Summary of May 29, 2019
TAC and Monitoring Partners Workshops
on Existing Water Quality Monitoring Programs

Draft
June 10, 2019

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PECONIC ESTUARY PROGRAM
Protecting & Restoring Long Island's Peconic Bays

NEIWPCC
New England Interstate Water Pollution Control Commission

1. Background

The Peconic Estuary Program (PEP) and its partners are currently updating the Peconic Estuary Comprehensive Conservation and Management Plan (CCMP). As part of the CCMP update the participants wish to evaluate and, if necessary, update their water quality monitoring strategy. PEP selected CoastWise Partners (CWP) to assist in evaluating the current monitoring strategy. As an initial step in the evaluation process, PEP and CWP organized two workshops that were held on the morning and afternoon of May 29, 2019. The morning workshop was done as part of a PEP Technical Advisory Committee (TAC) meeting; the afternoon workshop included several TAC members along with representatives of federal, state and local government agencies and university-based organizations that are conducting water quality monitoring in the Peconic estuary and its watershed. A list of workshop participants is attached as Appendix A.

Prior to both workshops, participants were provided with a draft document prepared by CWP[1] summarizing existing monitoring programs. That document included information on the types of water monitored by each program (surface, ground, estuarine, fresh, point source, etc.), the sponsoring organization, water quality parameters monitored, sampling frequency, numbers of stations, available periods of record, and miscellaneous notes and comments. Workshop participants were asked to review the information relevant to their programs and provide corrections and other recommendations to CWP so that the document could be corrected and finalized for submission to PEP as a deliverable of the monitoring strategy evaluation project.

The primary purposes of the PEP monitoring strategy are to ensure that water quality monitoring efforts are aligned with the resource management objectives identified in the CCMP and provide the information needed to track progress toward those objectives. Therefore, participants in the TAC workshop were asked to provide their recommendations on the types of monitoring data (and other information) that will be needed to allow PEP and its partners to assess progress towards the water-quality-related objectives listed in the current (April 11, 2019) draft of the updated CCMP. A set of preliminary recommendations, which was prepared by CWP prior to the meeting and shared with workshop participants to help kickstart discussion, is included as Section 2 of this report. Section 3 summarizes the feedback provided by TAC workshop participants.

Participants in the monitoring partners workshop, which was held on the afternoon of May 29th, were shown summaries of the recommendations that flowed from the TAC workshop. They were asked to provide feedback on those recommendations, and to consider ways that the existing monitoring programs may need to be modified in order to provide the data that will be needed to track progress toward CCMP objectives. Along with the TAC's recommendations, Section 3 of this report also summarizes the items discussed by the monitoring partners in response to those requests.

This project was funded by an agreement awarded by the Environmental Protection Agency to the New England Interstate Water Pollution Control Commission in partnership with the Peconic Estuary Program. Although the information in this document was been funded wholly or in part by the United States Environmental Protection Agency under agreement CE97230303 to NEIWPCC, it has not undergone the Agency's publications review process and therefore, may not necessarily reflect the

[1] CoastWise Partners. 2019. Draft summary of existing water quality monitoring programs in the Peconic Estuary and watershed. Submitted to the Peconic Estuary Program, May 23, 2019.

views of the Agency and no official endorsement should be inferred. The viewpoints expressed here do not necessarily represent those of the Peconic Estuary Program, NEIWPPC, or EPA, nor does mention of trade names, commercial products or causes constitute endorsement or recommendation for use.

We thank PEP staff and the workshop participants for the time, energy, enthusiasm and expertise they provided while preparing for and holding the two workshops. This document was prepared by Gerold Morrison (gerold.morrison@gmail.com), Holly Greening (hgreening@coastwisepartners.org) and Rich Batiuk (rich.batiuk@gmail.com) of CoastWise Partners.

2. Preliminary CWP recommendations on data needed to track progress toward CCMP objectives

The current draft of the updated Peconic Estuary CCMP includes a number of objectives that are directly related to water quality monitoring, supporting a goal of Clean Waters and Watershed (WQ):

- Objective WQ-1: Substantially reduce present-day and future sources of nutrient pollution into the Peconic estuary watershed;
- Objective WQ-2: Develop and implement strategies to manage existing, historical nutrient loads presently in groundwater that could enter the Peconic estuary;
- Objective WQ-3: Reduce harmful algal blooms (HABs) in the Peconic estuary;
- Objective WQ-4: Reduce pathogen loading to the Peconic estuary;
- Objective WQ-5: Maintain and protect existing high-quality waters; and
- Objective WQ-6: Understand various types of toxic contaminants and their impacts, and work to address current and emerging concerns.

Other goals, such as Healthy Ecosystems with Abundant Wildlife (HE), and Resilient Estuary Communities Prepared for Climate Change (CC), also include objectives that involve water quality monitoring, either directly or indirectly. These include:

- Objective HE-3: Improve water quality to increase habitat suitability for eelgrass and establish new or restored eelgrass beds.
- Objective HE-4: Maintain and restore wetland habitat.
- Objective HE-6: Maintain, restore and enhance viable diadromous fish spawning and maturation habitat.
- Objective CC-3: Develop strategies to understand and address ocean acidification.

Based on previous work experience in Tampa Bay, Chesapeake Bay and other estuary management programs, CWP suggests that the following types of monitoring data and analyses would be most helpful for tracking progress toward meeting these objectives:

- Objective WQ-1: Monitoring of ambient WQ in surface water (fresh, estuarine and marine) and ground water, including all WQ parameters needed to characterize status and trends in "nutrient pollution." If tracking of nutrient contributions from individual source categories is desired, annual nutrient loads (based on flows and concentrations) from those source categories will also be needed.
- Objective WQ-2: Groundwater discharge should be monitored or estimated, and the nutrient levels contributed by historical sources (e.g., historical duck farms) quantified in order to quantify past, present and potential future nutrient loads entering the estuary from those sources.
- Objective WQ-3: Regular monitoring of HABs in order to track the frequency, magnitude and severity of blooms.

- Objective WQ-4: The same types of monitoring and analysis as Objective 1, with pathogen-related WQ parameters substituted for nutrients.
- Objective WQ-5: High-quality waters will need to be identified, and WQ status and trends in those waters monitored and reported on a regular (preferably annual) basis. Periodic pollutant loading estimates (e.g., comprehensive estimates that are updated every 3-5 years), and a 'decision matrix' outlining actions that will be taken by Management Conference members if significant declining WQ trends are observed in a high-quality waterbody, would also be helpful for management purposes.
- Objective WQ-6: This appears to be a research-oriented rather than a monitoring-oriented objective, although existing toxics monitoring programs may need to be adjusted to include the contaminants of greatest management concern.
- Objectives HE-3, HE-4 and HE-6: Monitoring adequate to track status and trends in key water quality attributes that determine habitat suitability for eelgrass, healthy wetlands, and diadromous fish spawning and maturation
- Objective CC-3: Recent EPA guidelines[2] recommend monitoring of pCO_2, pH, dissolved inorganic carbon (DIC) and total alkalinity (TA) to track water column acidification processes and changes in the coastal carbonate system.

3. Recommendations provided by the TAC and monitoring partners

During the two workshops, brief synopses of the comments and ideas provided by participants were transcribed using a laptop computer and projected on a screen to allow speakers to ensure that their input was captured accurately. The following is a summary of the two groups' recommendations, and the preliminary recommendation provided by CWP, for each water-quality-related CCMP objective.

WQ-1. Substantially reduce present-day and future sources of nutrient pollution in the watershed.

CWP:

- Monitor, calculate and report annual nutrient loads to the estuary from major source categories (e.g., atmospheric, groundwater, surface water) and sub-categories (e.g., agricultural lands and operations, residential properties, commercial facilities, fertilizer applications, manure applications, wastewater discharges).

TAC:

- Need smart, measurable metrics;
- Interim goals/objectives may be helpful if long-term goals will take too long to achieve;
- Information/data will be needed to address sea level rise and coastal flooding and the resultant changes in nitrogen and phosphorus loads;
- Need acquisition of more comprehensive land cover/land use data to support the PEP partners' modeling tools;
- Need to monitor the quality and quantity of groundwater more comprehensively and consistently in order to fully estimate nutrient loads to the estuary by establishing a baseline groundwater monitoring network for ecosystem objectives and sustain it through time);
- Need a dedicated staff person to carry out the annual compilation of all the generated monitoring data and undertake the analysis of the collected data to address PEP management needs;

[2] Pimenta, A.R. and J.S. Grear. 2018. Guidelines for measuring changes in seawater pH and associated carbonate chemistry in coastal environments of the eastern United States. EPA/600/R-17/483. Washington, DC.

- Need to address the effects of the dramatic seasonal human population changes in the watershed in the design of watershed and estuarine monitoring networks — to track summer increases in watershed population levels, water use, waste generation, etc.;
- Scalability of the monitoring data generated needs to be taken into account;
- Don't forget the important roles of microbes in nutrient cycling in soils and the estuarine system;
- Need to focus on public messaging about clean water in terms the general public can understand—make the connection with their backyard, with their pocketbook;
- Need to be positioned to take full advantage of sources of foundation funding;
- Analyze the monitoring data, interpret the trends and synthesize the findings in ways that are clearly related to things valued by the general public.

Monitoring Partners:

- A monitoring program design cannot predict future sources, so it will have to be open to future modifications if needed;
- Groundwater plumes can show up in surface water and may contain nutrients and other contaminants (household products, pesticides, etc.). Some emerging contaminants do not yet have standard analytical methods, and their impacts are not yet known. The County has access to hundreds of groundwater monitoring wells, but it is difficult to sample them on a regular basis. Monitoring money is scarce. Consider better links to the towns to provide additional funding?
- Drinking water monitoring is subject to many regulatory requirements. The same requirements are not present for non-drinking water sampling;
- Submarine groundwater discharge may also be an important nutrient loading source;
- Peconic River: monitoring at the USGS gage includes continuous flow measurements but only quarterly sampling of water quality parameters, which will increase the uncertainty of loading estimates calculated for the site;
- The Peconic River is also groundwater-driven, so nutrient loads observed there will have a groundwater component;
- Need to understand seasonality of loadings.
- The New York State Department of Environmental Conservation (NYSDEC) shellfish monitoring programs provides data on fecal coliforms, salinity and water temperature at the mouths of many contributing streams. Might potentially be used as indicators for other parameters. The shellfish monitoring program does not sample in upstream areas of the creeks;
- Including a spatial component of monitoring strategy is very important–specifically, consider more detailed data collection efforts in some critical areas, especially shallow-water areas, along with existing bay-wide sampling effort;
- Look at existing County surface water quality monitoring locations, and, if necessary, consider reallocating the collective effort by the monitoring program partners to better match strategic information needs.

WQ-2. Manage existing, historical nutrient loads in groundwater that could enter the estuary

CWP:

- Monitor and report nutrient concentrations and annual loads to groundwater and from groundwater to the estuary;
- Identify contributing sources (e.g., legacy agriculture, legacy wastewater, current agricultre, current wastewater) and quantify their relative contributions;

- Identify and prioritize management actions that can be used to reduce loads to estuary;
- Implement priority management actions and use monitoring data to track progress.

TAC:

- Complete the Solute Transport Model to include a time variable hydrodynamic model and continuing to run scenarios and use the tool to support decision making;
- Measure nutrient concentrations/loads in the hyporheic discharge zone—need improve monitoring and understanding of loads in this 'hand-off' zone between the watershed and the estuarine system (critical data set for supporting model calibration and validation);
- Recognize the importance of monitoring to validate whether expected outcomes did in fact come to pass, as a result of management actions taken in the past.

Monitoring Partners:

- Revisit a groundwater load path determined in the past to detect potential changes over time. Pesticides on the North Fork as example. Need repeated sampling of wells or flowpaths of contaminants to be able to detect concentration changes in the groundwater;
- Need to have a programmatic connection to support long-term groundwater monitoring, rather than only focusing on the issue of the day;
- Re-establish monitoring for the Peconic River;
- Groundwater wells are sampled twice a year at about 50 wells in the Peconic River watershed. Need to verify that some of the wells are on the flowpaths of contaminants. Need to couple these data with the Solute Transport Model. Use this program to support needs of the model validation effort. Sampling nutrient suite also. May be able to put together a more comprehensive monitoring program from this baseline. Also need site-specific studies on groundwater.

WQ-3. Reduce HABs

CWP:

- Monitor and report the frequency, extent and severity of HABs;
- Identify and prioritize management actions that can be used to reduce frequency, extent and severity of HABs;
- Implement priority management actions and use monitoring data to track progress in reducing HABs.

TAC:

- Include monitoring for the novel species that are showing up—don't just limit the species composition to focus on species which have been detected in the past;
- This will require a lot of interdisciplinary research and monitoring programs directed towards answering some basic questions about HABs within the Peconic Estuary and Long Island Sound—e.g., what are the major factors contributing to bloom generation and dynamics?
- Need a wider range of people working together to address these questions – academic researchers, resource managers, etc.

Monitoring Partners:

- A 2017 HAB Action Plan is available, which receives periodic updates as funding allows. Updated in the last couple of years;

- Many HABs currently present in the Peconics are mixotrophs, which may impact which nutrient forms need to be monitored;
- NYSDEC has recently launched a HAB platform for other parts of the state – may be helpful to look at those methods and recommendations.

WQ-4. Reduce pathogen loading to the estuary

CWP:

- Monitor and report annual pathogen loads to the estuary from major source categories (e.g., wildlife, livestock, pets, residential & commercial wastewater);
- Consider adding a human health risk component to monitoring programs, in addition to the existing monitoring of fecal coliforms and other fecal indicator bacteria (FIB)? Human fecal sources tend to pose more human health risks than pets and livestock, which often pose more risk than birds and other wildlife. FIB data alone doesn't provide information on contaminant sources. Microbial source tracking (MST) or other analytical methods would be necessary to help identify sources).

TAC:

- Keep the focus on human health risks when monitoring bathing beaches and shellfish harvesting areas;
- Need the data necessary to support the goal of opening as many shellfish beds to commercial harvest as possible while addressing human health concerns;
- Don't forget the human health connection via HABs as well as shellfish and bathing beaches;
- Need a dedicated science communicator or expanded role for Cooperative Extension to work with PEP to communicate the information from monitoring programs to the public and public officials;
- Need a focus on human behavior (e.g., household waste treatment, pet waste pickup and disposal) and its links with pathogens in the waterways;
- The New York state agency responsible for opening and closing shellfish beds does not have adequate funding or staffing to effectively carry out the work towards the goal of maximizing the opening of shellfish beds for harvest;
- Need monitoring directed toward understanding whether we are actually changing the populations of pathogens in our waterways.

Monitoring Partners:

- USGS has an ongoing microbial source tracking project in the Peconics, to help identify and quantify sources (e.g., humans, pets, birds, other wildlife) of fecal indicator bacteria that are detected in the waters;
- Stony Brook University staff are also doing source tracking, on a bi-weekly basis, using different methods than USGS, but it would be useful to compare results of the two programs;
- Monitoring designs can differ depending on the purpose of the monitoring and utility of the data. Some are more focused on education, others on regulatory requirements, others on environmental resource management;
- Any monitoring that PEP helps fund must be done in compliance with an approved quality assurance project plan (QAPP). Other funding sourced may not have that requirement. Need to discuss how/when/whether to use data not collected under a QAPP. Possibly consider a tiered approach for QAPPs that involve citizen monitoring;

- Consider working with NYSDEC's Division of Water and Watershed Management Division to develop monitoring strategy to support 303(d) listings or other things. Waterbody segmentation is an example – could coordinate with the state's 303(d) effort. The Priority Waterbodies List (PWL) delineations, available from the state, could potentially be used as a basis for segmentation and assigning station locations. Could also integrate groundwater sub-basins with surface water segments to decide where monitoring stations should be located.

WQ-5. Maintain and protect existing high-quality waters

CWP:

- Identify and map existing high-quality waters;
- Monitor and report water quality status and trends in those waters on a regular (preferably annual) basis.

TAC:

- Need an accurate inventory of land uses above/upstream from existing and potential high-quality waters;
- Ensure the accuracy of New York State's existing 303(d) list of impaired waters;
- Need to recognize that some high-quality waters are at risk, and monitoring networks should generate the data needed to enable us to understand and manage for those risks;
- Data and information regarding high-quality waters as well as listed impaired waters are generally not readily available in a form that is very useable for management purposes;
- Need to address the vulnerability of groundwater resources to impacts from overlying land uses;
- Additional monitoring needs to be directed towards the embayments within the Peconic Estuary;
- Need to recognize the localized impacts of wildlife on water quality and ensure that data about such sources get shared along with routine monitoring data;
- Need to coordinate efforts related to maintaining and protection existing high-quality waters with local interests.

Monitoring Partners:

- NYSDEC shellfish monitoring program conducts shoreline surveys for potential pathogen sources. They have maps and can share the information. It's not yet in GIS;
- Along those lines, WHO has a set of recommended methods for estimating human health risks based on land use intensity. Florida DEP has developed similar tools. CWP can pass the information along to PEP;
- How to estimate nitrogen loads from atmospheric deposition? Existing monitoring stations are in rural areas; additional monitoring may be needed for more urbanized area. Cost-effective methods are available. Consider a west to east (highly urban to more rural) transect for the Peconic watershed?
- Digital infrared aerial photography could be used in spring and fall to help track groundwater flow paths by detecting differences in water temperature;
- Stable isotopic analyses of reactive nitrogen forms (ammonia-N and nitrate-N) could be used to help identify and quantify the sources of nitrogen loads (e.g., fossil fuel combustion, fertilizer, wastewater, animals, internal cycling from sediments).

WQ-6. Understand various types of toxic contaminants and their impacts, and work to address current and emerging concerns.

CWP:

- This appears to be more research-oriented than monitoring-oriented, but may require tweaking of monitoring programs to include newly-identified contaminants of concern.

TAC:

- Need to understand the level of chemical contaminants in groundwater as well as surface waters from a human health/drinking water perspective (need to engage the Suffolk County Water Authority in this larger water quality monitoring strategy development);
- In addition to human health issues, need a better understanding of chemical contaminants' effects on underwater Bay grasses and other measures of ecosystem health;
- Need to recognize that we are only beginning to understand the impacts of chemical contaminant impacts on ecosystem health and its implications for human health—examples include sediment contamination.

Monitoring Partners:

- Barnegat Bay has done work with shellfish and contaminants. PFAs need to be highlighted a little more, especially since the Peconics are a groundwater-driven system;
- Need to consider how to monitor impacts, in addition to concentrations and loads – e.g., tissues. Challenging to monitor in receptors.

HE-3. Improve WQ to increase habitat suitability for eelgrass

CWP:

- Monitor and report key water quality parameters that impact seagrass health and cover (e.g., water clarity, PAR, water temperature);
- Identify and prioritize management actions that can be used to increase seagrass health and cover;
- Implement priority management actions and use monitoring data to track progress.

TAC:

- Need to better understand the potential impacts of chemical contaminants beyond herbicides on the health of seagrass communities.

Monitoring Partners:

- Increase integration of eelgrass monitoring and water quality monitoring;
- How confident are we that existing eelgrass monitoring is adequate to detect true change? Cornell monitoring at individual persistent sites may provide this;
- Groundwater discharge may be a cooling factor in some persistent eelgrass beds. Maps of these areas may help to identify sites where transplanting could be effective. Couple with results of the groundwater transport model to assist with identifying future areas for restoration.
- Map areas where PAR and water temperature could support eelgrass and focus restoration areas there.

HE-6. Maintain, restore and enhance viable diadromous fish spawning and maturation habitat

CWP:

- Monitor and report key water quality parameters that impact fish habitat (e.g., dissolved oxygen, HABs);
- Identify and prioritize management actions that can be used to protect, restore and enhance the water quality-related aspects of habitat quality;
- Implement priority management actions and use monitoring data to track progress.

TAC:

- No continuous monitoring of the key diadromous fish habitats—e.g., temperature—within most streams;
- Current monitoring is periodic in nature; useful for long term trends but not for understanding more immediate impacts on spawning and nursery life stages.

Monitoring Partners:

- The USGS has a continuous monitoring station in the Peconic River, recording water temperature, DO, salinity and other parameters.

CC-3. Develop strategies to understand and address ocean acidification

CWP:

- See recent EPA guidance document on monitoring coastal acidification (Pimenta, A.R. and J.S. Grear. 2018. Guidelines for measuring changes in seawater pH and associated carbonate chemistry in coastal environments of the eastern United States. EPA/600/R-17/483.);
- Coastal acidification is affected by CO2 emissions, and also by eutrophication (e.g., due to increased microbial respiration, nitrification, denitrification);
- EPA's recommended monitoring parameters include pH, DIC, pCO_2 and total alkalinity (TA).

TAC:

- NY State had an Ocean Acidification Task Force that was looking at needs for enhancing existing monitoring network to include parameter specific to ocean acidification.

Monitoring Partners:

- It may be possible to include climate change adaptation in water quality models to identify potential areas of impact;
- USGS has data from long-term water quality grab samples and recent continuous data collection at 2 sites. Are there other parameters needed to support model development and management? Maybe velocity mid-estuary?
- Ecosystem modeling may also be a useful tool for investigating this issue;
- Offshore impacts and effects should also be considered (e.g., effects on predation).

Appendix A. Participants list from the May 29, 2019 workshops

SIGN-IN SHEET:
PEP TAC Meeting
Stony Brook Marine Station- upstairs classroom
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May 29, 2019
10AM

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Summary of Existing Water Quality Monitoring Programs in the Peconic Estuary and Watershed

June 7, 2019

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PECONIC ESTUARY PROGRAM
Protecting & Restoring Long Island's Peconic Bays

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Background

The Peconic Estuary Program (PEP) and its partners are currently updating the Peconic Estuary Comprehensive Conservation and Management Plan (CCMP). As part of the CCMP update the participants also wish to evaluate and, if necessary, update their water quality monitoring strategy. PEP selected CoastWise Partners to assist in evaluating the current monitoring strategy. This draft summary of existing water quality monitoring programs is an initial step in the evaluation process.

The primary purposes of the PEP monitoring strategy are to ensure that water quality monitoring efforts are aligned with the resource management objectives identified in the CCMP and provide the information needed to track progress towards those objectives. The monitoring strategy should also make efficient use of available budget and staff resources by streamlining monitoring efforts, encouraging cooperation and collaboration between monitoring programs, and eliminating unnecessary duplication of effort wherever possible.

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We thank PEP staff (Joyce Novak, Sarah Schafer, Elizabeth Hornstein and Lauren Scheer) and program partners (A.J. Smith, Gavin Lemley and Matt Richards with NYSDEC; Doug Feldman, Michael Jensen, Ron Paulsen, Nancy Pierson and Andrew Rapiejko with SCDHS; Chris Gobler and Jennifer Goleski with SBU/SOMAS; and Chris Schubert with USGS) for providing, and helping to interpret and review, the information included here.

CCMP Objectives:

The current draft of the updated Peconic Estuary CCMP includes eight Objectives supporting the goal of Clean Waters and Watershed (WQ):

- Objective WQ-1: Substantially reduce present-day and future sources of nutrient pollution into the Peconic estuary watershed.
- Objective WQ-2: Develop and implement strategies to manage existing, historical nutrient loads presently in groundwater that could enter the Peconic estuary.
- Objective WQ-3: Reduce harmful algal blooms (HABs) in the Peconic estuary.
- Objective WQ-4: Reduce pathogen loading to the Peconic estuary.
- Objective WQ-5: Maintain and protect existing high-quality waters.
- Objective WQ-6: Understand various types of toxic contaminants and their impacts, and work to address current and emerging concerns.

- Objective WQ-7: Reduce macro- and micro-plastic pollution.
- Objective WQ-8: Support water quality monitoring and research that will help guide and evaluate management efforts.

Other goals, such as Healthy Ecosystems with Abundant Wildlife (HE), and Resilient Estuary Communities Prepared for Climate Change (CC), also include objectives that involve water quality, either directly or indirectly. These include:

- Objective HE-3: Improve water quality to increase habitat suitability for eelgrass and establish new or restored eelgrass beds.
- Objective HE-4: Maintain and restore wetland habitat.
- Objective HE-6: Maintain, restore and enhance viable diadromous fish spawning and maturation habitat.
- Objective CC-3: Develop strategies to understand and address ocean acidification.

Tracking progress toward meeting these objectives will require the following types of monitoring data and analyses:

- Objective WQ-1: Monitoring of ambient WQ in surface water (fresh, estuarine and marine) and ground water will be necessary, including all WQ parameters needed to characterize status and trends in "nutrient pollution." If tracking of nutrient contributions from individual source categories is desired, annual nutrient loads (based on flows and concentrations) from those source categories will also be needed.
- Objective WQ-2: Groundwater discharge will need to be monitored or estimated, and the nutrient levels contributed by historical sources (e.g., historical duck farms) will need to be quantified in order to track current and future nutrient loads entering the estuary from those sources.
- Objective WQ-3: Regular monitoring of HABs will be needed to track the frequency, magnitude and severity of blooms.
- Objective WQ-4: This will require the same types of monitoring and analysis as Objective 1, with pathogen-related WQ parameters substituted for nutrients.
- Objective WQ-5: High-quality waters will need to be identified, and WQ status and trends in those waters monitored and reported on a regular (preferably annual) basis. Periodic pollutant loading estimates (e.g., comprehensive estimates that are updated every 3-5 years), and a 'decision matrix' outlining actions that will be taken by PEP partners if significant declining WQ trends are observed in a high-quality waterbody, would also be helpful for management purposes.
- Objective WQ-6: This appears to be a research-oriented rather than a monitoring-oriented objective, although existing toxics monitoring programs may need to be adjusted to include the contaminants of greatest management concern.
- Objective WQ-7: This will require monitoring efforts similar to those needed to support Objectives 1 and 4, with a focus on macro- and micro-plastic pollution.
- Objectives HE-3, HE-4 and HE-6: These will require monitoring to track status and trends in key water quality attributes that determine habitat suitability for eelgrass, healthy wetlands, and diadromous fish spawning and maturation

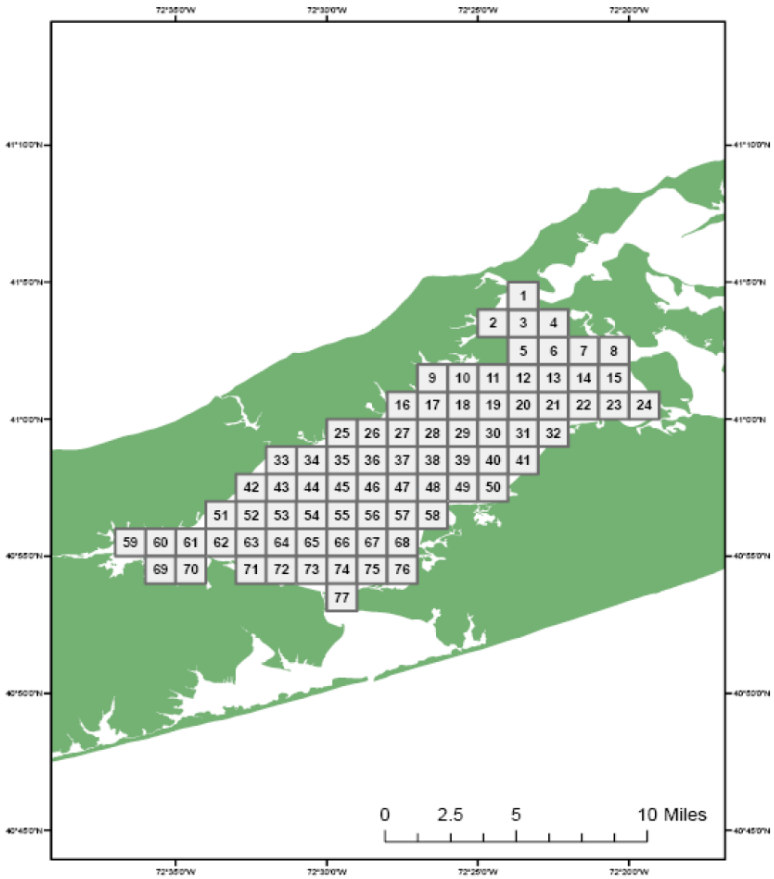
- Objective CC-3: Current EPA guidelines[1] recommend monitoring of pCO_2, pH, dissolved inorganic carbon (DIC) and total alkalinity (TA) to track water column acidification processes and changes in the coastal carbonate system.

The tables that follow present a summary of monitoring programs that are currently active in the PEP project area.

[1] Pimenta, A.R. and J.S. Grear. 2018. Guidelines for measuring changes in seawater pH and associated carbonate chemistry in coastal environments of the eastern United States. EPA/600/R-17/483. Washington, DC.

I. New York State Department of Environmental Conservation (NYSDEC), Division of Marine Resources, Fishery-Independent Trawl Survey

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water Quality	**Estuarine/ Marine**	**NYSDEC**	Water Temperature (°C) – surface and bottom Salinity (psu) – surface and bottom DO (mg/l) – surface and bottom Secchi depth Water depth (at beginning and end of trawl)	Weekly, from May through October Stations in 16 randomly chosen blocks are sampled per week.	77 1-minute latitude and longitude survey blocks (see map below)	1987 – present (with data gaps in 2005, 2006, 2008, 2010)	Data, reports and other information on this monitoring program are available from NYSDEC



Peconic Estuary survey blocks used in the NYSDEC fishery-independent trawl survey, based on 1' latitude by 1' longitude grid cells. Trawls begin near the center of each randomly-selected block. (Source: NYSDEC)

II. New York State Department of Environmental Conservation (NYSDEC), Division of Water, RIBS Program

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water Quality	**Fresh**	**NYSDEC**	Alkalinity, Total (As CaCO3) (total,mg/l) Aluminum (dissolved,ug/l) Aluminum (total,ug/l) Arsenic (total,ug/l) Calcium (total,ug/l) Chloride (As Cl) (total,mg/l) Copper (dissolved,ug/l) Copper (total,ug/l) Dissolved Organic Carbon (dissolved,mg/l) Hardness (As CaCO3) (total,mg/l) Iron (total,ug/l) Lead (dissolved,ug/l) Lead (total,ug/l) Magnesium (total,ug/l) Manganese (total,ug/l) Mercury (total,ng/l) Nickel (dissolved,ug/l) Nickel (total,ug/l) Nitrogen, Ammonia (As N) (total,mg/l) Nitrogen, Kjeldahl, Total (total,mg/l) Nitrogen, Nitrate-Nitrite (total,mg/l) Nitrogen, Nitrate (As N) (total,mg/l) pH (total,ph units) Phosphorus (total,mg/l) Potassium (total,ug/l) Silver (total,ug/l) Sodium (total,ug/l) Specific Conductance (total,umhos/cm) Sulfate (As SO4) (total,mg/l) Total Dissolved Solids (Residue, Filterable) (total,mg/l) Total Organic Carbon (total,mg/l) Total Solids (total,mg/l) Total Suspended Solids (total,mg/l) Total Volatile Solids (total,mg/l) Turbidity (total,ntu) Zinc (dissolved,ug/l) Zinc (total,ug/l)	Monthly, from April through November, at 5-year intervals	1 (Peconic River)	2004 – present (2004, 2009, 2014)	In addition to the water chemistry parameters listed here, the RIBS program also includes taxonomic and habitat quality data. (See program summary below.)

Note: **Rotating Integrated Basin Studies (RIBS) (http://www.dec.ny.gov/chemical/30951.html)**

"The objectives of the Rotating Integrated Basin Studies (RIBS) program are to assess water quality of all waters of the state, including the documentation of good quality waters and the identification of water quality problems; identify long-term water quality trends; characterize naturally occurring or background conditions; and establish baseline conditions for use in measuring the effectiveness of site-specific restoration and protection activities. The program is designed so that all major drainage basins in the state are monitored every five years.

To address the objectives and the rotating cycle, the program is designed around three related monitoring schemes:

The Screening Network provides a narrative assessment of water quality at a large number of sampling sites based on biological assessment using macroinvertebrate community analysis, measures of acute toxicity in the water, physical habitat evaluation and water chemistry. Locations identified during the screening year may be selected for additional sampling during the following year.

Special Surveys are designed to answer specific questions regarding habitat and water quality and may employ multi-media sampling-depth integrated water chemistry, bottom sediment and invertebrate tissue chemistry, toxicity testing, macroinvertebrate or fish community assessments, habitat assessment--depending on the focus of the survey.

The Routine Trend Monitoring Network provides information for establishing basic water quality characteristics and baseline conditions, and for identifying long-term trends by sampling at fixed sites across the state, conducted each year, regardless of the rotating cycle.
RIBS program water quality data and information are used to support assessment and management functions within NYSDEC Division of Water (DOW), including the Waterbody Inventory/Priority Waterbodies List (WI/PWL), New York State's Clean Water Act Section 305(b) Water Quality Report, and Section 303(d) List of Impaired Waters of the state.

More details on methods, assessment criteria and their application in the RIBS program are contained in the Quality Assurance Program Plans and Standard Operating Procedures for each of the sampling media. These documents are available from NYSDEC on request."

III. NYSDEC, Division of Marine Resources, Shellfish Growing Area Classification Unit

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water Quality	**Estuarine/ Marine**	**NYSDEC Bureau of Marine Resources**	Fecal coliforms (MPN/100ml) Salinity (psu) Water Temperature (^{o}C)	Variable, depending on station requirements (typically 2-15+ per year)	Variable, based on potential pollution sources	Varies between stations	Data from some stations extends back to the 1970s Information on current shellfish growing area closures is available at https://nysdec.maps.arcgis.com/apps/webappviewer/index.html?id=d98abc91849f4ccf8c38dbb70f8a0042

Notes:

- Current monitoring in the Peconic Estuary includes 20+ growing areas, with an average of ~20 sampling sites per area. (M. Richards, NYSDEC, pers. comm.)
- To help determine and quantify sources of the fecal indicator bacteria detected in growing areas, NYSDEC is collaborating with the USGS on a microbial source tracking project (https://www.sciencebase.gov/catalog/item/593aa553e4b0764e6c602044) that uses several analytical techniques to identify the host organisms (e.g., humans, pets, livestock, birds and other wildlife) and hydrologic transport mechanisms (e.g., wastewater, stormwater, groundwater) involved in the discharging fecal contaminants.
- As part of its ongoing shellfish monitoring program, NYSDEC is also collaborating with a number of federal, state and local government agencies to and NGOs to identify shellfish harvesting areas impacted by marine biotoxins associated with harmful algal blooms, such as PSP, ASP and DSP, and initiate emergency closures in those areas to protect public health (see https://www.dec.ny.gov/outdoor/64824.html).

IV. **PEP Long-Term Eelgrass Monitoring Program (PEP LTEMP)**

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water / Eelgrass Habitat	**Estuarine/ Marine**	**Cornell University, Cooperative Extension of Suffolk County**	Eelgrass shoot density (per m^2) Water temperature (^oC) Light availability (PAR) Macroalgae cover (%)	Annually or every 3 years (see note below)	Variable	1997 - present	Data are summarized in annual reports, available on request from the PEP program office. 2017-2023 (9 annually; 13 in 2017, 2020, 2023/) Bullhead Bay (annually) Gardiners Bay (annually) Coecles Harbor (annually) Fort Pond (annually) Napeague Harbor (annually) Sag Harbor (annually) New Three Nile Harbor (annually) Cedar Point (annually) Orient Point (annually) Northwest Harbor (2017, 2020, 2023) Orient Harbor (2017, 2020, 2023) Three Mile Harbor (2017, 2020, 2023) Southold Bay (2017, 2020, 2023) 2008-2016 (8) Bullhead Bay, Gardiners Bay, Northwest Harbor, Orient Harbor, Three Mile Harbor, Cedar Point, Orient Point, Southold Bay 1999-2008 (6) Bullhead Bay, Gardiners Bay, Northwest Harbor, Orient Harbor, Three Mile Harbor, Southold Bay 1997 & 1998 (3) Bullhead Bay, Northwest Harbor, Orient Harbor

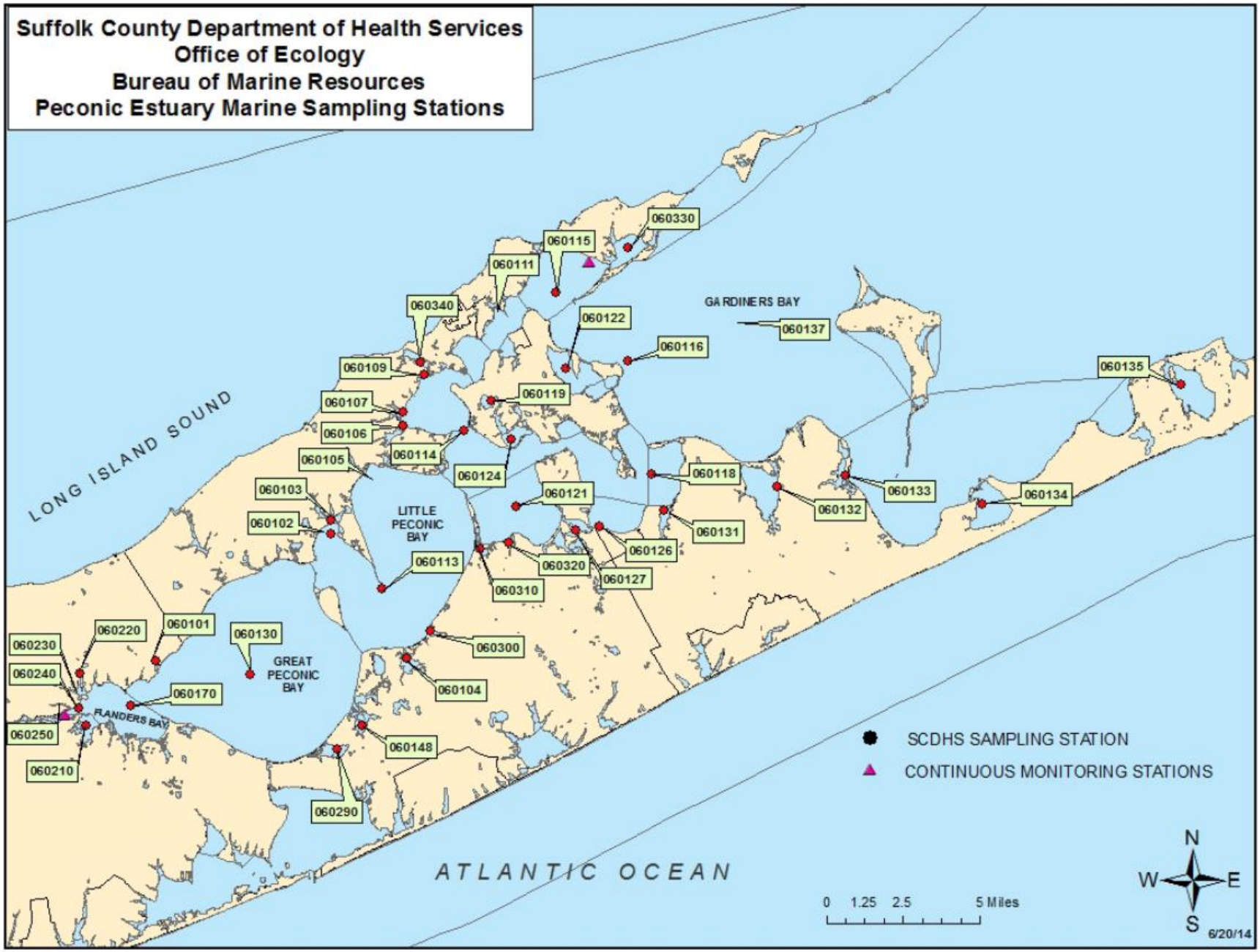
Note: For the 2017 monitoring season, it was agreed that all of the LTEMP sites, original and new, would be monitored, but for future seasons, the LTEMP sites that no longer support eelgrass (Northwest Harbor, Orient Harbor, Southold Bay, and the original Three Mile Harbor) would be monitored once every 3 years.

V. **Stony Brook University, School of Marine and Atmospheric Sciences (SBU/SOMAS)**

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water Quality	**Fresh/ Estuarine/ Marine**	**Stony Brook University, SOMAS, LIMMN Program**	Min. DO (mg/l) Secchi depth (m) Site depth (m) Fecal coli. (per 100ml) Chl-a (ug/l) HABs (cells/ml)	Weekly from the Monday after Memorial Day to the Monday before Labor Day	6 in Peconic system	2014 - present	During active sampling periods, real-time data are available at https://you.stonybrook.edu/goblerlab/real-time-water-quality-data/

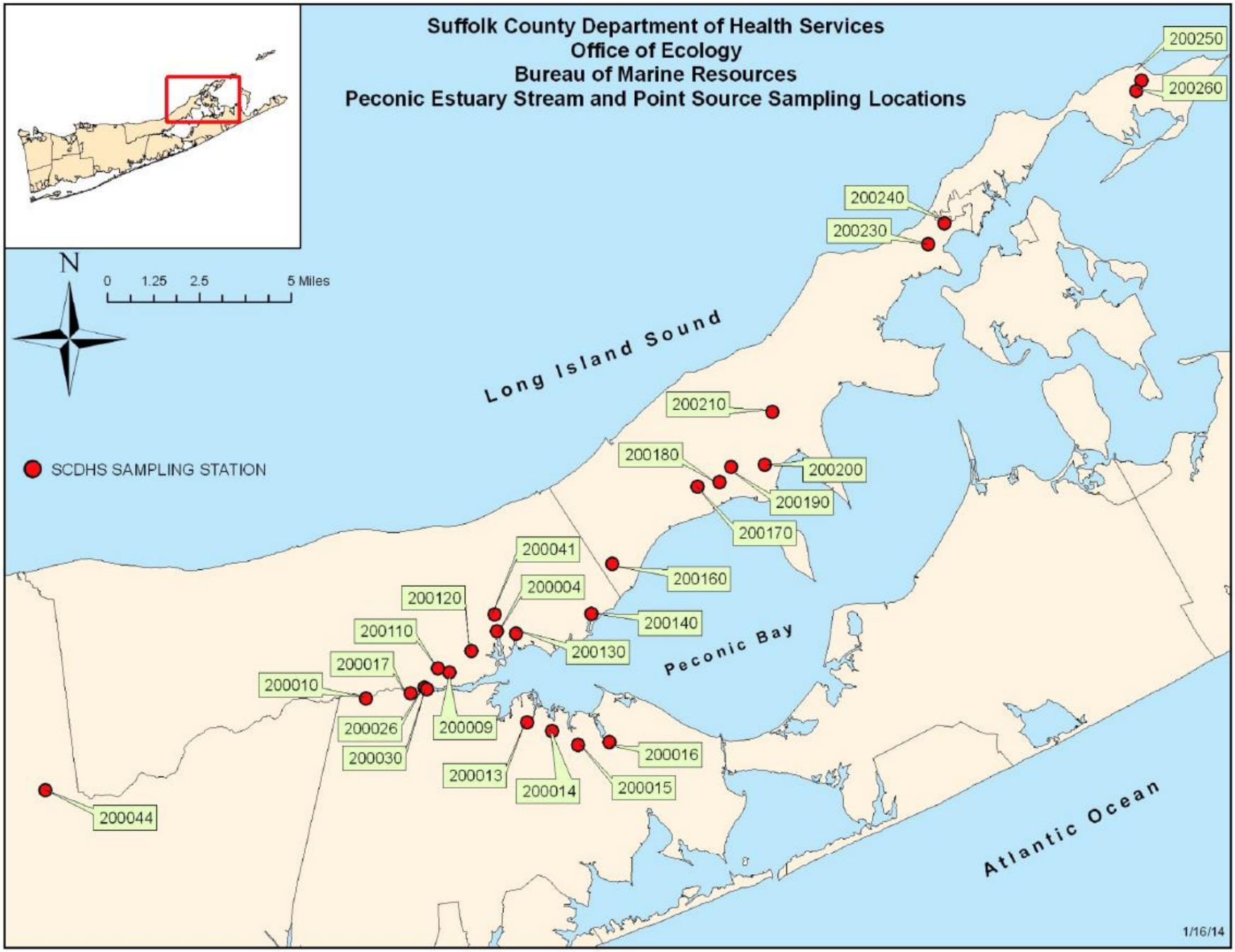
VI. Suffolk County Department of Health Services (SCDHS), Office of Ecology

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water Quality	**Estuarine/ Marine**	**SCDHS, Ecology**	N forms (mg N/l) NHx-N NO2-N & NO3-N NOx-N Urea-N TKN/DKN TN/DN P forms (mg P/l) TPO4/DPO4-P TP/DP o-PO4-P Chlorophyll-a (ug/l) Total Fractionated (<10 um) Organic Carbon (mg C/l) TOC & DOC SiO3 (mg Si/l) Aureococcus counts (cells/ml) Coliforms (MPN/100 ml) Total & Fecal Secchi Depth (ft) Water Temp (^{o}C) DO (mg/l) Salinity (PSU) Spec. Conduct. (uS/cm) pH (unitless) Other (Tide, Weather, Water Depth, Color)	Approx. Monthly (see notes)	Variable (see notes and map below)	 1976-2018 1976-1989 1989-2018 1994-2003 1976-2000 2000-2018 1976-2000 2000-2018 1977-2018 1988-2018 1988-2009 1988-2002, 2007 1988-2003 (1995 missing) 1985-2018 1976-2016 (1978, 1981, and 1982 missing) 1976-2016 (1983 and 1984 missing) 1976-2018 1987-2018 1976-2018 2001, 2011 (2016 missing) 2010-2018 2012-2018	Numbers of stations vary from year to year: • Min=10 (1992-1993) • Mean=31 • Max=49 (2016) • 46 stations sampled in 2018 Data and metadata are available at https://gisportal.suffolkcountyny.gov/gis/home/item.html?id=8107f192ffac406380b6d61d3d3dbf7d For all parameters, some years included in POR may have months with missing data.



(Source: SCDHS)

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water Quality	**Fresh (streams and point sources)**	**SCDHS, Ecology**	N forms (mg N/l) NHx-N NO2-N & NO3-N NOx-N Urea-N TKN/DKN TN/DN P forms (mg P/l) TPO4/DPO4-P TP/DP o-PO4-P Organic Carbon (mg C/l) TOC & DOC SiO3 (mg Si/l) Coliforms (MPN/100 ml) Total & Fecal Chloride (mg/l) Sulfate (mg/l) Water Temp (^{o}C) Water Depth (ft) Streamflow (cfs, at 10 stream/river stations) DO (mg/l) Salinity (PSU) Spec. Conduct. (uS/cm) pH (unitless) Tide state (1-4 scale)	Approx. Quarterly (see notes)	Variable (see notes and map below)	 1976, 1987-2018 1976, 1987-2018 1988-2018 2001-2003 1976, 1987-2000 2000-2018 1976, 1987-2000 2000-2018 1987-1996, 2001-2018 Partial data 1976, 1987-1989, 2001 Partial data 1988-1993 and 2001-2003 1976, 1987-2018 1987-1990, 2000-2018 2000-2018 1976, 1987-2018 2002, 2008-2018 1976, 1987-1998 1976, 1987-1989, 1999-2018 2000-2018 1976, 1987-2018 1987-1989, 2002-2018 2012-2013, 2015-2018	Numbers of stations vary from year to year: • Min=8 (1990-1994) • Mean=22 • Max=39 (2002) • 25 stations sampled in 2018 Data and metadata available at https://gisportal.suffolkcountyny.gov/gis/home/item.html?id=8107f192ffac406380b6d61d3d3dbf7d For all parameters, some years included in POR may have months with missing data. An extensive metals and organics data set is also available for stream and point source stations from SCDHS



(Source: SCDHS)

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water Quality	**Fresh/Estuarine/ Marine Bathing Beaches**	**SCDHS, Ecology**	*E. coli* (freshwater beaches) *Enterococcus* (estuarine/marine beaches)	Risk-based; twice per week at higher-risk beaches, less frequently at lower-risk beaches	187 stations in County; 30+ in Peconic system. Sampling performed mid-May through mid-September	2000 - present	Data and metadata available at https://gisportal.suffolkcountyny.gov/gis/home/item.html?id=025cb4dadb57413980dbd7e760b94da8

Note: SCDHS also collaborates with NYSDEC and SBU/SOMAS to identify shellfish harvesting areas impacted by marine biotoxins associated with harmful algal blooms, such as PSP, ASP and DSP, so that NYSDEC can initiate emergency closures in those areas when necessary to protect public health (see https://www.dec.ny.gov/outdoor/64824.html).

VII. Suffolk County Department of Health Services (SCDHS), Office of Water Resources

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Community Public Supply Wells	**Groundwater**	**SCDHS, Water Resources**	A,B,C,Da,Di,H M,Si,Sv,V (All parameters may not have been analyzed every year.)	Annual	77	Variable	Readily available data for some wells goes back to 1998, while other, newer wells, only have data going back to the year they went on-line. Some historic data goes back to 1980s.
Non-Community Public Supply Wells	**Groundwater**	**SCDHS, Water Resources**	A,B,C,Da,Di,H M,Si,V (All parameters may not have been analyzed every year.)	Annual	87	Variable	Readily available data for some wells goes back to 1998, while other, newer wells, only have data going back to the year they went on-line. Some historic data goes back to 1970s
Monitoring Wells	**Groundwater**	**SCDHS, Water Resources**	Variable	Variable	~400	Variable	Readily available data for some wells goes back to 2011. Earlier data (paper copies) goes back to 1970s. Parameters will vary depending on sample year (older samples generally have less parameters). Some stations were only sampled one or time times, Some wells have a longer sampling history.
Freshwater Streams	**Surface Water**	**SCDHS, Water Resources**	Variable	Variable	47	Variable	Data for some streams goes back to 1970s. Parameters will vary depending on sample year. Some stations were only sampled one or time times, fewer have a long sampling history

Parameter codes:

A = Carbamate Pesticides
B = Bacteria
C = Chlorinated Pesticides
Da = Dacthal & Metabolites
Di = 1,4-Dioxane
H = Herbicide Metabolites
M = Metals
Si = Standard Inorganics
Sv = Semi-volatiles
V = Volatile Organic Compounds

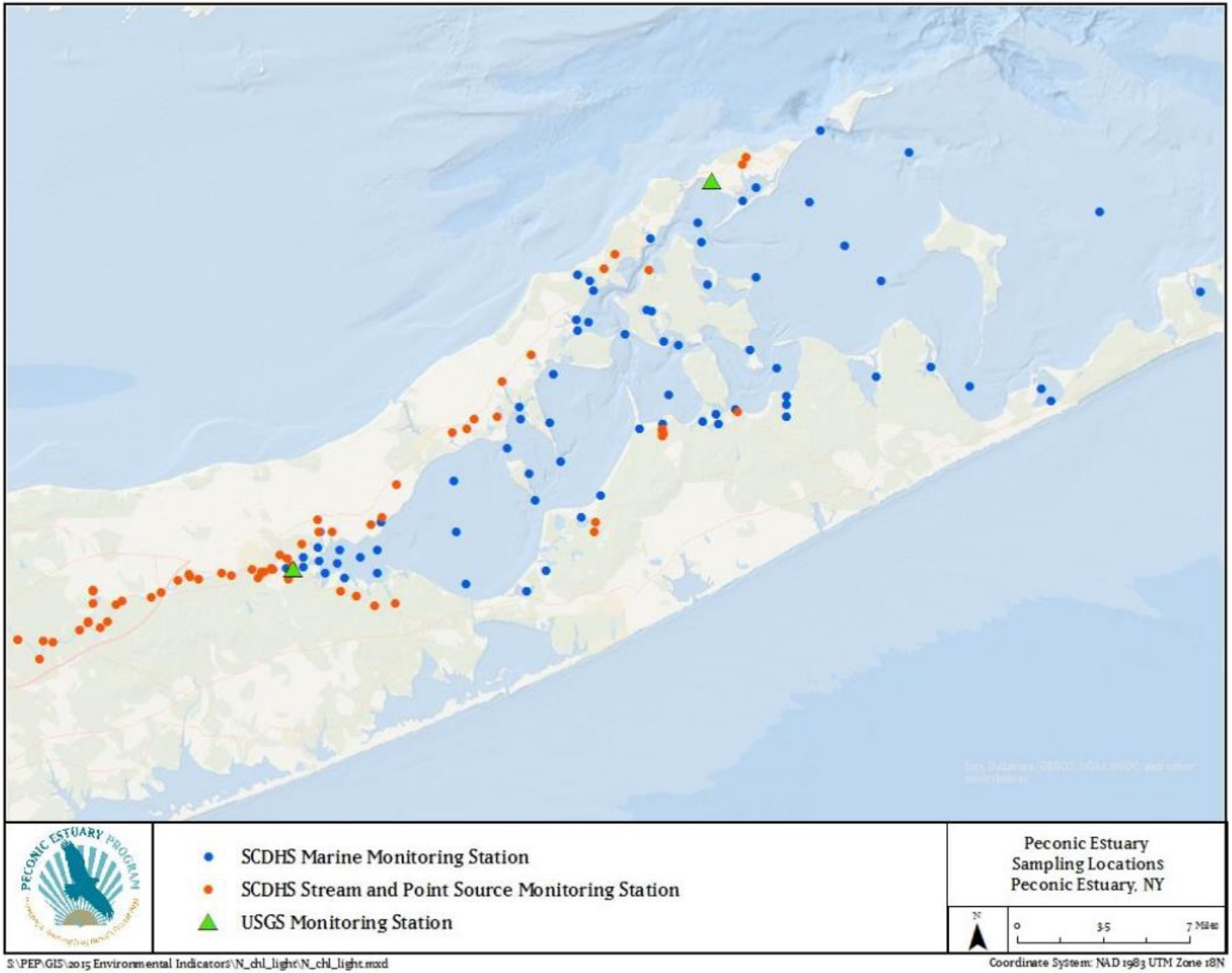
VIII. Surf Rider Foundation / Blue Water Task Force

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water Quality	**Fresh/Estuarine/ Marine Waters; Stormwater Ponds and Discharges**	**Surf Rider Foundation/ BWTF**	*Enterococcus*	Weekly in summer, bi-weekly in spring and fall, monthly during winter	50 stations in 2017 (number in Peconic Estuary not yet known)	2013-present	Data available at https://easternli.surfrider.org/wp-content/uploads/2018/06/2017_ELI-BWTF_WaterQualityAnalysis.pdf

IX. USGS continuous monitoring stations

Category	Water Type	Monitoring Entity	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Surface Water Quality	**Estuarine/ Marine**	**USGS**	Water stage (ft.) Water temp. (^{o}C) Spec. Cond. (uS/cm) Salinity (psu) DO (mg/l) Turbidity (FNU) Chlorophyll-a (ug/l) Nitrate (mg N/l) pH (standard units)	WQ monitoring at 6 to 30-min. intervals, depending on parameter	1 (Peconic River at County Highway 105 at Riverhead, NY)	August 2012 - present June 2017 – present	USGS site no. 01304562; data and metadata available at https://waterdata.usgs.gov/nwis/uv/?site_no=01304562 For location, see map below
	Estuarine/ Marine	**USGS**	Water stage (ft.) Water temp. (^{o}C) Spec. Cond. (uS/cm) Salinity (psu) DO (mg/l) Turbidity (FNU) Nitrate (mg N/l) pH (standard units)	WQ monitoring at 6 to 30-min. intervals, depending on parameter	1 (Orient Harbor at Orient, NY)	August 2012 - present	USGS site no. 01304200; data and metadata available at https://waterdata.usgs.gov/ny/nwis/inventory/?site_no=01304200&agency_cd=USGS For location, see map below

Note: USGS has also collected a large quantity of shorter-term (project-specific) surface and ground water quality data at numerous sites in the Peconic Estuary and its watershed. These historical data sets are available from the agency's NWIS website https://waterdata.usgs.gov/nwis.



Locations of USGS continuous monitoring stations with respect to SCDHS estuarine and freshwater water quality stations. (Source: PEP)

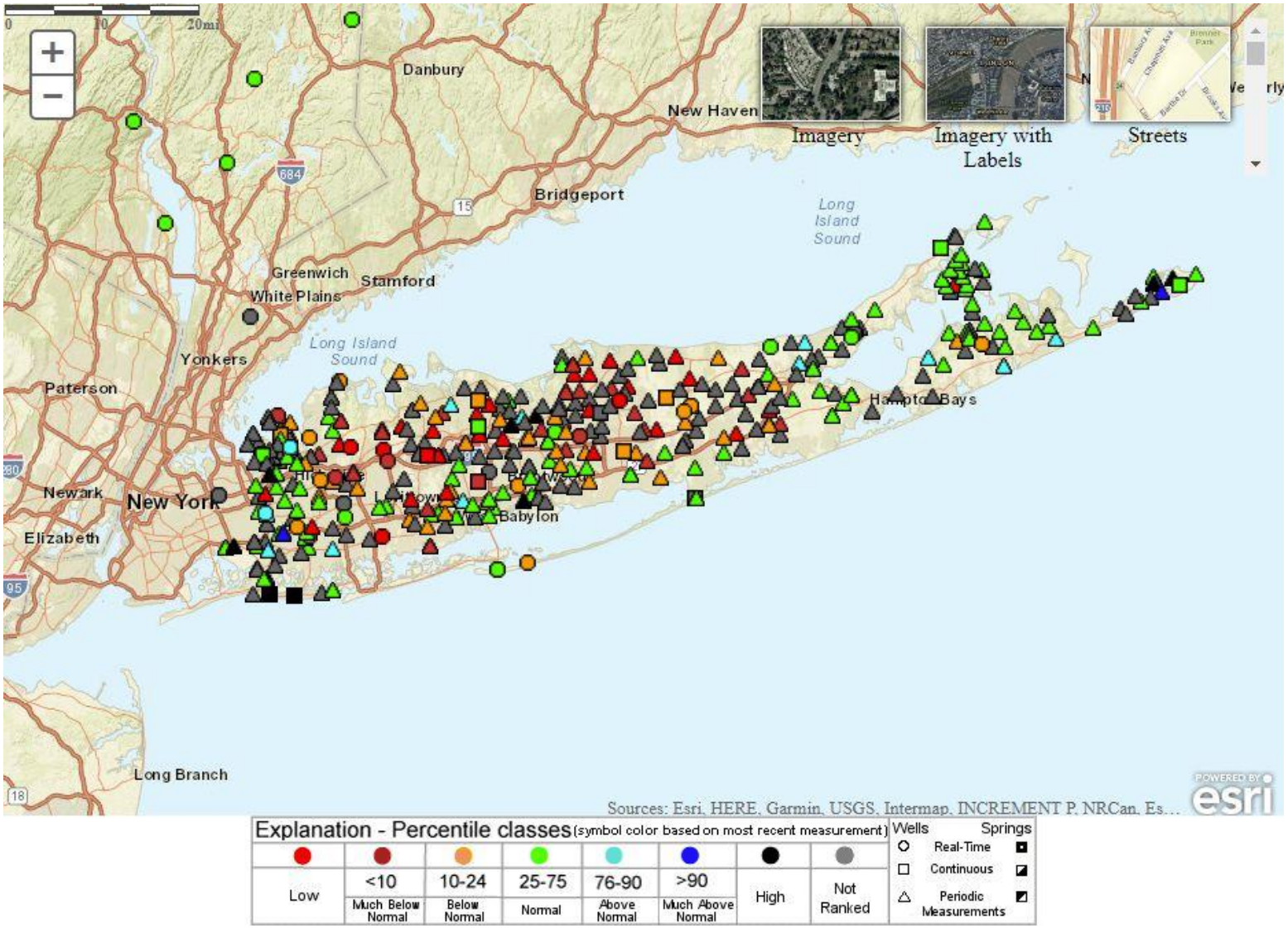
X. Data to support calculation of pollutant loading estimates:

Category	Source Type	Monitoring Entities	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Pollutant Loadings	**Atmospheric Deposition**	SCDHS through the National Atmospheric Deposition Program (NADP) Office (Wisconsin State Laboratory of Hygiene)	National Trends Network (NTN): pH conductance sulfate chloride nitrate, orthophosphate ammonium calcium magnesium sodium potassium	Continuous (wet deposition only)	1	2003 to present	Data available at http://nadp.slh.wisc.edu/data/sites/siteDetails.aspx?net=NTN&id=NY96 NADP also provides calculated estimates of annual TN deposition (for the years 2000 – present) at http://nadp.slh.wisc.edu/committees/tdep/tdepmaps/
			Clear Air Status and Trends Network (CASTNET): nitric acid nitrate ammonium sulfur forms chloride base cations	Continuous (dry deposition only)	4	1993 to present	
			Ambient Ammonia Monitoring Network (AMoN): ammonia gas (NH_3)	Continuous	1	2014 to present	

Category	Source Type	Monitoring Entities	Parameters	Sampling Frequency	No. Stations	Period of Record	Notes/Comments
Pollutant Loadings	**Surface Water (point sources)**	SCDHS USEPA and individual facilities	Flows and constituent concentrations	Variable	Variable	Variable	Data sources and methods for estimating point source loads for the Peconic Estuary are described in Lloyd (2014)[2]
Pollutant Loadings	**Surface Water (streams)**	USGS	Flow	Continuous	1	6/1942 – present	USGS gage 01304500, Peconic River at Riverhead, NY (partial-record flows, measured periodically, are also available from NWISWeb or on request from the USGS for several smaller tributaries to the Peconic Estuary)
		USGS SCDHS NYDEC	Constituent concentrations measured at or near stream gages	Variable	Variable	Variable	See previous listings for these WQ monitoring programs
Pollutant Loadings	**Ground Water**	USGS	Flow	Variable	Variable	Variable	Available data describing the rate of direct groundwater discharge consist of records of water table altitude, which document the hydraulic gradient to the Peconic Estuary (see p. 27 of Schubert, 1998[3]) and are available from NWISWeb.
		USGS	Constituent concentrations	Variable	Variable	Variable	Historical and recent ground water quality data are available from NWISWeb for many sites within the Peconic Estuary watershed.
		SCDHS	Constituent concentrations	Variable	Variable	Variable	Historical and recent ground water quality data are available from County monitoring programs for many sites within the Peconic Estuary watershed (see previous listing).

[2] Lloyd, S. 2014. Nitrogen load modeling to forty-three subwatersheds in the Peconic Estuary. The Nature Conservancy in partnership with the Peconic Estuary Program. (https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/Documents/Nitrogen%20load%20modeling%20to%20the%20Peconic%20Estuary%20-%20TNC%20May%202014.pdf)

[3] Schubert, C.E. 1998. Areas contributing ground water to the Peconic Estuary, and ground-water budgets for the North and South Forks and Shelter Island, eastern Suffolk County, New York. U.S. Geological Survey Water Resources Investigations Report 97-4136. Coram, NY.



Explanation - Percentile classes (symbol color based on most recent measurement)							
Low	<10 Much Below Normal	10-24 Below Normal	25-75 Normal	76-90 Above Normal	>90 Much Above Normal	High	Not Ranked

Wells	Springs
Real-Time	
Continuous	
Periodic Measurements	

Example of USGS groundwater monitoring network: a July 2018 snapshot from the USGS Groundwater Watch interactive mapper that provides information on hydrologic monitoring locations and groundwater levels for Long Island. (Source: https://www.usgs.gov/centers/ny-water/science/long-island-groundwater-network?qt-science_center_objects=0#qt-science_center_objects)