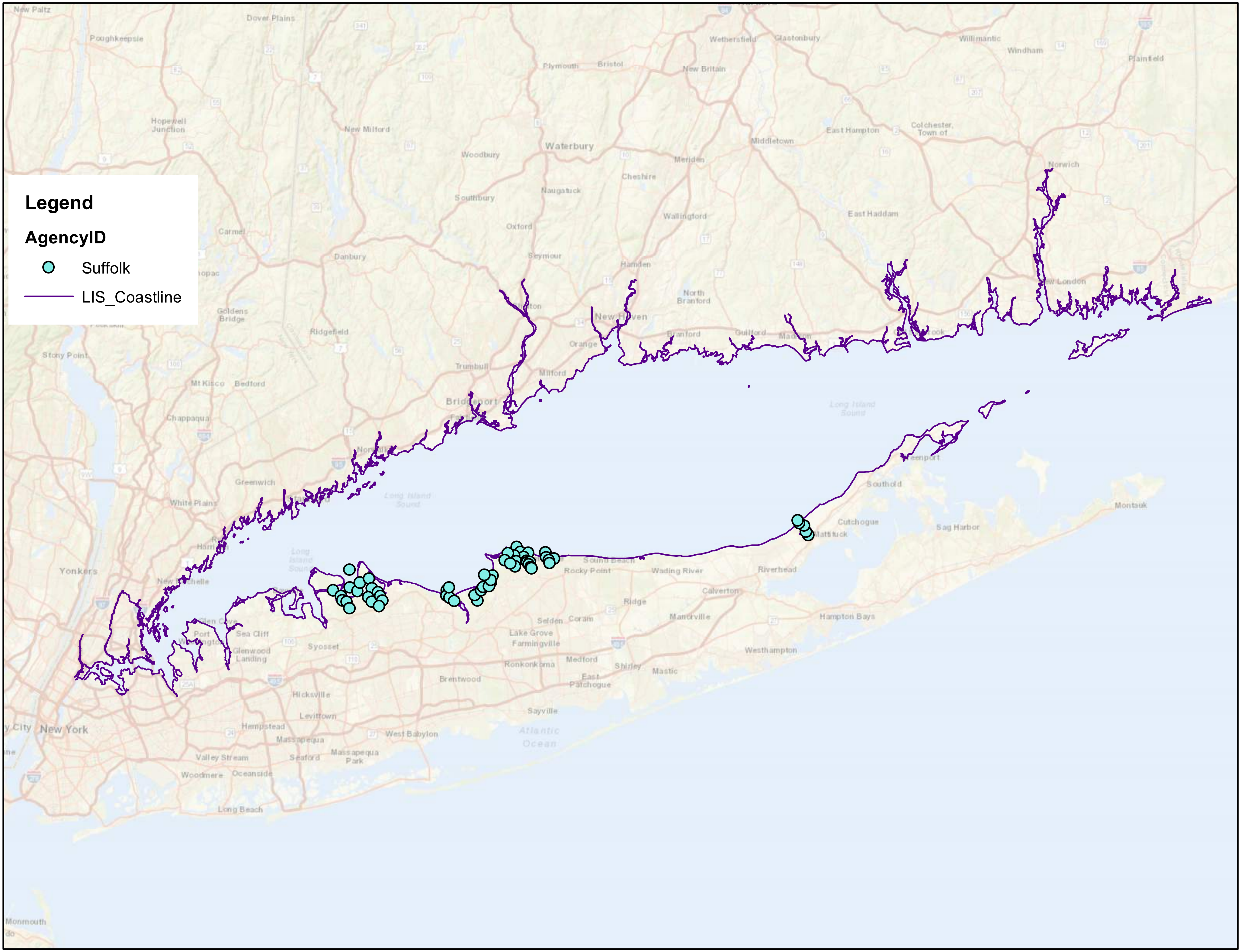

Legend
AgencyID
EPA OEP
LIS_Coastline

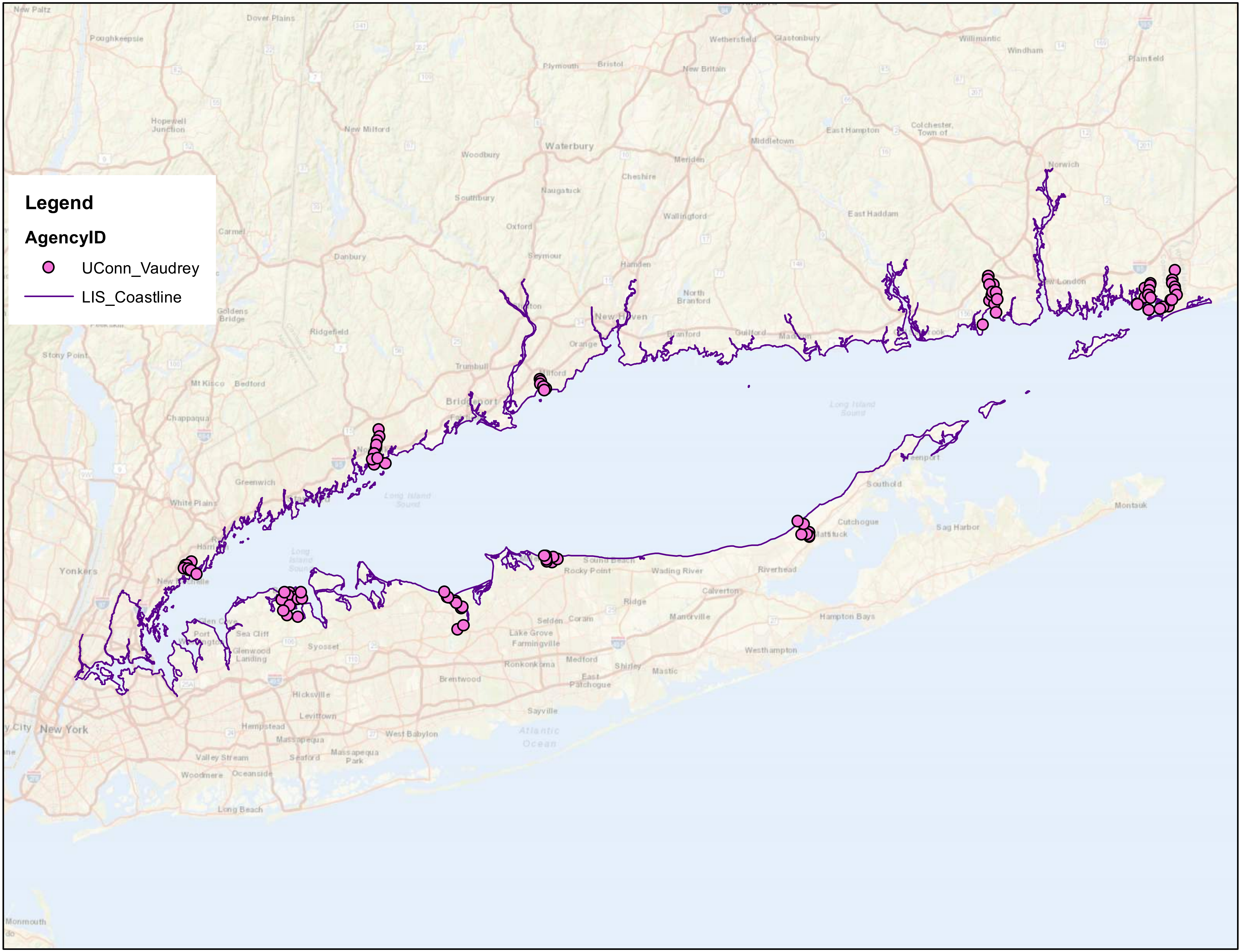

Legend
AgencyID
EPA ORD
LIS_Coastline

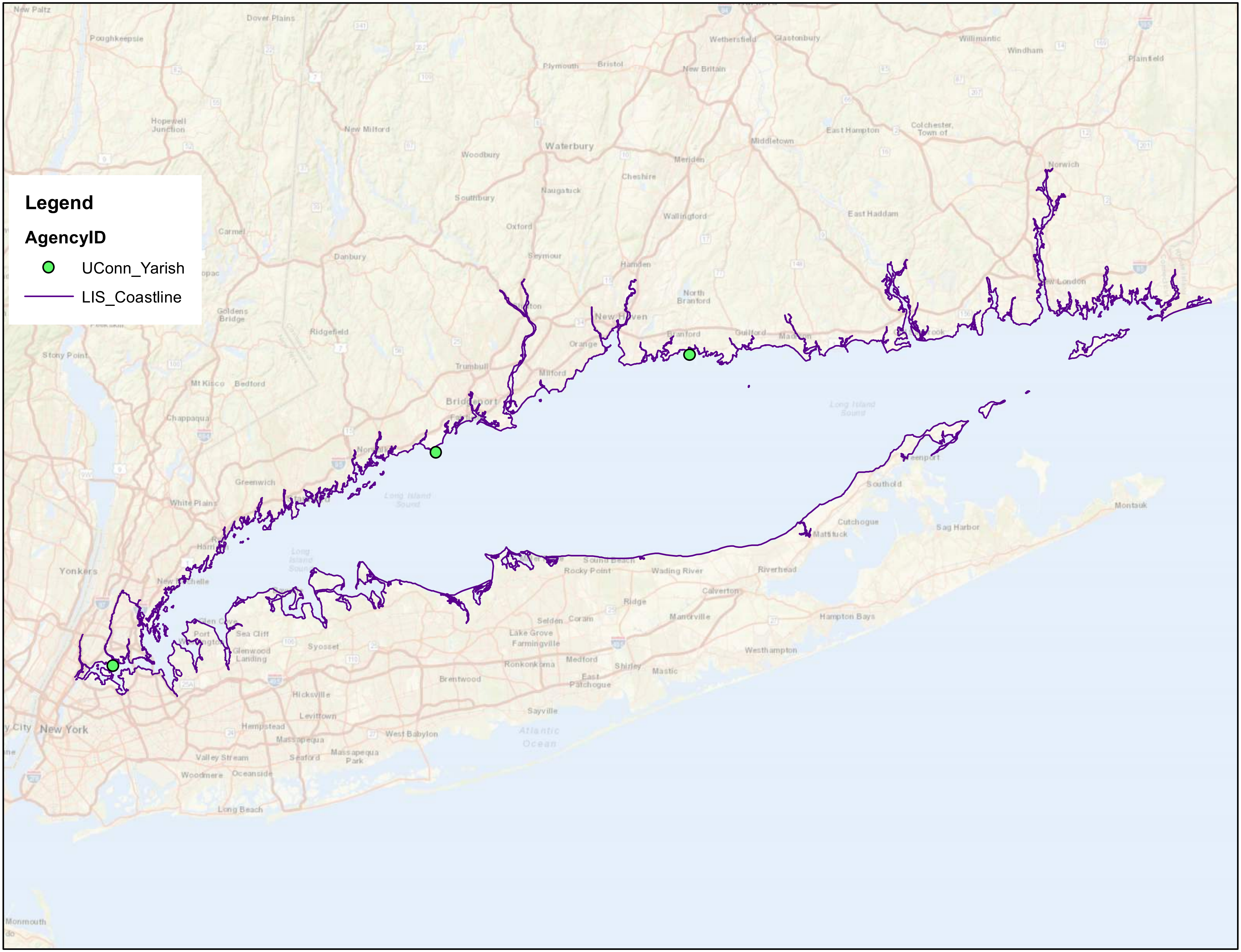

Legend
AgencyID
Friends of the Bay
LIS_Coastline

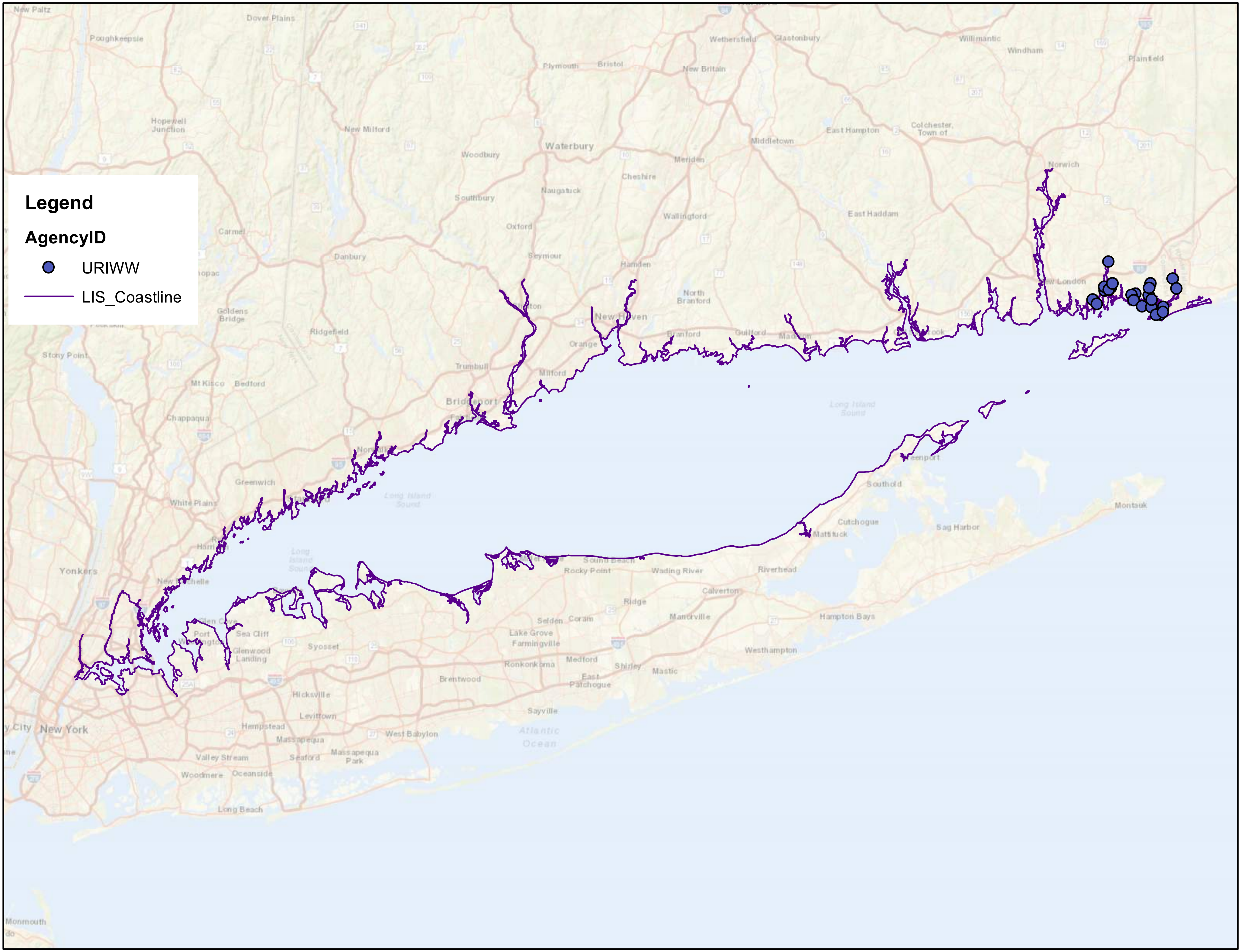

Legend
AgencyID
Harbor Watch
LIS_Coastline


Legend
AgencyID
Stony Brook - Dr. Gobler
LIS_Coastline


Legend
AgencyID
Suffolk
LIS_Coastline


Legend
AgencyID
UConn_Vaudrey
LIS_Coastline
Long Island Sound
Atlantic Ocean
New York
Yonkers
White Plains
Greenwich
Bridgeport
New Haven
Waterbury
Danbury
Middletown
Norwich
New London
Montauk
Riverhead
Southold
Sag Harbor
Hampton Bays
Westhampton
Brentwood
Hicksville
Hempstead
Long Beach


Legend
AgencyID
UConn_Yarish
LIS_Coastline


Legend
AgencyID
URIWW
LIS_Coastline