HRECOS Water Quality and Weather Stations
QUALITY ASSURANCE PROJECT PLAN

December 1, 2012
Version 2012.08

New York State Department of Environmental Conservation

Approval Signatures (on file with the HRECOS Coordinator)

_____Date _____
Alene Onion, HRECOS Coordinator, QA Officer for non NYSDEC DOW stations and Station Operator: Albany and Mohawk stations

_____Date _____
Michael Bocchi, Station Operator: Mohawk at Utica Water Quality Station

_____Date _____
Stuart Findlay, Station Operator: Schodack Island and Piermont Water Quality stations

_____Date _____
Wade McGillis, Station Operator: Piermont Pier Weather station

_____Date _____
Gary Wall, Station Operator: Schodack Island Weather station

_____Date _____
Sarah Fernald, Station Operator: Norrie Point and Tivoli stations

_____Date _____
Carrie Roble, Station Operator: Pier 84 Station

_____Date _____
Dave Runnels, HRECOS Database Manager

_____Date _____
Jason Fagel, DOW QA Officer

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DISTRIBUTION LIST

The following individuals must receive a copy of the approved QAPP in order to complete their role in this project. Note if copy will be electronic or hard copy.

Name	Organization	Document type
Alene Onion	New England Interstate Water Pollution Control Commission for the NY State Department of Environmental Conservation	Electronic
Michael Bocchi	NYS DEC DOW	Electronic
Stuart Findlay	Cary Institute	Electronic
David Fischer	Cary Institute	Electronic
Wade McGillis	Lamont-Doherty Earth Observatory	Electronic
Diana Hsueh	Lamont-Doherty Earth Observatory	Electronic
Gary Wall	US Geological Survey	Electronic
Sarah Fernald	Hudson River National Estuarine Research Reserve	Electronic
Christopher Mitchell	Hudson River National Estuarine Research Reserve	Electronic
Carrie Roble	Hudson River Park Trust	Electronic
David Runnels	Stevens Institute of Technology	Electronic
Jason Fagel	NY State Department of Environmental Conservation	Electronic

INTRODUCTION

The Hudson River Environmental Conditions Observing System (HRECOS) was established in 2008 to provide high frequency real-time data geographically distributed across large rivers in the Hudson River watershed. HRECOS consists of water quality and weather stations operated by a consortium of partner institutions from the government and research community who collaborate to report data in real-time to a public website (www.hrecos.org).

This QA project plan has been prepared to clearly delineate the field methods, data review, and documentation and reporting procedures for the HRECOS water quality and weather stations. These stations include: Mohawk at Lock 8, Port of Albany, Schodack Island, Tivoli Bays, Norrie Point, Marist Pump Station, Piermont Pier, and Pier 84.

The HRECOS Pump Station at Marist College includes a water quality sonde and equipment for collecting grab water samples under specified conditions. The operation of the water quality sonde is defined by this QAPP. The operation of all other equipment is defined by a separate document: The HRECOS Pump Station Quality Assurance Project Plan.

The HRECOS equipment on board the Sloop Clearwater is purely for educational purposes and is operated by external partners using external funds. For these reasons, this QAPP no longer applies to the equipment on board the Sloop Clearwater.

I. PROJECT MANAGEMENT

1. Organization/Responsibilities

A list of participants and their respective responsibilities are given in Table 1.

Organization Chart

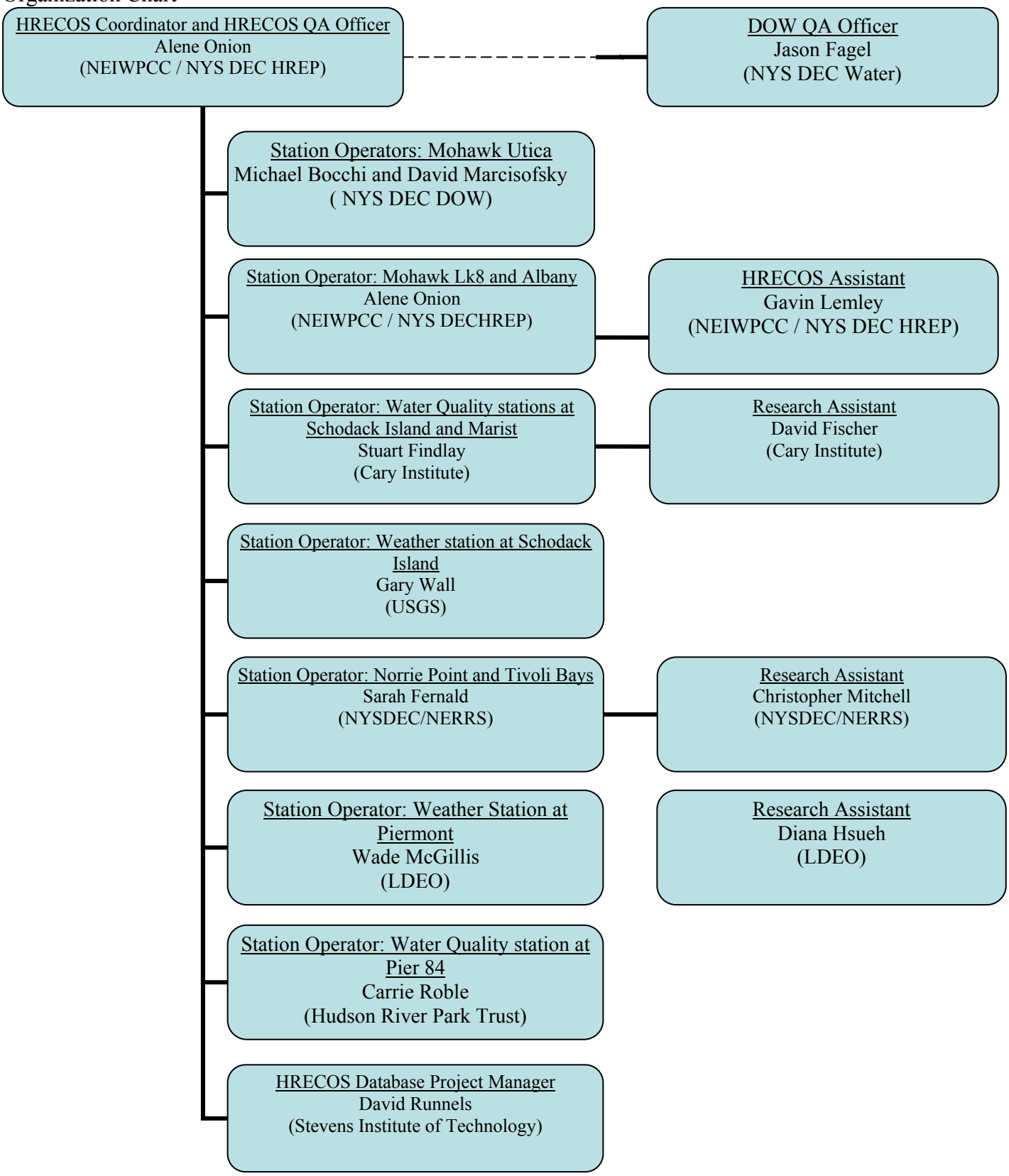

Table 1. HRECOS Estuary Participants

	Title	Responsibilities	Contact Information
Jason Fagel	DOW QA Officer	The DOW QA Officer will review and approve this QAPP and all associated SOP documents and will perform audits of NYSDEC DOW station managers.	jrfagel@gw.dec.state.ny.us 518 402 8156
Alene Onion NYSDEC HREP	HRECOS Coordinator	Manages HRECOS Budget including but not limited to the construction of new stations and the purchase and distribution of spare parts and consumables. Coordinates quality control and corrective actions. Maintains all metadata files in collaboration with the station operators. Collaborates with the HRECOS Database Manager to manage HRECOS database.	amonion@gw.dec.state.ny.us. 518-402-8166
	HRECOS QA Officer	Coordinates quality control and corrective actions. Performs annual audits of all station managers who are not NYSDEC DOW personnel.	amonion@gw.dec.state.ny.us. 518-402-8166
	Station Operator – Mohawk Lk 8 and Albany	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data flagging.	amonion@gw.dec.state.ny.us. 518-402-8166
Gavin Lemley NYSDEC HREP	HRECOS Assistant	Assists the HRECOS coordinator with data management and station operation tasks.	gmlemley@gw.dec.state.ny.us
Michael Bocchi and David Marcisofsky NYS DEC Water	Station Operator – Utica Water Quality	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data flagging.	mjbocchi@gw.dec.state.ny.us 315 793 2561 demarcis@gw.dec.state.ny.us
Stuart Findlay Cary Institute of Ecosystem Studies	Station Operator – Schodack Island, Marist and Piermont Water Quality.	Supervision of the Research Assistant. Monitoring the real-time data stream for abnormalities. Performs HRECOS assessments of site representativeness	findlays@caryinstitute.org 845-677-7600 x 138
David Fischer Cary Institute of Ecosystem Studies	Research Assistant – Schodack Island,Marist and Piermont Water Quality	Instrument calibration, maintenance, and repair. Data flagging.	fischerd@caryinstitute.org
Gary Wall USGS	Station Operator – Schodack Island Weather	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data upload and management. Data flagging.	grwall@usgs.gov 518-285-5621
Sarah Fernald NYSDEC/NERRS	Station Operator – Tivoli Bays and Norrie Point Water Quality and Weather	Supervision of the Research Assistant. Monitoring the real-time data stream for abnormalities. Managing the HRNERR Monitoring Budget.	shfernal@gw.dec.state.ny.us 845-889-4745 x 111
Christopher Mitchell NYSDEC/NERRS	Research Assistant – Tivoli Bays and Norrie Point Water Quality and Weather	Instrument calibration, maintenance, and repair. Station programming, maintenance and repair. Data upload and management. Data flagging.	cgmitche@gw.dec.state.ny.us 845 889 4745 (119)
Wade McGillis LDEO	Station Operator - Piermont Pier Weather	Supervision of the Research Assistants.	wade.mcgillis@columbia.edu 845 677 7600 x138
Diana Hsueh LDEO	Research Assistant – Piermont Pier Weather	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data upload and management. Data flagging.	hsueh.diana@gmail.com
David Runnels Stevens Institute of Technology	HRECOS Database Project Manager	Manages the HRECOS database and the HRECOS website in collaboration with the HRECOS Coordinator.	drunnels@stevens.edu
Carrie Nobel Hudson River Park Trust	Station Operator – Pier 84 Water Quality	Monitoring the real-time data stream for abnormalities. Instrument calibration, maintenance, and repair. Data flagging.	croble@hrpt.ny.gov

2. Background – Description of Problem

Fundamental knowledge of the Hudson River Watershed, its resources and management has progressed dramatically over the past 25 years. Understanding of the river system, however, has been hampered by manual approaches to data collection that cannot adequately capture rare events or describe rapid fluctuations and episodic pulses in environmental conditions.

The HRECOS stations established in the major rivers of the Hudson River Watershed make available continuous information and real-time data on water quality and weather conditions. These data have broad use to the communities of the Hudson Watershed including academic, environmental management, industrial, recreational and educational purposes. For this reason, there are multiple partners external to the NYS DEC who value the data and have committed their own time and resources to the maintenance and growth of this network.

The NYS DEC is committed to the continued operation of this network primarily for the purpose of environmental management. HRECOS stations are used to define ambient river conditions and to assess a variety of anthropogenic impacts across the watershed. For example, permit engineers in the Division of Water track the impacts of CSOs and SSOs with the HRECOS stations in Albany and Utica.

HRECOS stations are also used to manage the Hudson River resources. For example salinity and temperature data from all stations help managers to track anadromous fish migrations every spring and fall. Dissolved oxygen concentrations help managers to assess the beneficial impacts of submerged aquatic vegetation (SAV). Most significantly, the HRECOS network has been crucial in determining the impacts of episodic storm events like superstorm Sandy and tropical storms Irene and Lee. For example, these high frequency data captured surges in primary production, dramatic losses in SAV populations, and contributed to sediment discharge estimates which for tropical storms Irene and Lee were 2.75 million tons.

Finally, NYS DEC educators have done excellent work bringing HRECOS into the classroom. Although this isn't the primary purpose of the network, it is a significant benefit. Thousands of students have been able to access the Hudson and Mohawk Rivers from their classrooms via place-based educational curricula developed by NYS DEC's Hudson River Estuary Program and Hudson River National Estuarine Research Reserve Program.

3. Project/Task Description

3.1 Network Description

A network of stations is established in the Hudson River Watershed which record water quality and weather data once every fifteen minutes. All stations operate year round except the Tivoli Bays water quality stations where instruments are removed during the ice season (January – April) to avoid equipment damage and because of dangerous conditions. The complete list of parameters for every station is given in Table 2 and a map of all station sis given in figure 2.

3.2 Funding Status

At this time, HRECOS is partially funded and dependent on the voluntary contribution of equipment and time from the partner institutions.

3.3 Project Schedule

The schedule for implementing this project is outlined in Table 3.

Table 2: Parameters Recorded at Each HRECOS Station

Parameter	Mohawk Utica	Mohawk Lock 8	Albany	Schodack Island	Tivoli Bays	Norrie Point	Marist Pump St.	Piermont	Pier 84
Water Temperature	√	√	√	√	√	√	√		√
Specific Conductivity	√	√	√	√	√	√	√		√
Salinity				√	√	√	√		√
Dissolved Oxygen	√	√	√	√	√	√	√		√
Depth			√	√	√	√			√
Water Elevation		√	√	√	√	√	√		
pH	√	√	√	√	√	√	√		√
Turbidity	√	√	√	√	√	√	√		√
Chlorophyll					√	√			
Air Temperature	√	√	√	√	√	√		√	√
Barometric Pressure	√	√	√	√	√	√		√	√
Relative Humidity	√	√	√	√	√	√		√	√
Wind Speed	√	√	√	√	√	√		√	√
Wind Direction	√	√	√	√	√	√		√	√
Radiation	√	√	√	√	√	√		√	
Rainfall	√	√	√	√	√	√		√	√

Figure 2. Sample Distribution/Map

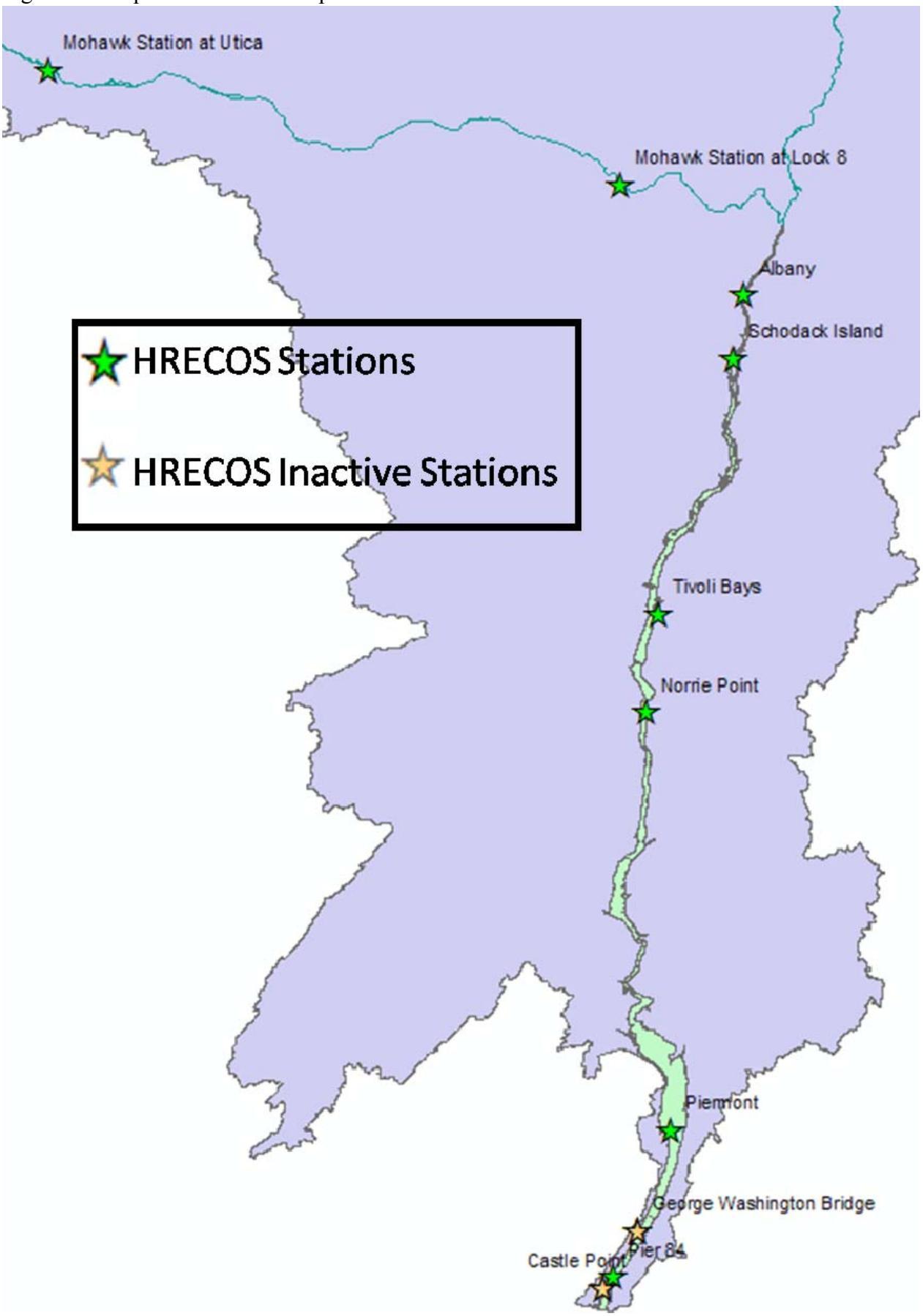

Table 3: Project Schedule

Task	Completion Date
QAPP and SOPs submitted for review	December 1, 2012
QAPP and SOPs approved	December 31, 2012
Sample Collection	Every 15 minutes
Quarterly Flagging Procedures Completed	Within 3 months of the end of the quarter
Final annual files and metadata files	Within 3 months of the end of the year.

4. Quality Objectives and Criteria

4.1 Precision and Accuracy

The precision and accuracy criteria for all parameters measured by HRECOS water quality and weather stations are given in Table 4. In addition, total dissolved solid samples are collected and analyzed by an ELAP certified laboratory for the Annual Assessment of Site Representativeness. These analyses must have an accuracy of at least +/- 0.1 mg/L and a precision of at least 20 relative percent difference (RPD).

4.2 Representativeness

Basin wide representativeness is not a goal of this project. Instead, the station locations are chosen to address a local need (see Section II for each local justification). The following requirements ensure the HRECOS stations are representative of the local conditions:

4.2.1 Ensuring Site Representativeness for Water Quality Stations

4.2.1.1 Station Location

Water quality stations must be located on structures such as a bulkhead, dock, pier, or piling which capture as close to main channel conditions as possible. For the same reason, sensors must be installed at least 0.5 meters from the river bottom. The location also must avoid influence by local outfalls, tributaries, and/or marsh systems. Ideally, cross channel conditions should be uniform both for solutes and particulates.

4.2.1.2 Assessment of Site Representativeness

Since conditions are subject to change, a cross channel assessment should be conducted annually if funding allows or at least once every five years to properly describe the representativeness of each HRECOS station for the user community.

4.2.2 Ensuring Site Representativeness for Weather Stations

Weather stations must be located on the shoreline and far enough away from tall buildings or trees to prevent shading during any time of the day. Specific requirements for each weather sensor are provided in the HRECOS SOP 2012.02: Weather Monitoring Standard Operating Procedure.

4.3 Comparability

In order to ensure comparability across the network, all HRECOS stations must use a YSI EXO2, a YSI 6600 V2 or YSI 6920 V2 water quality sonde with attached YSI 6560 or EXO temperature / conductivity probe, YSI 6150 or EXO dissolved oxygen probe, YSI 6589 or EXO ph probe, and the YSI 6136 or EXO turbidity probe. We have found that sondes from different manufacturers provide significantly different results.

Stations may use any depth sensor or weather monitoring equipment as long as it meets the precision and accuracy requirements given in Table 4.

4.4 Completeness

Our goal is to record and accept after QAQC checks at least 90% of the total possible observations. Since a measurement is collected once every fifteen minutes, the maximum number of observations would be 35040 per year for every parameter. Therefore, it is our goal that each station records at least 31536 observations per year for every parameter.

Table 4. Precision and Accuracy Criteria for HRECOS Water Quality and Weather Stations

Temperature	Range	-5 to +45°C
	Resolution	0.01°C
	Accuracy	±0.15°C
Conductivity	Range	0 to 100 mS/cm
	Resolution	0.001 to 0.1 mS/cm (range-dependent)
	Accuracy	±0.5% of reading + 0.001 mS/cm
Salinity	Range	0 to 70 ppt
	Resolution	0.01 ppt
	Accuracy	±1% of reading or 0.1 ppt, whichever is greater
Dissolved Oxygen % Saturation	Range	0 to 500%
	Resolution	0.1%
	Accuracy	0-200% air saturation: +/-1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading
Dissolved Oxygen mg/L	Range	0 to 50 mg/L
	Resolution	0.01 mg/L
	Accuracy	0-20 mg/L: +/-0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/-15%
Acidity	Range	0 to 14 pH units
	Resolution	0.01 unit
	Accuracy	±0.2 unit
Depth	Range	0 to 9 m
	Resolution	0.001 m
	Accuracy	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m
Turbidity	Range	0 to 1,000 NTU
	Resolution	0.1 NTU
	Accuracy	+/- 2 % of reading or 0.3 NTU (whichever is greater)
Chlorophyll	Range	0 to 400 ug/L chl a; 0 to 100 RFU
	Resolution	~ 0.1 ug/L
	Accuracy	0.1 ug/L chl a, 0.1% FS
Air Temperature	Range	-40ºC to +60 ºC
	Accuracy	± 0.2 ºC @ 20 ºC
Relative Humidity	Range	0 to 100% non-condensing
	Accuracy	at 20 ºC: ± 2% RH (0-90%), ±3% RH (90-100%)
Barometric Press.	Range	500-1100 mbar
	Accuracy	+/- 0.3 mbar at +20ºC
Wind Speed	Range	0 to 44 m/s
	Accuracy	±0.5 m/s; ±3% 17 to 30 m/s; 4% 30 to 47 m/s
Wind Direction	Range	0 to 358°, 2° Dead Band
	Accuracy	±5 Degrees
Radiation	Range	0-1280 µA
	Accuracy	typically 5 µA per 1000 µmoles s-1 m-2
Precipitation	Range	Temperature: -20° to +70°C; Humidity: 0 to 100%
	Accuracy	±1.0% at up to 20 mm per hour

5. Training Requirements/Certifications

The HRECOS Coordinator will ensure that all individuals involved with the project receive and are familiar with this document to ensure proper adherence to the procedures outlined within.

New staff must perform side-by-side calibration and maintenance procedures with an experienced staff member at least three times and have demonstrated capability before operating independently. Individual station managers are responsible for training their staff and insuring that training has been documented; annual audits ensure a consistent level of effort across the network.

6. Documentation and Records

6.1 HRECOS QAPP Distribution and Amendments

The HRECOS Coordinator maintains the official approved Quality Assurance Project Plan for the HRECOS Water Quality and Weather Stations. Any modifications to the QAPP require a signature from all the station operators, the HRECOS Database Manager, the HRECOS Coordinator and the NYSDEC DOW Quality Assurance Officer. Copies of the amendments will be sent electronically and signatures may be received by mail or as scanned copies.

6.2 Calibration Logs

Each Station Operator is responsible for maintaining calibration logs for their own station. Updated metadata files must be sent to the HRECOS Coordinator within three months after the end of the calendar year.

6.3 Results of the Assessment of Site Representativeness

Each water quality station must be assessed at least once every five years for site representativeness. These results are summarized in the metadata file for each station.

6.3 HRECOS Database

The HRECOS database is managed by the HRECOS Coordinator and the Stevens Institute of Technology according to the Data Handling and Archival Standard Operating Procedure (HRECOS SOP 2012.07).

6.4 Annual Historical Files and Metadata Files

Within three months after the end of the calendar year, the HRECOS Coordinator compiles all the verified data for a station into an annual data file. She also compiles all the metadata for each station including specific comments from each station operator, instrument calibration results, and the results of the cross channel assessment. Both the annual files and the metadata are posted to the historical data page of the HRECOS website: www.hrecos.org. The metadata files are also associated with each station in the "Current Conditions Page." As a backup, the HRECOS Coordinator will maintain a copy of all the annual files and metadata files on her desktop computer for at least 20 years.

II. DATA GENERATION AND ACQUISITION

1. Sampling Methods

1.1 Water Quality Measurements

The following water quality parameters are recorded by a YSI EXO2, 6600 or 6920 sonde according to the Water Quality Monitoring Standard Operating Procedure (HRECOS SOP 2012.12): water temperature, conductivity, salinity, turbidity, dissolved oxygen, dissolved oxygen saturation, acidity, and water depth. Sondes are swapped with newly calibrated instruments at the end of each deployment to avoid breaks in data collection and are assessed (within one week) by a post calibration to determine instrument drift. Sondes are never deployed for a period longer than three months.

Water depth is measured by an OTT bubbler at the Albany, Mohawk Lock 8 and Marist stations. These instruments are maintained according to USGS standard operating procedure.

For the Assessment of Site Representativeness: Total suspended sediments samples collected according to the DOWSOP 201-12: Collection of Ambient Water Quality Samples and are processed by an ELAP certified lab which may use any equipment that meet the required detection limit given in section I.4.

The specific equipment found at each water quality and weather station are given in Table 5.

1.2 Weather Measurements

The following weather parameters are measured according to the Weather Monitoring Standard Operating Procedure (HRECOS SOP 2012.02): air temperature, barometric pressure, dew point, radiation, rainfall, relative humidity, wind speed, wind direction, wind gusts. The purpose of this document is to provide the minimum operation and maintenance requirements; some stations use site specific SOPs which satisfy these minimum requirements. Tivoli Bays and Norrie Point station operators use the site specific HRECOS SOP 2012.04: National Estuarine Research Reserve SWMP Campbell Scientific CR1000 Weather Monitoring Station Standard Operating Procedure. Piermont station operators use site specific HRECOS SOP 2012.03 Piermont Meteorology Station Standard Operating Procedure.

1.3 Power Supply

All stations are powered by a solar panel with a backup marine battery.

1.4 Data Recording and Transmission

Data are recorded by a data logger and transmitted to the HRECOS database via satellite, cellular modem, wireless transmitter, or direct internet connection. Operation of the solar panel, data logger and data transmitter are performed according to the manufacturer's instructions.

1.5 Real-Time Data Calculations

In near-real time the HRECOS database calculates the following parameters: daily rainfall accumulation, water elevation relative to NAVD88 (Hudson River) or NGVD29 (Mohawk River), dew point, and corrected depth (for Schodack Island only whose depth sensor is not vented to the atmosphere).

1.6 Quarterly Data Calculations

Once per quarter, the HRECOS Coordinator updates the Database with data modifications. First, the HRECOS Coordinator calculates and uploads corrected depth measurements for Tivoli North (whose depth sensor is not vented to the atmosphere but cannot be corrected in real-time). Second, the HRECOS Coordinator inserts any data that were lost due to data transmission issues. Specifics for the maintenance of the HRECOS database and

website are provided in the Data Handling and Archival Standard Operating Procedure (HRECOS SOP 2012.07).

1.7 Assessments of Site Representativeness

Assessments of site representativeness are performed every year or as funding permits: To determine how well the shore-mounted sites capture variability across the channel, water samples are collected from the river transect and analyzed for total suspended solids (TSS), turbidity, conductivity, pH, dissolved oxygen, and temperature. These parameters match those collected by the HRECOS water quality stations except TSS. We added TSS because turbidity is often used as a proxy for TSS and many of our users are interested in the local accuracy of this correlation.

Three points along the east/west river transect are sampled; at each point, two samples are collected each from the surface, mid-depth and the near-bottom for a total of 18 samples. The turbidity, conductivity, pH, dissolved oxygen, and temperature measurements are collected using a YSI 6600 sonde. A grab sample is collected according to DOW SOP 201-12: Collection of Ambient Water Quality Samples and submitted to an ELAP certified laboratory for analysis of total suspended solids (TSS) according to Standard Methods for Examination of Water and Wastewater, #2540D. Total Suspended Solids Dried at 103-105^{o}C.

That same day, an ISCO Automatic Sampler is deployed for 24 hours at a location within 6 meters of the HRECOS station being analyzed. This sampler collects twenty four (24) discrete hourly grab-samples according to the Grab Sample guidelines provided in section 8 of DOWSOP 301-11: Wastewater Sample Collection. These samples are collected at the end of the 24h collection period and sent to an ELAP certified laboratory for analysis of total suspended solids (TSS) according to Standard Methods for Examination of Water and Wastewater, #2540D. Total Suspended Solids Dried at 103-105^{o}C.

Custody procedures for the total dissolved solid samples collected for this assessment are defined by DOWSOP 301-11: Wastewater Sample Collection which requires a chain of custody form for each sample collection.

Any participants riding or driving a boat are required to have a NYS Boating Safety Certificate.

The Schodack Island Water Quality Station Operator, Research Assistant, and the HRECOS Coordinator will be responsible for collecting these samples and transporting them to the laboratory.

1.8 Station Specific Information

1.8.1 Mohawk Utica Station

Justification:

The new HRECOS station in the Mohawk River at Utica will be installed in March 2013. The primary use for this station will be to monitor the impact of CSOs and SSOs on ambient river conditions. This community is investing considerable effort and resources to improving the water quality in this section of the Mohawk River.

Instrumentation

The Mohawk Utica station is a water quality station only. A YSI Harbor Buoy will be installed in the main channel of the Mohawk River upstream of the Frankfort Marina (43.04479 N latitude,-75.069559 W longitude). The water depth at this location is approximately 5m. Sensors will be deployed 2.5 meters from the surface and will report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, and Water Temperature.

Location Access:
The Mohawk Utica station is located in the mid channel of the Mohawk River northwest of the Frankfort Marina. The river channel is open to public access but instruments are secured in a locked enclosure. Researchers interested in accessing these enclosures to co-locate monitoring equipment or to collect grab samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166).

1.8.2 Mohawk Lock 8 Station
Justification:
The HRECOS station at the Lock 8 was installed primarily to provide advanced flood warnings to Schenectady County Emergency Managers. This reach of the lower Mohawk River has chronic ice jam problems, particularly between the Stockade District and Rexford Knolls where water levels can rise 4.5 meters or more. High frequency water level data from this station will provide forecasts and life- and property-saving flood warnings.

The Mohawk is the largest tributary to the Hudson (and the greatest source of sediment) but a small percentage of monitoring and management efforts have been directed toward it. High frequency monitoring at the HRECOS Mohawk Lock 8 station will greatly improve existing models of water quality, tidal flow and sediment transport in the Hudson Estuary system.

Instrumentation
The water quality station for Mohawk Lock 8 is at the downstream end of the sheet piling below Lock 8 (42.828147 N latitude,-73.990376 W longitude). Water depth at this location is approximately 5.5 meters when the locks are down (June – December) and approximately 2 meters when the locks are up. Sensors are deployed approximately 1.5 meters off the bottom and report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, and Water Temperature. Water elevation relative to NGVD29 is calculated from water depth in real-time by the HRECOS database (Water Elevation = 60.96m + water depth).

The weather station for Mohawk Lock 8 is just north of the lock 8 buildings (42.830139 N latitude,-73.992523 W longitude). Sensors are installed on a 3 meter tower that is above nearby vegetation and over 15 meters from any nearby structure. Sensors report air temperature, barometric pressure, radiation, rainfall, relative humidity, wind speed, wind direction, wind gusts. Dew point and cumulative rainfall are calculated by the HRECOS database in real-time.

Location Access
The Lock 8 Mohawk water quality station is located at Lock 8 of the Erie Canal. The grounds are public property and easily accessed but instruments are secured in locked enclosures. Researchers interested in accessing these enclosures to co-locate monitoring equipment or to collect grab samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166).

1.8.3.Albany Station
Justification
The Albany Port station is located at the southern edge of the Albany pool, where the impact of CSOs on ambient river conditions is the focus of a considerable water quality improvement effort to restore the river for recreational use. The HRECOS data has already been used by regulators to identify dissolved oxygen fluctuations that were missed by less frequent monitoring.

Instrumentation
The water quality station for Albany is on the concrete reinforced shoreline just to the south of the Cargill Grainery on the western edge of the Port of Albany (42.61954 N latitude, -73.75890 W longitude). The channel depth at this location is 10 meters. Sensors are deployed 2.5 meters from the surface and report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, Water Temperature, and Water Depth. Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = -2.0514m + water depth).

The weather instrumentation is also on the concrete reinforced shoreline just to the south of the Cargill Grainery on the western shore of the Port of Albany (42.61954 N latitude, -73.75890 W longitude). Sensors are installed on a 3 meter tower that is above nearby vegetation and over thirty meters from nearby structures. Sensors report air temperature, barometric pressure, dew point, radiation, cumulative rainfall, rainfall, relative humidity, wind speed, wind direction, wind gusts.

Location Access:
Albany station is located within the Port of Albany. The Albany Port is not publically accessible and the HRECOS instruments are secured in locked enclosures. Researchers interested in accessing these enclosures to co-locate monitoring equipment or to collect grab samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166) and Richard Hendrick, Port of Albany General Manager (518 463 8763).

1.8.4 Schodack Island Stations
Justification:
The Schodack Island water quality station was installed by external partners the year the HRECOS network began. The purpose of this station was to provide a shallow water, upriver comparison to the mid and lower river stations already in place.

Instrumentation
The water quality station for Schodack Island is immediately south of the Schodack Island State Park boat launch and is fixed to the steel bulkhead. Total water depth is approximately 2m at this location. Sensors are deployed 0.5m from the river bottom and report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, Water Temperature, and Water Depth. Water depth measurements are corrected in real-time because the depth sensor is not vented to the atmosphere (Corrected Depth = Depth + ((1013- Barometric Pressure) * .0102)). Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = -1.48265 + water depth).

The weather instrumentation is on a small island (42°30'4.32"N, 73°46'49.37"W) just west of Schodack Island State Park (SISP) and just south of the I-90 by-pass bridge. Sensors are attached to the tower holding the navigation aids (marker # 197) and report air temperature, barometric pressure, radiation, rainfall, relative humidity, wind speed, wind direction, wind gusts. Dew point and cumulative rainfall are calculated by the HRECOS database in real-time. The island is at least 130 m from either shore so there is no interference from nearby vegetation or ridgelines. The island is owned by the U.S. Coast Guard.

Location Access:
The Schodack Island water quality station is publically accessible but instruments are secured in locked enclosures. The weather station is on private property and is not publically accessible. Researchers interested in accessing the locked water quality enclosure to co-locate monitoring equipment or to collect grab samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166). Researchers interested in accessing the weather station must obtain permission from the HRECOS Coordinator as well as the U.S. Coast Guard Saugerties, NY office ((845) 246- 7612).

1.8.5 Tivoli Bays Stations

Justification:

The objective of this station is to monitor surface water quality at the Tivoli Bays component of the Hudson River National Estuarine Research Reserve (NERR). Two tidal freshwater wetlands, Tivoli North Bay and Tivoli South Bay are monitored using four dataloggers (YSI 6600 sondes). In Tivoli North Bay and Tivoli South Bay the dataloggers monitor the ebbing and flooding Hudson River water. These data are included in the HRECOS network also. In Stony Creek and Saw Kill Creek, the dataloggers are deployed above the area of tidal influence and monitor the quality of water entering the Tivoli Bays via stream flow. These data are not included in the HRECOS network but may be accessed through the NERR website: http://www.hrnerr.org/. Thus, the relative importance of stream flow and tidal exchange and the potential impacts of intertidal areas on the water quality of the Tivoli Bays can be determined.

Monitoring the water quality of the tributaries is important because it has previously been determined that urban and residential land use practices are markedly influencing the water chemistry of the tributaries, especially Saw Kill Creek. Since residential coverage continues to increase, we hope that the intensive monitoring of the surface waters in these watersheds will identify trends associated with this rapid development. Examining the influence of tidal exchange allows identification of long-term trends in the water quality of the Hudson River Estuary at this location and the potential inputs to the Estuary from the Tivoli Bays. Finally, the influence of intertidal areas on water quality within the Tivoli Bays is interesting because of the potential impacts of both floating and emergent invasive plant species present in this system.

Instrumentation:

The Tivoli weather station is located at the Bard College Field Station in Annandale, NY (42°01'05.46"N 73°55'01.13"W). Sensors are elevated on a 30 foot, aluminum tower and record air temperature, barometric pressure, radiation, rainfall, relative humidity, wind speed, wind direction, wind gusts. Dew point and cumulative rainfall are calculated by the HRECOS database in real-time. Although trees surround the area, the tree line begins approximately 18 meters from the tower in most directions. The trees are at similar heights to the tower, but the sensors are not shaded at that location. The tower is approximately 1.2 miles southeast of the Tivoli South Bay water quality monitoring station, and 2.3 miles southeast of the Tivoli North Bay water quality monitoring station.

There are two water quality stations in the Tivoli Bays: one in the South Bay and a second in the North Bay. The water quality station in Tivoli South Bay is fixed to the concrete sidewall of the northernmost outlet (latitude 42° 01' 37.336" N, longitude 73° 55' 33.445" W). The depth at the sampling location ranges from 0.5 to 2.5 meters. Water quality sensors are deployed 0.5 meters off the bottom and record acidity, dissolved oxygen,chlorophyll, specific conductance, turbidity, water temperature, and water depth. Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = 0.175m + water depth).

The water quality station in Tivoli North Bay is fixed to an abandoned piling in the southernmost outlet (latitude 42° 02' 11.56464" N, longitude 73° 55' 31.16645"). The depth at the sampling location ranges from 0.5 to 3.0 meters. Water quality sensors are deployed 0.5 meters from the substrate and record Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, Water Temperature, chlorophyll, and Water Depth. Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = 0.076m + water depth). Corrected water depth is calculated retroactively once per quarter because the depth sensor is not vented to the atmosphere yet a real-time calculation is not possible (Corrected Depth = Depth + ((1013- Barometric Pressure) * .0102)).

Location Access:
Tivoli Weather and Tivoli North and Tivoli South Water Quality Stations are located within the NYS DEC Tivoli Bays Wildlife Management Area and within the boundary of the Hudson River National Estuarine Research Reserve. Researchers interested in accessing locked instrument housings to co-locate monitoring equipment or to collect the grab sample must obtain permission from the HRNERR Research Coordinator, Sarah Fernald (shfernald@gw.dec.state.ny.us, 845 889 4745 x 119) and Nathan Ermer, Manager of Tivoli Bays Wildlife Management Area (nmermer@gw.dec.state.ny.us, 845-256-3047).

1.8.6 Norrie Point Stations
Justification:
The Norrie Point water quality station was installed by external partners the year the HRECOS network began. Since the Tivoli stations monitor primarily marsh waters, a new station was added to monitor mid river conditions in comparison to the upriver and lower river stations.

Instrumentation
The Norrie Point water quality station is located on a piling off of the dock at the Norrie Point Environmental Center (41°49'53.80114"N 73°56'31.53180"W). The depth at the sampling location ranges from approximately 1.0 to 2.5 meters. Sensors are deployed approximately 1.0 meters off the bottom and report Acidity, Dissolved Oxygen, Specific Conductance, Turbidity, Water Temperature, and Water Depth. Water Elevation relative to NAVD88 is calculated from water depth in real-time (Water Elevation = -2.184 + sonde depth).

The Norrie Point weather station is located on the terrace of the Norrie Point Environmental Center in Staatsburg, NY (41°49'53.80114"N 73°56'31.53180"W). Sensors are mounted to a 30 foot tower and report Air Temperature, Barometric Pressure, Radiation, Rainfall, Relative Humidity, Wind Direction, Wind Gust, and Wind Speed. The tower is located approximately 40 yards from a building, and the sensors are not shaded at that location. The tower is approximately 130 yards southeast of the Norrie Point water quality monitoring station.
Location Access:
Norrie Point Weather and Norrie Point Water Quality Stations are located in the publically accessible Margaret Lewis Norrie State Park. Researchers interested in accessing locked instrument housings to co-locate monitoring equipment or to collect the grab sample must obtain permission from the HRNERR Research Coordinator, Sarah Fernald (shfernald@gw.dec.state.ny.us, 845 889 4745 x 119).

1.8.7.Marist Pump Station
Justification:
The Marist Pumped Monitoring Station was constructed for NYS DEC's Rotating Integrated Basin Studies program. This novel sampling technology allows researchers and regulators to collect water samples from the mid channel remotely or in response to a spike in water quality parameters including DO, turbidity, temperature, or conductivity. This specific location was selected because it is a historic RIBS sampling site for the lower Hudson River and because Marist College is a motivated partner for the continued maintenance and upkeep.

Instrumentation:
This QAPP will only address the water quality monitoring equipment at the Marist Pump Station. A description of all other instrumentation may be found in the HRECOS Pump Station Quality Assurance Project Plan.

The intake for the pump station is located 91 meters from the main channel and is raised by a tripod approximately 3 meters from the river bottom (41.720993 N,-73.942569 W). Water depth is 18 meters at this location. Water is pumped from this location into the pump house where water quality sensors record Acidity,

Dissolved Oxygen, Specific Conductance, Turbidity, and Water Temperature. A separate sensor records water elevation from the southern edge of the Marist Boat dock (41.720585 N,-73.938794 W).

Location Access:
The Marist Pump Station is a locked facility on the Marist campus. Researchers interested in accessing the station to co-locate monitoring equipment or to use the pump facility to collect samples must obtain permission from the HRECOS Coordinator, Alene Onion (amonion@gw.dec.state.ny.us, 518 402 8166), Marist College (Neil Fitzgerald, Neil.Fitzgerald@marist.edu, (845) 575-3000 ext. 2491), and USGS (Gary Wall, grwall@usgs.gov, 518 256 3016).

1.8.8 Piermont Stations
Justification:
This station was constructed by Lamont Doherty Earth Observatory as part of their laboratory located at the end of Piermont Pier in Piermont, NY. Scientists at this laboratory examine a wide range of topics including air/water gas exchange and ambient toxics concentrations.

Instrumentation:
The water quality station at Piermont Pier was destroyed by superstorm Sandy.

The weather station is on the roof of the Lamont Doherty Earth Observatory laboratory at the end of Piermont Pier in the village of Piermont, NY (41° 2' 35.6784"N, 73° 53' 47.6448"W). Sensors are mounted to a 15 foot tower and record air temperature, barometric pressure, solar radiation, relative humidity, rain, wind direction, wind gust, and wind speed. Dew point and cumulative rainfall are calculated by the HRECOS database in real-time. The building is at least 3 m from tree growth and the sensors are not shaded at this location.

Location Access:
Piermont Pier is publically accessible but instruments are secured in locked enclosures. Researchers interested in accessing locked instrument housings to co-locate monitoring equipment must obtain permission from the Piermont station operator, Wade McGillis (wade.mcgillis@columbia.edu, 845 677 7600 x138).

1.8.9. Hudson River Park – Pier 84 Station
Justification
The purpose of the Hudson River Park Pier 84 station is to generate a consistent and precise stream of water quality and atmospheric data for the general public and interested stakeholders. The goal in collecting this data is to ultimately inform Hudson River management policies, restoration efforts, and extreme event planning. This station was selected due to its location near the NYC Harbor and in lower Manhattan, one of the world's most heavily developed and densely populated urban environments.

Instrumentation
The Hudson River Park Pier 84 water quality station is located on the southeastern piling at the end of Pier 84's finger pier (40.7646 N,-74.0032 W). The total depth at this location ranges from 4.5 to 6 meters. Sensors are deployed approximately 2 meters off the bottom and record Dissolved Oxygen (mg/L and %sat), pH, Specific Conductance (µS/cm) and Salinity (ppt), Turbidity (NTU), Depth (m), and Water Temperature (°C).

The meteorological station is anticipated to be installed when power is restored at the Hudson River Park Trust classroom building at Pier 84 (40.7646 N,-74.0032 W). Power was lost at the building late October 2012 during Hurricane Sandy. The station will be located approximately 3 meters above Pier 84 and simultaneously record Air Temperature (°C), Relative Humidity (%), Wind Speed (m/s), Gust Speed (m/s), Wind Direction (°), Precipitation (mm), Solar Radiation (mmoles m-2) and Barometric Pressure (mbar).

Location Access

Pier 84 is publically accessible, but the instruments are strategically located and locked to prohibit tampering. Researchers interested in accessing the instrument are required to contact Carrie Roble (croble@hrpt.ny.gov) at Hudson River Park Trust to receive proper permitting and permission.

Table 5. Instrument Specifications

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
General Information	Date first operational	expected 3/2013	12/09/2011	01/04/2011	05/09/2008	07/01/1996	05/01/1995	06/16/2008	10/25/2012	12/19/2012
	Date of first transmission	expected 3/2013	01/04/2012	01/04/2011	05/09/2008	10/03/2006	11/15/2005	07/01/2008	10/25/2012	12/21/2012
	Data Logger Model	CR1000-ST-SW-NC	CR1000-ST-SW-NC	CR1000-ST-SW-NC	CR10X_PB	YSI 6600	YSI 6600 EDS	YSI 6600 V2/4	CR1000-ST-SW-NC	ISS-SER-CR200-C
	Data Transmitter	900 MHz spread spectrum Radio	900 MHz spread spectrum Radio	900 MHz spread spectrum Radio	Airlink Raven Cellular Modem	Sutron Model #SL2-G312-1 geo-stationary satellite data transmitter	Sutron Model #SL2-G312-1 geo-stationary satellite data transmitter	Sutron Model #SL2-G312-1 geo-stationary satellite data transmitter	Airlink Raven Cellular Modem	Raven XT Cellular Modem
	Collection Interval	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes	15 minutes
Temperature	Units	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (°C)	Celsius (◦C)
	Sensor type	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor	Thermistor
	Model #	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	EXO2 - 599870-01
	Range	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 45 °C	-5 to 35 °C
	Accuracy	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	+/-0.15 °C	±0.01 °C
	Resolution	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.01 °C	0.001 °C
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point
Salinity	Units				parts per thousand (ppt)	parts per thousand (ppt)	parts per thousand (ppt)	parts per thousand (ppt)	parts per thousand (ppt)	parts per thousand (ppt)
	Sensor type				Calculated from conductivity and temperature	Calculated from conductivity and temperature	Calculated from conductivity and temperature	Calculated from conductivity and temperature	Calculated from conductivity and temperature	Calculated from conductivity and temperature
	Range				0 to 70 ppt	0 to 70 ppt	0 to 70 ppt	0 to 70 ppt	0 to 70 ppt	0 to 70 ppt
	Accuracy				+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater	+/- 1.0% of reading or 0.1 ppt, whichever is greater
	Resolution				0.01 ppt	0.01 ppt	0.01 ppt	0.01 ppt	0.01 ppt	0.01 ppt
	Collection				One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Conductivity	Units	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm	mS/cm
	Sensor type	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with autoranging	4-electrode cell with auto ranging
	Model #	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	YSI 6560	EXO2 - 599870-01
	Range	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 100 mS/cm	0 to 200 mS/cm
	Accuracy	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	+/-0.5% of reading + 0.001 mS/cm	0 to 100: ±0.5% of reading or 0.001 mS/cm, w.i.g.; 100 to 200: ±1% of reading
	Resolution	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.001 mS/cm to 0.1 mS/cm (range dependent)	0.0001 to 0.01 mS/cm (range dependent)
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Dissolved Oxygen Saturation	Units	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)	percent air saturation (%)
	Sensor type	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning	Optical probe w/ mechanical cleaning
	Model #	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	EXO2 - 599199-01
	Range	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation	0 to 500% air saturation
	Accuracy	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading	0 to 200%: ±1% of reading or 1% saturation, w.i.g.; 200 to 500%: ±5% of reading
	Resolution	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation	0.1% air saturation
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Dissolved Oxygen	Units	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)	milligrams/Liter (mg/L)
	Sensor type	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity	Calculated from % air saturation, temperature, and salinity
	Model #	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	YSI 6150 ROX	EXO2 - 599199-01
	Range	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L	0 to 50 mg/L
	Accuracy	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater; 20 to 50 mg/L: +/- 15% of the reading	0 to 20 mg/L: ±0.1 mg/L or 1% of reading, w.i.g.; 20 to 50 mg/L: ±5% of reading
	Resolution	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point
Water Level (shallow depth)	Units	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)	meters (m)
	Sensor type	OTT Bubbler Sensor	OTT Bubbler Sensor	OTT Bubbler Sensor	Stainless steel strain gauge	Stainless steel strain gauge	Stainless steel strain gauge	Stainless steel strain gauge	OTT Bubbler Sensor	Pressure Transducer
	Vented to Atmosphere	vented	vented	vented	Non-vented (corrected for barometric pressure in real-time since EST 9/23/2011 00:00:00)	non-vented (corrected for barometric pressure in real-time since EST 9/23/2011 00:00:00)	vented	vented	vented	integral; non-vented
	Range	0-15.24 m	0-15.24 m	0-15.24 m	0 to 9.1 m	0 to 9.1 m	0 to 9.1 m	0 to 9.1 m	0-15.24 m	0-10 m
	Accuracy	0-4.6m: +/- 0.003 m; 4.6-10.7m: +/- 0.065%; 10.7-15.2m: +/- 0.006m	0-4.6m: +/- 0.003 m; 4.6-10.7m: +/- 0.065%; 10.7-15.2m: +/- 0.006m	0-4.6m: +/- 0.003 m; 4.6-10.7m: +/- 0.065%; 10.7-15.2m: +/- 0.006m	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m	0-3m: +/- 0.003 m; 3-9.1m: +/- 0.018 m	0-4.6m: +/- 0.003 m; 4.6-10.7m: +/- 0.065%; 10.7-15.2m: +/- 0.006m	±0.04% FS (±0.004 m or ±0.013 ft)
	Resolution	0.9 m/min	0.9 m/min	0.9 m/min	0.001 m	0.001 m	0.001 m	0.001 m	0.9 m/min	0.001 m
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Acidity	Units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
	Sensor type	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode	Glass combination electrode
	Model #	YSI 6589 Flat Glass	YSI 6589 Flat Glass	YSI 6589 Flat Glass	YSI 6589 Flat Glass	YSI 6561 Flat Glass	YSI 6561 Flat Glass	YSI 6561 Flat Glass	YSI 6589 Flat Glass	EXO2 - 599702
	Range	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units	0 to 14 units
	Accuracy	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	+/- 0.2 units	±0.1 pH units within ±10˚C of calibration temp; ±0.2 pH units for entire temp range
	Resolution	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units	0.01 units
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point
Turbidity	Units	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)	nephelometric turbidity units (NTU)
	Sensor type	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning	Optical, 90 ° scatter, with mechanical cleaning
	Model #	YSI 6136	YSI 6136	YSI 6136	YSI 6136	YSI 6136	YSI 6136	YSI 6136	YSI 6136	EXO2 - 599101-01
	Range	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0 to 1000 NTU	0-4000 NTU
	Accuracy	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	+/- 2 % of reading or 0.3 NTU (whichever is greater)	0 to 999 NTU: 0.3 NTU or ±2% of reading, w.i.g.; 1000 to 4000 NTU: ±5% of reading
	Resolution	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0.1 NTU	0 to 999 NTU = 0.01 NTU; 1000 to 4000 NTU = 0.1 NTU
	Collection	One point	One point	One point	One point	One point	One point	One point	One point	One point

Table 5. Instrument Specifications (continued)

Water Quality		Mohawk Utica	Mohawk Lock 8	Albany	Schodack	Tivoli N	Tivoli S	Norrie	Marist	Pier 84
Chlorophyll	Units					micrograms/Liter (ug/L)	micrograms/Liter (ug/L)	micrograms/Liter (ug/L)		
	Sensor type					optical fluorescence sensor	optical fluorescence sensor	optical fluorescence sensor		
	Model #					6025	6025	6025		
	Range					0 to 400 ug/L chl a; 0 to 100 RFU	0 to 400 ug/L chl a; 0 to 100 RFU	0 to 400 ug/L chl a; 0 to 100 RFU		
	Detection Limit					~ 0.1 ug/L	~ 0.1 ug/L	~ 0.1 ug/L		
	Resolution					0.1 ug/L chl a, 0.1% FS	0.1 ug/L chl a, 0.1% FS	0.1 ug/L chl a, 0.1% FS		
	Collection					One point	One point	One point		

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
General Information	Date first operational	01/04/2011	01/04/2011	04/25/2008	07/15/1999	01/17/2008	04/25/2008	12/19/2012
	Date of first transmission	01/04/2011	01/04/2011	04/25/2008	11/14/2005	02/15/2008	04/25/2008	12/21/2012
	Data Logger Model	CR1000-ST-SW-NC	CR1000-ST-SW-NC	CR10X_PB accessed from shore by a Campbell RF401 spread spectrum radio	Campbell CR1000	Campbell CR1000	HOBO Weather Station Data Logger	ISS-SER-CR200-C
	Data Transmitter	900 MHz spread spectrum Radio	900 MHz spread spectrum Radio	Airlink Raven Cellular Modem	Sutron Model #SL2-G312-1 geo-stationary satellite data transmitter	Directly connected to a DSL internet feed.	SolarStream Wireless Data Transceiver	Raven XT Cellular Modem
	Collection Interval	15 min	15 min	15 min	15 min	15 min	15 min	15 minutes
Temperature	Sensor Type	Platinum resistance temperature detector	Platinum resistance temperature detector	resistive platinum sensors	Platinum resistance temperature detector	Platinum resistance temperature detector	12-Bit Temperature/RH Smart Sensor	capacitive measurement
	Sensor Model	HMP45C Temperature and Relative Humidity	HMP45C Temperature and Relative Humidity	Vaisala HMP45A/D	HMP45C Temperature and Relative Humidity	HMP45C Temperature and Relative Humidity	HOBO S-THB-M002	WXT520
	Units	Celsius	Celsius	Celsius	Celsius	Celsius	Celsius	Celsius (◦C)
	Operating temperature	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40°C to 75°C	-52 to 60 °C
	Range	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40℃ to +60 ℃	-40°C to 75°C	±0.3 °C
	Accuracy	± 0.2 ℃ @ 20 ℃	± 0.2 ℃ @ 20 ℃	± 0.2 ℃ @ 20 ℃	± 0.2 ℃ @ 20 ℃	± 0.2 ℃ @ 20 ℃	0.2°C @ 0°C to 50°C	0.1 °C
	Collection	One point	One point	One point	One point	One point	One point	Average (sampling rate: every minute)

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
Relative Humidity	Sensor Type	Platinum resistance temperature detector	Platinum resistance temperature detector	Vaisala HUMICAP© 180 capacitive thin film polymer	Vaisala HUMICAP© 180 capacitive relative humidity sensor	Vaisala HUMICAP© 180 capacitive relative humidity sensor	12-Bit Temperature/RH Smart Sensor	capacitive measurement
	Sensor Model	HMP45C Temperature and Relative Humidity	HMP45C Temperature and Relative Humidity	Vaisala HMP45A/D	HMP45C Temperature and Relative Humidity	HMP45C Temperature and Relative Humidity	HOBO S-THB-M002	WXT520
	Units	Percent	Percent	Percent	Percent	Percent	Percent	Percent
	Operating temperature	N/A	N/A	N/A	N/A	N/A	-40°C to 75°C	n/a
	Temperature Dependence	± 0.05% RH/ºC	± 0.05% RH/ºC	± 0.05% RH/ºC	± 0.05% RH/ºC	± 0.05% RH/ºC	NA	see "Accuracy" below
	Range	0 to 100% non-condensing	0 to 100% non-condensing	0.8 to 100% RH	0 to 100% non-condensing	0 to 100% non-condensing	0 to 100% RH	0-100%
	Accuracy	at 20 ºC: ± 2% RH (0-90%), ±3% RH (90-100%)	at 20 ºC: ± 2% RH (0-90%), ±3% RH (90-100%)	at 20 ºC: ± 2% RH (0-90%), ±3% RH (90-100%)	at 20 ºC: ± 2% RH (0-90%), ±3% RH (90-100%)	at 20 ºC: ± 2% RH (0-90%), ±3% RH (90-100%)	±2.5% from 10 to 90% RH	±3 %RH within 0-90 %RH ±5 %RH within 90-
	Collection	One point	One point	One point	One point	One point	One point	Average (sampling rate: every minute)
Barometric Pressure	Sensor Type	CS-1056Vaisala Barocap© silicon capacitive pressure sensor	CS-1056Vaisala Barocap© silicon capacitive pressure sensor	Vaisala BAROCAP Barometer	CS-105 Vaisala Barocap© silicon capacitive pressure sensor	CS-105 Vaisala Barocap© silicon capacitive pressure sensor	HOBO Barometric Pressure smart sensor	capacitive measurement
	Sensor Model	Campbell Scientific CS106	Campbell Scientific CS106	PTB110	#PTB101B	#PTB101B	HOBO S-BPA-CM10	WXT520
	Units	mbar	mbar	mbar	Millibars	Millibars	Millibars	hPa
	Humidity	Non-condensing	Non-condensing	Non-condensing	non-condensing	non-condensing		Non-condensing
	Range	500-1100 mbar	500-1100 mbar	500-1100 mbar	Pressure: 600 to 1060 mb; Temperature: -40°C to +60°C	Pressure: 600 to 1060 mb; Temperature: -40°C to +60°C	660 mb to 1070 mb Temperature -40°C to 70°C	600-1100 hPa
	Accuracy	±0.3 mb @ +20°C; ±0.6 mb @ 0° to 40°C; ±1.0 mb @ -20° to +45°C; ±1.5 mb @ -40° to +60°C	±0.3 mb @ +20°C; ±0.6 mb @ 0° to 40°C; ±1.0 mb @ -20° to +45°C; ±1.5 mb @ -40° to +60°C	+/- 0.3 mbar at +20°C	± 0.5 mb @ 20°C; +/- 2 mb @ 0°C to 40°C; +/- 4 mb @ -20°C to 45°C; +/- 6 mb @ -40°C to 60°C	± 0.5 mb @ 20°C; +/- 2 mb @ 0°C to 40°C; +/- 4 mb @ -20°C to 45°C; +/- 6 mb @ -40°C to 60°C	±3.0 mbar over full pressure range at 25°C (77°F) Maximum Error of ±5.0 mbar over -40°C to 70°C	±0.5 hPa at 0 ... +30 °C (+32 ... +86 °F) ±1 hPa at -52 ... +60 °C (-60 ... +140 °F)
	Collection	One point	One point	One point	One point	One point	One point	Average (sampling rate: every minute)

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
Wind Speed	Sensor Type	balanced anodized aluminum vane	balanced anodized aluminum vane	3-cup anemometer	18 cm diameter 4-blade helicoids propeller molded of polypropylene	18 cm diameter 4-blade helicoids propeller molded of polypropylene	3-cup anemometer	Ultrasound via 3 transducers
	Sensor Model	MetOne model 034B	MetOne model 034B	MetOne model 034B	R.M. Young 05103 Wind Monitor	R.M. Young 05103 Wind Monitor	Onset Wind Speed and Direction Smart Sensor S-WCA-M003	WXT520
	Units	m/s	m/s	mph	m/s	m/s	m/s	m/s
	Range	0 to 50 m/s	0 to 50 m/s	0-100 mph	0-60 m/s (130 mph); gust survival 100 m/s (220 mph)	0-60 m/s (130 mph); gust survival 100 m/s (220 mph)	0 to 44 m/s	0-60 m/s
	Accuracy	±0.11 m/s (0.25 mph) when less than 10.1 m/s (22.7 mph) or	±0.11 m/s (0.25 mph) when less than 10.1 m/s (22.7 mph) or	<22.7mph=0.25mph, >22.7 ±1.1%	±2%	±2%	±0.5 m/s ±3% 17 to 30 m/s ±4% 30 to 47 m/s	±3% at 10 m/s
	Collection	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Average (sampling rate: 4 times a second)
Wind Direction	Sensor Type	balanced anodized aluminum vane	balanced anodized aluminum vane	balanced anodized aluminum vane	balanced vane, 38 cm turning radius	balanced vane, 38 cm turning radius	balanced aluminum vane	Ultrasound via 3 transducers
	Sensor Model	MetOne model 034B	MetOne model 034B	MetOne model 034B	R.M. Young 05103 Wind Monitor	R.M. Young 05103 Wind Monitor	Onset Wind Speed and Direction Smart Sensor S-WCA-M003	WXT520
	Units	degrees	degrees	degrees	degrees	degrees	degrees	degrees
	Range	360° mechanical, 356° electrical	360° mechanical, 356° electrical	360° mechanical, 356° electrical	360° mechanical, 355° electrical (5° open)	360° mechanical, 355° electrical (5° open)	0 to 358°, 2° Dead Band	0-360 degrees
	Accuracy	±4 degrees	±4 degrees	±4 degrees	±5%	±5%	±5 Degrees	±3 degrees
	Collection	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Averaged over 15 minutes	Average (sampling rate: 4 times a second)

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
Radiation	Sensor Type	High stability silicon photovoltaic detector (blue enhanced)	High stability silicon photovoltaic detector (blue enhanced)	ISO-9060 Secondary Standard compliant	High stability silicon photovoltaic detector (blue enhanced)	High stability silicon photovoltaic detector (blue enhanced)	Silicon Pyranometer Sensor	n/a
	Sensor Model	LI190SB	LI190SB	Kipp & Zonen CM 11	LI190SB	LI190SB	HOBO S-LIB-M003	n/a
	Units	mmoles m-2 (total flux)	mmoles m-2 (total flux)	W/m^2	mmoles m-2 (total flux)	mmoles m-2 (total flux)	W/m^2	n/a
	Light Spectrum Waveband	400 to 700 nm	400 to 700 nm	305-2800 nm	400 to 700 nm	400 to 700 nm	300 to 1100 nm	n/a
	Temperature Dependence	0.15% per °C maximum	0.15% per °C maximum	<±1% (-10 to 40deg C)	0.15% per °C maximum	0.15% per °C maximum	0.38 W/m^2/°C from 25°C (0.21 W/m^2/°F from 77°F)	n/a
	Stability	<±2% change over 1 yr	<±2% change over 1 yr	NA	<±2% change over 1 yr	<±2% change over 1 yr	<±2% change over 1 yr	n/a
	Operating temperature	-40°C to 65°C; Humidity: 0 to 100%	-40°C to 65°C; Humidity: 0 to 100%	-40°C to 80°C	-40°C to 65°C; Humidity: 0 to 100%	-40°C to 65°C; Humidity: 0 to 100%	-40°C to 75°C	n/a
	Sensitivity	typically 5 µA per 1000 µmoles s-1 m-2	typically 5 µA per 1000 µmoles s-1 m-2	4-6 $mV/W/m^2$	typically 5 µA per 1000 µmoles s-1 m-2	typically 5 µA per 1000 µmoles s-1 m-2	NA	n/a
	Collection	One point	One point	One point	One point	One point	One point	n/a

Table 5. Instrument Specifications (continued)

Weather		Mohawk Lock 8	Albany	Schodack	Tivoli Bays	Norrie Point	Piermont Pier	Pier 84
Precipitation	Sensor Type	6 inch diameter tipping bucket	6 inch diameter tipping bucket	12 inch diameter tipping bucket	Tipping Bucket Rain Gauge (heated)	Tipping Bucket Rain Gauge (heated)	6" diameter Tipping Bucket Rain Gauge	acoustic: detects in the impact of individual rain drops - converts to accumulated rainfall
	Sensor Model	Campbell Scientific TE525WS-L30	Campbell Scientific TE525WS-L30	Handar 444B	TE525	TB3	HOBO Rain Gauge Smart Sensor S-RGA-M002	WXT520
	Units	millimeters (mm)	millimeters (mm)	millimeters (mm)	millimeters (mm)	millimeters (mm)	Millimeters (mm)	mm
	Rainfall per tip	0.254 mm	0.254 mm	1 mm	0.01 inch	0.01 inch	0.2 mm	n/a
	Range	NA	NA	NA	Temperature: 0° to +/- 50°C; Humidity: 0 to 100%	Temperature: -20° to +70°C; Humidity: 0 to 100%	10 cm or 0" to 5" per hour; Temperature 0° to 50°C	0-200 mm/hr
	Accuracy	Up to 1 in./hr: ±1%; 1 to 2 in./hr: +0, -3%; 2 to 3 in./hr: +0, -5%	Up to 1 in./hr: ±1%; 1 to 2 in./hr: +0, -3%; 2 to 3 in./hr: +0, -5%	±3.0% up to 100 mm/hr	±1.0% up to 1 in./hr; +0, -3% from 1 to 2 in./hr; +0, -5% from 2 to 3 in./hr	±1.0% up to 1 in./hr; +0, -3% from 1 to 2 in./hr; +0, -5% from 2 to 3 in./hr	±1.0% at up to 20 mm or 1" per hour	5%
	Collection	One point	One point	One point	One point	One point	One point	Sum of acoustic detection

2. Sample Custody Procedures

2.1 Water Quality Instruments

Water quality equipment is installed in a PVC or aluminum casing with a locked lid. The casing itself is attached by screws to a piling, dock, or buoy.

2.2 Weather Instruments

Weather instruments are difficult to access which protects them from vandalism. They are installed at a significant height and in hard to reach locations such as a building top or an island. In addition, instruments at Mohawk Lock 8, Norrie Point and Tivoli Bay are locked in place.

2.3 Data Loggers and Transmission Equipment

All stations have locked strong boxes that hold the data loggers, transmission equipment, and battery. These boxes are fixed to a permanent structure above the high water line.

2.4 Samples Collected for the Site Assessments for Water Quality Stations

The total dissolved solid samples collected for the Annual Site Assessment for Water Quality Stations are collected according to DOWSOP 301-11: Wastewater Sample Collection which requires a chain of custody form for each sample collection.

3. Maintenance and Calibration

3.1 Maintenance and Calibration Procedures

3.1.1 Water Quality Sensors

All water quality sensors are calibrated immediately before and after deployment according to the Water Quality Monitoring Standard Operating Procedure (HRECOS SOP 2012.01). A sensor is never deployed if it fails calibration. As a further precaution, measurements from two sets of sensors are compared at least once per quarter. Since water quality sensors are swapped for newly calibrated instruments at the end of each deployment this is easily accomplished by comparing the readings before and after the swap. Finally, sensors are serviced by the manufacturer at least once every five years and preferably once every two years.

3.1.2 Weather Sensors

Weather instruments are inspected once per quarter according to the Weather Monitoring Standard Operating Procedure (HRECOS SOP 2012.02). Instruments are calibrated as funding permits.

3.2 Maintenance Records

Station operators are responsible for keeping all maintenance records. Within three months after the end of each quarter, station operators must submit calibration results *only* for water quality stations and any problems identified at the weather stations to the HRECOS Coordinator to update station metadata files.

3.3 Calibration Materials and Replacement Equipment

Calibration materials and replacement equipment are distributed by the HRECOS coordinator to the station operator once per year. It is the responsibility of the station operator to properly store these materials until needed. Should a station need unexpected repairs or equipment replacement,

station operators and the HRECOS coordinator collaborate on a repair plan and work together to secure funding for this purpose.

3.4 Frequency of Maintenance.
Water Quality instruments must be calibrated at least once per quarter. Instruments are calibrated more frequently if a statistically significant and unexpected trend is observed in the output. Weather instruments will be inspected quarterly.

4. Data Management
Data handling and archive will follow the procedures of the Data Handling and Archival Standard Operating Procedure (HRECOS SOP 2012.07).

III. ASSESSMENT AND OVERSIGHT

1. Quality Control and Corrective Actions
The following measurements and corrective actions are used to ensure the quality of the data generated in this project.

1.1 Accuracy
1.1.1 Water Quality Sensors
If a water quality sensor does not match (within accuracy limits) the duplicate sensor during the instrument swap, then it is recalibrated. If a sensor displays a statistically significant change over the course of a deployment, then it is removed and recalibrated. If a water quality sensor fails calibration it is sent to the manufacturer for a certified calibration. If it fails this calibration also, it is removed from the deployment cycle.
1.1.2 Weather Sensors
If weather sensors do not match (within 10x the accuracy limits) two sets of external instruments, then it is sent to the manufacturer for a certified calibration. Also, if a rain gauge fails the annual calibration, then it is also returned for a certified calibration. If any sensor fails the manufacturer's calibration, then it is removed from the HRECOS network.
1.1.3 Time Records
If, during the quarterly check, the recorded time differs from EST by more than 5s, then the clock is reset and the change is noted in the metadata.

1.2 Precision
1.2.1 Water Quality Sensors
If a water quality sensor fluctuates during calibration by a value larger than the accuracy limit (see table 4), then the sensor must be returned to the manufacturer for a certified calibration. If the sensor fails the manufacturer's calibration then it is removed from the HRECOS network.
1.2.2 Weather Sensors
If a weather sensor fails the manufacturer's calibration then it is removed from the HRECOS network.
1.2.3 Time Records

If the time recorded by a data logger drifts by more than five seconds over the course of a deployment then the data logger is returned to the manufacturer for a certified calibration. If the logger fails the manufacturer's calibration, it is removed from the HRECOS network.

1.3 Representativeness

If the results of the annual site assessment for a water quality station indicate that main channel conditions are significantly different from those measured by a HRECOS water quality station, then the HRECOS management team will investigate alternative locations.

1.4 Comparability

Procedures described in A, B and C will ensure comparability across stations.

1.5. Completeness

1.5.1 Response to Failed Data Transmission

If a station fails to report for 12 hours or more, the Station Operator receives an automated notice. If an instrument fails to report for 12 consecutive hours, the Station Operator will visit the station to check if the data transmission program is running. If transmission is running, the Station Operator will check the instrumentation and make any changes necessary.

1.5.2 Quarterly Assessment of Data Completeness

At every quarterly meeting, the HRECOS Coordinator reports the percentage of total possible records a station has reported. Our goal is to record at least 90% of the total possible observations. Deficiencies will be discussed at the quarterly meeting. In some cases, solutions will require postponement if insufficient funding is available. If a station fails to follow any of the QC requirements for more than one quarter than the Management Team will consider removing the station from the network.

2. Data Review

2.1 Data Flagging

Data will be reviewed once per quarter. Those data that do not meet the following quality criteria will be flagged.

2.1.1 Automatic Flagging

The automatic flags defined in table 6 are added in real-time by the HRECOS database; the seasonal averages are based on the previous year's data.

2.1.2 Quarterly Data Flagging

Within three months after the end of the quarter, the HRECOS Coordinator adds any missing data. recalculates the automatic flags using actual seasonal averages and compiles data files for review by station operators and research assistants.

All Station Operators or their designated research assistants review the automatic flags and make a final determination for the public record according to the following standard operating procedures:
Water Quality data review and editing Standard Operating Procedure (HRECOS SOP 2012.05)
Weather data review and editing Standard Operating Procedure (HRECOS SOP 2012.06)

All quarterly flagging procedures are completed and uploaded to the HRECOS database within three months after the end of the quarter.

3. Performance and System Audits

The HRECOS Coordinator will visit each Station Operator once per year to observe maintenance procedures. Discrepancies are addressed immediately. Significant discrepancies are addressed at the quarterly meeting.

In addition, those stations funded and maintained by the NYS DEC DOW will be audited by the NYSDEC QA Officer to assess compliance with this quality assurance plan.

For those projects funded by NEIWPCC, NEIWPCC may implement, at their discretion, various audits or reviews of this project to assess conformance and compliance to the quality assurance project plan in accordance with the NEIWPCC Quality Management Plan.

4. Reports to Management

4.1 Annual Data Files

Finalized data is uploaded to the HRECOS database for public download within three months after the end of the quarter. Finalized annual files with inserted missing records are uploaded to the www.hrecos.org historical data website within three months after the end of the year.

4.2 Metadata Files

A single metadata file will be associated with every water quality and weather station.
Metadata files for water quality stations must include the following information:

- Disclaimer for Data Use
- Contacts for the Station
- Distribution and Attribution for HRECOS Data
- Description of How Data are Verified
- A Summary of Site Location and Character including assessments of representativeness
- Data Collection Period including all Deployment and Retrieval Dates
- Post Deployment Measurements for Dissolved Oxygen % Saturation, Specific Conductivity, pH, and Turbidity.
- Other remarks/notes including data coded as “See Metadata”
- Sensor Specifications
- QAQC Flag Definitions

Metadata files for weather stations must include the following information:

- Disclaimer for Data Use
- Contacts for the Station
- Distribution and Attribution for HRECOS Data
- Description of How Data are Verified
- A Summary of Site Location and Character
- Data Collection Period
- Inspection Results
- Other Remarks / Notes including data coded as “See Metadata”
- Sensor Specifications
- QAQC Flag Definitions

Table 6. Automatic and Manual Data Flags and Comment Codes

Provisional Data Flags

0	Acceptable data
5	Data that demonstrate a significant increase or decrease from the previous value
6	Flat lined data
30	Data outside three standard deviations of the seasonal mean
40	Data outside four standard deviations of the seasonal mean
100	Data outside the range of the instrument

Final Data Flags

0	Data determined to be acceptable after a final review by the site manager
10000	Suspicious data according to a final review by the site manager
20000	Corrected data
500000	Rejected data according to a final review by the site manager

General Errors

[GIM]	instrument malfunction
[GIT]	instrument recording error, recovered telemetry data
[GMC]	no instrument deployed due to maintenance/calibration
[GIC]	no instrument deployed due to ice
[GNF]	deployment tube clogged/no flow
[GPF]	power failure/low battery
[GQR]	rejected due to QAQC checks
[GSM]	see metadata
[GOW]	out of water event
[GMT]	instrument maintenance
[GDP]	power down
[GIM]	program reload

Sensor Errors

water quality stations only

[SBO]	blocked optic
[STF]	catastrophic temperature sensor failure
[SCF]	conductivity sensor failure
[SDF]	depth port frozen
[SDP	DO membrane puncture
[SDO]	DO suspect
[SIC]	incorrect calibration/contaminated standard
[SNV]	negative value
[SPC]	post calibration out of range
[SSDN]	sensor drift, record not corrected
[SSDC]	sensor drift, record corrected
[SSM]	sensor malfunction
[SOW]	sensor out of water
[SSR]	sensor removed (not deployed

[STS] turbidity spike
[SWM] wiper malfunction/loss
weather stations only:
[SIC] incorrect calibration constant, multiplier or offset
[SNV] negative value
[SSN] not a number/unknown value
[SOC] out of calibration
[SSM] sensor malfunction
[SSR] sensor removed

Comments
water quality stations only
[CAF] acceptable calibration/accuracy error of sensor
[CBF] biofouling
[CCU] cause unknown
[CDA] DO hypoxia <28 percent saturation
[CDB] disturbed bottom
[CDF] data appear to fit conditions
[CFK] fish kill
[CIP] surface ice present at sample station
[CLT] low tide
[CND] new deployment begins
[CRE] significant rain event
[CSM] see metadata
[CTS] turbidity spike
[CWD]data collected at wrong depth
[CAP] depth sensor in water, affected by atmospheric pressure
[CAB] algal bloom
[CVT] possible vandalism/tampering
[CMC] in field maintenance/cleaning
[CMD]mud in probe guard
weather stations only
[CAF] acceptable calibration/accuracy error of sensor
[CDF] data appear to fit conditions
[CRE] significant rain event
[CSM] see metadata
[CVT] possible vandalism/tampering

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Joseph Martens
Commissioner

M E M O R A N D U M

TO: Jason Fagel, NYSDEC DOW QA Officer

FROM: Alene Onion, HRECOS Coordinator

SUBJECT: Minor changes to the HRECOS QAPP

DATE: April 11, 2013

The following changes were made to the HRECOS Water Quality and Weather Stations Quality Assurance Project Plan on April 11, 2013:

The following sentence was added to 3.1.2 to clarify that weather station instruments are only calibrated as funding permits:
"Weather instruments are inspected once per quarter according to the Weather Monitoring Standard Operating Procedure (HRECOS SOP 2012.02). Instruments are calibrated as funding permits."

Two sentences were added to 1.8.5 Tivoli Bays Stations to clarify that only the tidal stations are part of the HRECOS network and to provide a weblink to access data for the Stony Creek and Saw Kill Creek data:
"The objective of this station is to monitor surface water quality at the Tivoli Bays component of the Hudson River National Estuarine Research Reserve (NERR). Two tidal freshwater wetlands, Tivoli North Bay and Tivoli South Bay are monitored using four dataloggers (YSI 6600 sondes). In Tivoli North Bay and Tivoli South Bay the dataloggers monitor the ebbing and flooding Hudson River water. These data are included in the HRECOS network also. In Stony Creek and Saw Kill Creek, the dataloggers are deployed above the area of tidal influence and monitor the quality of water entering the Tivoli Bays via stream flow. These data are not included in the HRECOS network but may be accessed through the NERR website: http://www.hrnerr.org/. Thus, the relative importance of stream flow and tidal exchange and the potential impacts of intertidal areas on the water quality of the Tivoli Bays can be determined."

cc: G. Lemley
M. Novak