Appendix A

2005 Grand Canal Environmental Assessment Report

Grand Canal, Oakdale, New York
Environmental Assessment

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January 2005

Grand Canal Environmental Assessment

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Grand Canal Environmental Assessment

Abstract
The water quality monitoring conducted for this assessment indicates that Grand Canal is significantly impacted by nutrient enrichment and, potentially, by pathogen contamination. Poor flushing in the canal has a negative effect on its ecology. Mosquitoes do not breed directly within the canal, but the adjacent wetlands are primary breeding areas. Vector Control has identified, through arboviral surveillance efforts, West Nile Virus positive birds and mosquito pools in the area. Although there is no immediate public health threat to the residents within the Grand Canal region, the area of the canal currently requires multiple larvicide events annually. Dredging the canal in conjunction with a comprehensive Open Marsh Water Management (OMWM) strategy to provide greater water flows to adjacent wetlands, could be a major step towards decreasing the need for annual larviciding. As always, any dredging activity must be conducted in a manner to avoid creating any adverse problems with changes in the current fish and wildlife habitat, and dredging spoils must be removed to prevent foul odors to the residents in the community. The plan could reduce pesticide usage and mosquito breeding, while enhancing the ecology, increasing water circulation in the canal and restoring the surrounding wetlands.

Introduction
Grand Canal consists of a series of shallow, interconnected canals located on the east side of the Connetquot River in Oakdale (Figure 1). According to a Dowling College website, the canal was built sometime prior to 1920 to serve the former "Idle Hour" estate of William K. Vanderbilt. The canal system includes a main "outside" canal that has north and south openings to the Connetquot River, and a number of "inner" finger canals that extend into what are now residential areas. There are a number of tidal wetlands within the area encompassed by the canal, in addition to a large marsh immediately to the east of the canal that includes both tidal and freshwater wetlands. All these wetlands depend on the canal for tidal circulation.

For a number of years Grand Canal has been the subject of complaints by area residents, reportedly concerned with progressive shoaling and with conditions potentially associated with a reduction in tidal flushing. Issues that have been raised include the potential for mosquito breeding, potential West Nile virus and other epizootic activity, the possible contamination of canal waters with Vector Control pesticides (used in adjacent marshes), and general water quality deterioration. The suggestion that these conditions collectively may represent a public health risk has, at the request of Suffolk County Executive Steve Levy, prompted this investigation.

Figure 1. Grand Canal, Oakdale

At a meeting in June 2004 among representatives of the County Executive's Office, the Department of Public Works (SCDPW), and the Department of Health Services (SCDHS), a multi-agency strategy was adopted to assess environmental conditions in the canal. The objective was to document existing conditions and determine whether a risk to public health exists, and if dredging of the canal would reduce that risk. The SCDHS Office of Ecology was assigned the tasks of assessing water quality conditions, coordinating monitoring efforts, and compiling a draft report. The SCDHS Division of Public Health was to evaluate mosquito and viral epizootic activity and assess the potential for public health implications. The SCDPW would evaluate adjacent wetland and ditch conditions as they relate to mosquito breeding, in addition to determining sediment conditions for potential dredging.

Canal Water Quality

In late June, staff from the Office of Ecology surveyed the canal to determine the degree of accessibility of various areas and to establish suitable sampling locations. Twelve sites representative of the different canal areas were selected, latitude-longitude coordinates obtained, and GIS maps prepared.

Water quality monitoring was conducted on four occasions from July through early September 2004. Samples were collected at or near the time of low tide, to avoid influences from the Connetquot River, from a depth approximately six inches below the surface. The samples were delivered to the Suffolk County Public & Environmental Health Laboratory (PEHL) in Hauppauge for analysis. Parameters analyzed included nutrients, salinity, coliform bacteria, and various organic constituents (solvents, pesticides, etc). At each site the water depth and secchi depth were recorded and measurements of surface and bottom temperature and dissolved oxygen also taken. Average values for physical measurements are given in Table 1. Tables 2 and 3 include results of inorganic and organic samples, respectively. Results for selected parameters are discussed below.

- ***Water Depth:*** Average depths at the sites monitored varied from 2.5 ft. at station 10 to 10.1 ft. at station 4. In general, the shallowest water was found in the stretch from station 7 to station 11, with the deepest water found at inner canal stations 3 through 6 where numerous boats are moored. Navigation with shallow-draft outboard powered boats (19 and 25' in length) was generally not a problem, although when a 25' inboard powered vessel was used it was very difficult to

Table 1. Average Values for Physical Measurements

Station	Depth	Temperature (°C)	Dissolved Oxygen (mg/L)		Salinity (%o)	Secchi (ft)
			Surface	Bottom		
GC1	4.8	23.9	**6.5**	5.0	19.1	1.5
GC2	4.1	24.0	6.6	4.8	19.0	1.6
GC3	9.9	24.3	7.1	1.7	19.5	1.6
GC4	10.1	24.3	5.5	0.9	**19.6**	1.3
GC5	**5.6**	24.2	6.5	2.9	19.2	1.8
GC6	6.0	24.6	8.2	1.1	19.0	1.9
GC7	4.0	24.4	7.3	3.5	**18.5**	1.9
GC8	3.5	24.4	5.6	5.4	18.1	1.6
GC9	3.4	24.6	6.4	4.1	15.9	2.0
GC10	2.5	24.5	4.4	4.1	15.0	1.4
GC11 *	3.0	26.9	---	----	7.1	1.0
GC12	4.3	25.4	10.4	5.9	16.5	1.8

* Only one sample collected; no D.O. data due to meter malfunction

turn around in the narrow canals without the boat striking the bottom. Many of the boats moored throughout the canal system are greater than 25' in length.

- *Salinity:* As would be expected, average salinities generally decreased in a northward direction with increasing distance from the tidal influence of Great South Bay. From stations 1 through 8 levels varied little, averaging from 18.1 to 19.6 parts per thousand. Further north at stations 9 through 12, average salinity declined to between 15.0 to 16.5 parts per thousand.

- *Secchi Depth:* The secchi depth, a general measure of water transparency, is obtained by lowering a white disk through the water column to the point at which it disappears. Average secchi depths found in Grand Canal ranged from 1.0 to 2.0 ft., levels indicative of very turbid conditions. Factors that may be contributing to the turbidity include algal blooms, sediments that are washed off area streets or re-suspended from the bottom by boat traffic, and detritus from adjacent wetlands. Samples collected from a turbid area near station 8 on 9/7/04 revealed a massive bloom of a flagellated brown alga, *Heterocapsa akashiwo,* an organism common in brackish waters.

Station	Total Coliform (MPN/100 ml)	Fecal Coliform (MPN/100 ml)	Dissolved Inorganic Nitrogen (DIN) (mg/L)	Total Nitrogen (mg/L)	Total Dissolved Nitrogen (mg/L)	Dissolved Inorganic Phosphorus (DIP) (mg/L)	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)
Table 2. Average Values for Coliforms and Nutrients								
GC1	1.033	433	0.148	0.36	0.19	< 0.005	0.063	< 0.025
GC2	3.800	967	0.092	0.45	0.24	< 0.005	0.049	< 0.025
GC3	470	197	0.132	0.38	0.18	< 0.005	0.053	< 0.025
GC4	290	130	0.212	0.56	0.30	< 0.005	0.056	< 0.025
GC5	5.713	253	0.251	0.38	0.46	< 0.005	0.057	0.030
GC6	533	193	0.092	0.24	0.20	< 0.005	0.038	< 0.025
GC7	633	533	0.221	0.47	0.32	< 0.005	0.073	< 0.025
GC8	3.500	567	0.428	0.45	0.36	< 0.005	0.050	< 0.025
GC9	1.050	650	0.633	0.76	0.94	< 0.005	< 0.025	< 0.025
GC10	1.033	777	0.668	0.96	0.82	< 0.005	0.061	< 0.025
GC11 *	1.300	800	1.350	1.50	1.50	< 0.005	0.052	0.038
GC12	460	147	0.531	1.07	0.85	< 0.005	0.071	< 0.025

Table 3. Organic Positive Detects

Date	Station	1,2,4-Trimethyl-benzene	Benzene	Carbon disulfide	1,2-Dichloro-ethene	Ethyl-benzene	Fluoranthene	MTBE	Naphthalene	Tetra-Chloroethene	Toluene	Total Xylene
07/ 26/04	GC1							1				
08/ 10/04	GC2	0.7		0.7				3	0.8	0.6	2	2
08/10/04	GC6							3				
07/26/04	GC7							3			1	1
08/10/04	GC7				0.5			3		0.9	1	1
08/10/04	GC8							2				
08/10/04	GC9				0.9			3		1		
07/26/04	GC10				1			2		0.9		
08/10/04	GC10				2		0.2	3		2	0.5	
07/26/04	GC12	1	0.9		2	0.9		2	0.9	1	5	5

* Only one sample collected

- ***Dissolved Oxygen:*** Adequate levels of dissolved oxygen (DO) are critical to the development and survival of aquatic organisms. Hypoxia (low DO) is a problem that often develops in waters that experience frequent algal blooms due to excessive levels of nutrients. Hypoxia can also develop from the decomposition of other resident plant material (macroalgae) or, in shallow systems, from the oxygen demand exerted by highly organic bottom sediments. A level of 5.0 mg/L, the New York State ambient water quality standard for DO, is a concentration below which adverse effects on aquatic organisms may begin to occur. As guidance to states developing water quality standards, the USEPA has established DO criteria for saltwater environments of 4.8 mg/L for species growth and 2.3 mg/L for species survival.

  In this survey, surface DO values in Grand Canal varied widely from 1.8 mg/L to 15.4 mg/L. Average values ranged from 4.4 mg/L at station 10 to 10.4 mg/L at station 12. Thirteen of the 44 surface measurements taken were below the 5.0 mg/L benchmark, and 3 were below the survival criteria. Bottom DO levels ranged from 0.2 mg/L to 9.2 mg/L with averages ranging from 0.9 at station 4 to 5.9 at station 12. Over 65% of the bottom DO measurements (29 of 44) were less than the 5.0 mg/L benchmark and 41% (18) were less than the 2.3 mg/L species survival criteria. The lowest averages were noted at the deeper inner canal stations (3, 4, 5 and 6). Because of the bottom topography in these areas (i.e. shallow sills preceding deeper basins), it is likely these sites act as sediment sinks for fine organic particulates that exert an increased oxygen demand during decomposition.

- *Coliform Bacteria:* Coliforms are a group of bacteria commonly found in soil, on vegetation, and in the intestinal tract of warm-blooded animals. Those of intestinal origin are referred to as "fecal coliforms" and although generally harmless, have long been used as an indicator for the possible presence of intestinal parasites or pathogens. Current standards for bathing waters permit a maximum 30-day average of 200 fecal coliforms per 100 ml of sample. The standard for shellfishing waters is 70 total coliforms per 100 ml of sample.

  Coliform levels found in Grand Canal were consistently elevated, with total coliform averages ranging from 290 to 5,713 organisms/ 100 ml and fecal coliforms averaging from 130 to 967 organisms/100 ml (Table 2). From a regulatory standpoint, these waters would be unsuitable for both shellfishing and bathing. Likely sources of coliforms in Grand Canal include stormwater runoff, waterfowl or other area wildlife, and perhaps, improperly functioning residential septic systems.

- ***Nutrients:*** Nutrients, including various nitrogen and phosphorous compounds, are essential for life in marine environments. However, over-enrichment with nutrients as a result of human activities (a process known as eutrophication) can have serious adverse impacts, both temporary and long-term, on the marine ecology. Excessive nutrient levels can cause explosive growths of phytoplankton (algal blooms), reduced water transparency, decreased levels of dissolved oxygen, and the production of foul odors. Over the long-term, impacts such as reduced species diversity and the proliferation of harmful algal species may result.

  Levels of dissolved inorganic nitrogen (DIN) are typically monitored in marine ecology programs as an indicator of nutrient enrichment. In Grand Canal, average DIN levels ranged from 0.09 to 0.67 mg/L. Stations 9 through 12 (nearest the college STP) in the northern canal area had the highest levels of DIN, collectively averaging three times as much as that found at stations 1 through 8. In comparison, long-term DIN levels in adjacent areas of Great South Bay have averaged less 0.05 mg/L. With this apparent high level of dissolved nitrogen in the canal, it is likely that algal blooms, reduced water transparency, and depressed oxygen levels are a common occurrence. Nutrient sources to the canal likely include leachate from area septic systems, runoff from fertilized lawns, and decomposing detritus from area wetlands. It is interesting to note, that the supply of nitrogen to the canal is so excessive that phosphorus has apparently become the limiting nutrient (usually not the case in temperate marine systems). This is evidenced by the very low levels of dissolved inorganic phosphate (DIP), normally at their peak during the summer, found during this survey.

- ***Organics:*** Samples were analyzed for numerous "organic" constituents (241 in total), including volatile organic compounds (VOCs), semi-volatile organics (SVOCs), carbamate and chlorinated pesticides, and a number of herbicide metabolites (a list of analytes is included in Appendix I). Because of laboratory limitations however, only a limited number of these samples could be collected. VOCs were collected at each station on one occasion; the remaining organics were only collected at 6 of the 11 sites monitored.

  Results were negative for all pesticide analytes, including the larvicide *methoprene* that is used by the Suffolk County Vector Control Division for mosquito control in adjacent wetlands. A number of VOC and SVOC compounds were identified. The gasoline additive MTBE was detected at all stations (Table 3). Many of the compounds found are present in petroleum products and likely have their source in boat engine exhaust or in stormwater runoff from area roads.

Mosquito Breeding

Routine mosquito larval surveillance conducted by the SCDPW Division of Vector Control has not identified mosquito breeding within Grand Canal. Although water movement in the canal is limited, there is apparently enough water depth and flow to allow access by fish and other predators. Representatives of Vector Control and the SCDHS Division of Public Health verified the absence of larvae in the canal this summer. This included a historical review of records of arboviral findings within three miles of the Grand Canal area. The Division of Public Health concluded that there is little relationship between the canal and arboviral findings.

Suffolk County Vector Control has however, identified several sites near the Grand Canal as primary breeding areas for mosquitoes. Although none of these sites are directly in Grand Canal itself, several are associated with freshwater and tidal wetlands that border the canal (Figure 2). Three of these sites are considered major mosquito breeding areas that are large enough to require the use of a helicopter to treat them regularly with larvicides.

Major vector species associated with these sites are *Ochlerotatus sollicitans*, *Oc. taeniorhynchus* and *Oc. cantator* in the salt marsh. Mosquito species breeding within the adjacent freshwater wetlands and along the upper reaches of the salt marsh are primarily *Culex pipiens/restuans* and *Aedes vexans.* Arboviral surveillance shows that during the period of 1999 to 2003, there have been 29 West Nile Virus (WNV) positive birds and 8 WNV positive mosquito pools found within a three-mile radius of the Grand Canal. In 1997, there were 5 Eastern Equine Encephalitis virus positive mosquito pools found one mile to the north of the Grand Canal at Connetquot River State Park.

Breeding potential at these three main sites, and several smaller ones near the canal, may actually have been created or exacerbated by earlier dredging projects in Grand Canal where dredge spoil was placed on a berm along the canal. This dredge spoil berm cut off tidal circulation to these marshes, causing rain and flood waters to accumulate on the marsh surface and created ideal breeding grounds for mosquitoes. In an effort to restore some tidal circulation to this marsh, Vector Control installed several culverts and opened a small breach along the berm. However, more substantial restoration work would be appropriate to restore the proper hydrology to the site and to reduce mosquito breeding.

Suffolk County Vector Control Primary Breeding Sites
Grand Canal Region - Oakdale

Figure 2

According to SCDPW, in their current condition these wetlands require aerial larviciding ten or more times a year, and it would be very desirable to reduce or eliminate the need for pesticide spraying via proper water management.

Dredging of Grand Canal, together with marsh restoration efforts and water management, would be expected to have a beneficial impact on reducing mosquito breeding in the area. Dredging of the canal, in conjunction with a program utilizing progressive Open Marsh Water Management (OMWM) techniques, should be considered as a first step of a comprehensive plan to fully restore the hydrology of the degraded wetlands. Such a project would need to be conducted with the cooperation of the primary owner of the wetlands along the Grand Canal: the New York State Department of Environmental Conservation (NYSDEC).

Open Water Marsh Management (OMWM)

The most effective, economical and potentially environmentally benign means of control for salt marsh mosquitoes is to manage their habitat such that the breeding of larvae and the subsequent propagation of adults is minimized. In the past, the practice of constructing mosquito grid ditches was intended as a means to drain the upper reaches of marshes in order to eliminate mosquito habitat. It is now widely recognized that this approach is only partly effective, in that all breeding sites may not be addressed by the grid pattern. Where tidal flow is limited, it is particularly difficult to provide adequate habitat for predatory fish. This is especially true for the marshes that are separated from Grand Canal by a dike. As a result, the application of mosquito larvicides (and potentially adulticides) has been necessary for mosquito control.

Open Marsh Water Management is a habitat restoration and mosquito control technique designed to re-establish natural flow patterns in ditched marshes. An OMWM project may involve a variety of procedures, including the plugging or filling of selected ditches, re-opening natural tidal creeks, and the excavation of small ponds to function as fish reservoirs. For an OMWM project to succeed, it is important that the marsh receive adequate tidal flow to ensure that marsh channels and ponds have water quality capable of supporting fish. OMWM has been successfully implemented in a number of areas of the northeast, including New Jersey, Connecticut, and Rhode Island. Currently in Suffolk County, an OMWM demonstration project is underway at the Wertheim National Wildlife Refuge as part of the Suffolk County Vector Control and Wetlands Management Long-Term Plan.

Dredging

***Dredging** History:* The Suffolk County Department of Public Works (SCDPW) has not dredged Grand Canal in the past, although the feasibility was briefly investigated in 1983. A hydrographic survey determined that there was adequate depth for navigation at that time.

Project Approvals: Grand Canal was approved for "interface dredging" in December of 2002 by the Dredging Projects Screening Committee (interface dredging clears sediment from the entrance of a canal or waterway). Other high priority projects have prevented the SCDPW from progressing with further investigation, as the Town of Islip has not requested the canal to be placed on the SCDPW priority list. The approved channel is approximately 500 ft. long adjacent to the marina at the south entrance of Grand Canal. Approval for dredging the entire length of Grand Canal (approximately 8,000 ft.) was tabled at the meeting.

- ***Sediment Composition:*** Four sediment samples from Grand Canal were recently obtained and analyzed by the SCDPW. According to the results of a grain-size analysis (Table 4), the sediment is composed mostly of fine silty material.

- ***Dredge Volume:*** Based upon an average channel width of 20 ft. (to maintain a safe distance from existing bulkheads), a design depth of 5 feet below Mean Low Water (which would yield an average depth of cut of 2.5 ft.), and a canal length of 8,000 ft., the estimated quantity of sediment to be dredged is 15,000 cubic yards.

- *Sediment Disposal:*
  a. Open Water Disposal (Surf Zone Disposal): This method of disposal utilizes direct discharge of dredged sediment into the ocean. Open water disposal is unacceptable to the regulatory agencies.

  b. Beach Nourishment: Beaches are sometimes replenished by pumping a mixture of sand and water onto them from a hydraulic dredging project. The high percentage of silt and clay found in Grand Canal makes it unsuitable for beach nourishment.

  c. Upland Disposal in a Containment Dike: This is the preferred method for disposing of sediment with a high percentage of fine material. A mixture of water and dredged sediment is pumped into a containment dike, settlement of the fine particles is allowed to occur, and clear water is allowed to return to the waterway through a spillway and effluent pipes.

Table 4. Results of Sediment Grain Size Analysis (% Passing)				
	Sample No.			
Sieve Size	1	2	3	4
3/4" (19mm)			*See*	100
1/2" (12.5mm)			*Note*	98
3/8" (9.5mm)			*Below*	*94*
1/4" (6.3mm)				91
No. 4 (4.75mm)				89
1/8" (3.17mm)				87
No. 8 (2.36mm)				86
No. 10 (2.00mm)				86
No. 16 (1.18mm)			100	83
No. 20 (0.850mm)	100	100	99	80
No. 30 (0.600mm)	99	99	97	74
No. 40 (0.425mm)	97	97	91	64
No. 50 (0.300mm)	93	96	84	55
No. 80 (0.180mm)	89	94	70	52
No. 100 (0.150mm)	85	93	66	48
No. 200 (0.075mm)	81	91	56	45
No. 230 (0.063mm)	81	90	55	44
No. 270 (0.053mm)	80	89	55	43

Note: Sample # 3 contained 36.0% organic material

Sediment Sampling Locations	
Sample No. 1	1500'± N/o southern canal entrance near Shore Dr. 425't S/o Tower Mews Rd. in center of canal at intersection of Grand Canal and small canal running south towards the marina
Sample No. 2	1300'±N/o Sample #1. 200'± NE/o intersection of Canal Rd and Edgewater Rd. Taken in the center of the intersection of Grand Canal and small canal that runs to the west
Sample No. 3	1900't N/o Sample #2. 200'± S/o Central Blvd, and 250'± W/o Hollywood Dr. Bridge. Taken in the center of the canal
Sample No. 4	2000'± W/o Sample #3. 300'± E/o the north entrance to Grand Canal. Taken in the center of the canal

- ***Possible Upland Dike Sites:*** Three viable sites for containment dikes have been identified (Table 5, Appendix III). A combination of sites may be necessary to dispose of the estimated 15,000 cubic yards of material to be dredged from the canal.

Table 5. Potential Upland Sites for Spoil Disposal				
Dike Location	**Land Area** (acres)	**Estimated Capacity (cubic yards)**	**Maximum Pumping Distance (feet)**	Comments
Area 1	3.0	13,500	6,500	Town owned drainage reserve area
Area 2	2.0	9,000	8,000	County owned, Timber Pt. Park
Area 3	1.3	6,000 (if emptied)	15,000	Current dike is full of material from prior dredging. Owned by St. John's University
Reference Calculation: (750cy/ac/ftx6ft high fill) All quantities are approximate and subject to survey				

Project Complications:

1. Low Clearance Bridges - There are four low clearance bridges, which would hinder mobilization and operation of the small 6-inch dredge. In order for the dredge to work past the bridge obstructions, it may be necessary to partially dismantle and reassemble it, or completely remove the dredge from the canal using a crane. This additional procedure will add extra equipment, time, and cost to the project.

2. Private Bulkhead Condition - The canal is lined with individually owned private bulkheads of unknown embedment depths. Significant portions of the bulkheads are in poor condition, which could be undermined without a carefully planned channel width for the dredging operation. Before dredging could commence it would be necessary for the adjacent owners to provide the County with ***Hold Harmless Agreements.***

3. Odors Generated - Dredging of the highly organic sediments may release noxious sulfide odors to the surrounding area. These odors are expected to be temporary during the dredging operations, but may persist for some time in the spoil area.

- ***Permitting Process:*** There are three regulatory agencies that must approve a proposed dredging project through a permit application process. All three regulatory agencies include a period of public notice and comment in their permit review processes.

  1. The NYS Department of State issues a Letter of Concurrence if the project complies with the State's Coastal Management Program (CMP).

  2. The Department of Environmental Conservation issues a Work Permit and a Water Quality Certificate according to State Environmental Conservation Law (ECL).

  3. The US Army Corps of Engineers issues a Work Permit according to comments from Federal Agencies, such as the National Marine Fisheries Service, the Fish and Wildlife Service, the US Environmental Protection Agency, and the US Coast Guard.

Regulations

Under Suffolk County law, in order for a dredging project to be approved it must be judged to be in the public interest. Criteria for making this determination are set forth in Article 8-5 of the county's Administrative Code. The full text of the article is included in Appendix II. The Criteria for county dredging projects states in section A8-5 B (5) that:

A dredging project shall be deemed to be in the public interest if it supports, advances or enhances the following types of uses activities and/or facilities: 5) Recreational uses, ***including but not limited to*** *(emphasis added) boat livery stations, party boats, charter boats, marinas and yacht clubs open to use by the general public.*

Recreational uses of the canal would certainly be enhanced by dredging and this section of the Criteria does not exclude the canal from consideration. Section A8-5 B (1) allows dredging at a boat ramp with parking for *at least six cars with trailers*. There can be little doubt that a canal that provides docking for more than 100 recreational boats provides greater recreational opportunities than a ramp with parking for six vehicles. It is inconsistent to differentiate the public interest by including a boat ramp that may be utilized by a half-dozen individuals in the dredge criteria versus more than 100 boat owners on Grand Canal.

The criteria relevant to a public health reason are contained in section A8-5 B (6), of the criteria that reads as follows:

Reduction of the risk of public health problems based upon a certification by the Suffolk County Department of Health Services that the public health will be protected by dredging for the particular year the channel is proposed to be dredged.

Poor flushing of the canal and altered marsh features contribute to high levels of mosquito breeding in the adjacent wetlands. West Nile Virus positive birds and mosquito pools have been documented in the area. Mosquito breeding areas along the South Shore in the vicinity of Grand Canal are not uncommon. However, efforts to reduce mosquito breeding to minimize risk to public health are certainly prudent, especially in light of the findings of West Nile Virus-positive birds and mosquito pools in the area. Enhanced management of the greater Grand Canal area (including adjacent wetlands) presents such an opportunity to reduce mosquito breeding, with multiple ancillary benefits of minimizing pesticide usage and restoring hydrology and ecology.

Conclusions&Recommendations

The water quality monitoring conducted for this assessment clearly indicates that Grand Canal is significantly impacted by nutrient enrichment and potentially, by pathogen contamination. The excessive levels of nitrogen found in the canal suggest that algal blooms, and the consequential reduction in water clarity and depleted levels of dissolved oxygen, are a common occurrence. Potential sources of contamination include stormwater runoff from fertilized lawns and roadways, area wildlife, and perhaps, improperly functioning residential septic systems. Whatever the source however, the effect is exacerbated by the canal's low tidal prism and lack of flushing. A dredging project designed to increase flow in the canal will undoubtedly have a positive effect on its ecology.

The county dredging criteria does not exclude the canal from consideration. Recreational uses of the canal by the public, assuming more than 100 taxpaying boat owners are considered "the public," would be enhanced by dredging. Docking for more than 100 recreational boats provides greater recreational opportunities for Suffolk County residents than the criteria of a ramp with parking for six vehicles. Moreover, the canal itself is a waterway accessible for public usage and touring.

Mosquitoes do not breed directly within the canal, but the adjacent wetlands are primary breeding areas. Vector Control has identified through arboviral surveillance efforts 29 West Nile Virus (WNV) positive birds and 8 WNV mosquito pools within a 3-mile radius of the canal. Mosquito control is a public health management issue requiring multiple larvicide events annually. The best method of addressing this public health issue is through source control and abatement. In this case the wetlands bordering Grand Canal are inadequately flushed, providing a mosquito habitat. Dredging the canal, in conjunction with an OMWM strategy to provide greater water flows to the surrounding marshlands, would be a major step in alleviating the mosquito problem in areas adjacent to the Grand Canal.

Dredging of Grand Canal could result in improvements in water quality, reduction in the use of pesticides, and enhancement of recreational uses. It is, therefore, recommended that a comprehensive program to design and implement an OMWM/dredging strategy be considered. Development and implementation of such a program should be eligible for 1/4% Sales Tax Water Quality Protection and Restoration Program funding.

Article XII Section C12-2 of the Suffolk County Charter (Drinking Water Protection Program) addresses programmatic expenses permissible under the 1/4% program. Under sub-section (a), which refers to projects recommended by the management plans of South Shore Estuary Reserve (SSER), Peconic Estuary Program (PEP), and/or the Long Island Sound Study (LISS), it appears that the proposed Grand Canal project would qualify under the *"wetlands preservation and enhancement"* and *"open marsh water management"* criteria of the *Aquatic Habitat Restoration* category.

Appendix I

Organic Constituents Analyzed by the Suffolk County Public & Environmental Health Laboratory

(Analytes detected appear in boldface type)

Group	Analyte
Carbamate pesticides	
3-Hydroxycarbofuran	Carbofuran
Aldicarb	Methiocarb
Aldicarb sulfone	Methomyl
Aldicarb sulfoxide	Oxamyl
A-Naphthol	Propoxur
Carbaryl	
Herbicide Metabolites	
2,4,5-T	Didealkylatrazine
2,4-D	Imidacloprid
2,4-DB	Malaoxon
2,6-Dichlorobenzamide	MCPA
2-Hydroxyatrazine	MCPP
3,5-Dichlorobenzoic Acid	Metolachlor ESA (CGA-354743)
4-Nitrophenol	Metolachlor Metabolite (CGA-37735)
Acifluorfen	Metolachlor Metabolite (CGA-40172)
Alachlor ESA	Metolachlor Metabolite (CGA-41638)
Alachlor OA	Metolachlor Metabolite (CGA-67125)
Bentazon	Metolachlor OA (CGA-51202)
Chloramben	Pentachlorophenol
Deisopropylatrazine	Picloram
Desethylatrazine	Propamocarb hydrochloride
Dicamba	Silvex (2,4,5-TP)
Dichloroprop	
Chlorinated Pesticides	
4,4 DDD	Dieldrin
4,4 DDE	Endosulfan I
4,4 DDT	Endosulfan II
Alachlor	Endosulfan sulfate
Aldrin	Endrin
Alpha - BHC	Endrin aldehyde
Beta - BHC	Gamma - BHC
Chlordane	Heptachlor
Dacthal	Heptachlor epoxide
Delta - BHC	Methoxychlor

Semi-volatile Organic Compounds (SVOCs)	
Acenaphthene	Diethyltoluamide (DEET)
Acenaphthylene	Dimethyl phthalate
Acetochlor	Dinoseb
Allethrin	Dioctyl phthalate
Anthracene	Disulfoton
Atrazine	Disulfoton sulfone
Azoxystrobin	EPTC
Benfluralin	Ethofumesate
Benzo(a)anthracene	Ethyl parathion
Benzo(b)fluoranthene	Fluoranthene
Benzo(ghi)perylene	Fluorene
Benzo(k)fluoranthene	Gemfibrozil
Benzo-a-pyrene	Hexachlorobenzene
Benzophenone	Hexachlorocyclopentadiene
Benzyl butyl phthalate	Hexachloroethane
bis(2-ethylhexyl) adipate	Ibuprofen
bis(2-ethylhexyl) phthalate	Indeno(1,2,3-cd)pyrene
Bloc	Iodofenphos
Bromacil	Iprodione
Butachlor	Isofenphos
Butylated Hydroxyanisole	Kelthane
Butylated Hydroxytoluene	Malathion
Caffeine	Metalaxyl
Carbamazepine	Methoprene
Carbazole	Methyl parathion
Carisoprodol	Metolachlor
Chlorofenvinphos	Metribuzin
Chlorothalonil	Naled (Dibrom)
Chloroxylenol	Napropamide
Chlorpyriphos	Pendimethalin
Chrysene	Pentachlorobenzene
Cyanazine	Pentachloronitrobenzene
Cyfluthrin	Permethrin
Cypermethrin	Phenanthrene
Deltamethrin	Piperonyl butoxide
Diazinon	Prometon
Dibenzo(a,h)anthracene	Prometryne
Dibutyl phthalate	Propiconazole
Dichlorbenil	Pyrene
Dichlorvos	Resmethrin
Diethyl phthalate	Siduron

Semi-volatile Organic Compounds (SVOCs)	
Simazine	Trichlorfon
Sumithrin	Triclosan
Tebuthiuron	Trifluralin
Terbufos	Vinclozolin
Triadimefon	
Volatile Organic Compounds (VOCs)	
1,1,1,2-Tetrachloroethane	**Benzene**
1,1,1-Trichloroethane	Bromobenzene
1,1,2,2-Tetrachloroethane	Bromochloromethane
1,1,2-Trichloroethane	Bromodichloromethane
1,1-Dichloroethane	Bromoform
1,1-Dichloroethene	Bromomethane
1,1-Dichloropropene	**Carbon disulfide**
1,2 dibromoethane	Carbon Tetrachloride
1,2 dibromomethane	Chlorobenzene
1,2,3-Trichlorobenzene	Chlorodibromomethane
1,2,3-Trichloropropane	Chlorodifluoromethane
1,2,4,5-Tetramethylbenzene	Chloroethane
1,2,4-Trichlorobenzene	Chloroform
1,2,4-Trimethylbenzene	Chloromethane
1,2-Dichlorobenzene (o)	**cis-1,2-Dichloroethene**
1,2-Dichloroethane	cis-1,3-Dichloropropene
1,2-Dichloropropane	Dibromomethane
1,3,5-Trimethylbenzene	Dichlorodifluoromethane
1,3-Dichloropropane	Diethyl ether
1,4-Dichlorobuane	Dimethyldisulfide
1-Bromo-2-chloroethane	d-Limonene
1-Methylethylbenzene	Ethenylbenzene (Styrene)
2,2-Dichloropropane	**Ethylbenzene**
2,3-Dichloropropene	Ethylmethacrylate
2-Bromo-l-chloropropane	Freon 113
2-Butanone (MEK)	Hexachlorobutadiene
2-Chlorotoluene	Isopropylbenzene
3-Chlorotoluene	Isopropyltoluene (p-cymene)
4-Chlorotoluene	m,p-Dichlorobenzene
Acrylonitrile	Methacrylonitrile
Allyl chloride	Methyl isothiocyanate
Methyl sulfide	tert-Amyl-Methyl-Ether
Methylene Chloride	tert-Butylbenzene
Methylmethacrylate	tert-Butyl-Ethyl-Ether
Methyl-Tertiary-Butyl-Ether (MTBE)	**Tetrachloroethene**
m-Xylene	Tetrahydrofuran

Volatile Organic **Compounds** (VOCs)	
Naphthalene	Toluene
n-Butylbenzene	Total Chlorotoluene
n-Propylbenzene	**Total Xylene**
o-Xylene	trans-1,2-Dichloroethene
p-Diethylbenzene	trans-1,3-Dichloropropene
p-Isopropyltoluene	Trichloroethene
p-Xylene	Trichlorofluoromethane
sec-Butylbenzene	Vinyl Chloride

Appendix II

Laws of Suffolk County, Part II Administrative Code
§ A8-5. Criteria for County Dredging Projects

A. A. No proposed county dredging project shall be approved by the Dredging Project Screening Committee nor by the County Legislature unless such project shall be in the public interest.

B. A dredging project shall be deemed to be in the public interest if it supports, advances or enhances the following types of uses, activities and/ or facilities:

1. Publicly owned, leased and/or operated marine facilities, including but not limited to mooring areas, boat basins, marinas, docks and boat ramps. Boat ramps need not consist solely of paved asphalt but may be composed of concrete, treated lumber, gravel or crushed stone extending to the mean low water mark. The parking areas associated with such a facility must accommodate at least six cars with trailers and may be composed of smooth grassed area, crushed stone, pavement or concrete. A public mooring area within an enclosed embayment must have within its proximity a publicly owned parcel of land fronting on the embayment permitting public access in order to qualify as a public purpose.

2. Marine commercial uses, including but not limited to boatyards, ship repair facilities, commercial fishery docks and product transfer sites.

3. Industrial, transportation and utility uses, including but not limited to petroleum product transfer facilities, ferry terminals and power plants.

4. Institutional uses such as education and public safety facilities.

5. Recreational uses, including but not limited to boat livery stations, party boats, charter boats, marinas and yacht clubs open to use by the general public.

6. Reduction of the risk of public health problems based upon a certification by the Suffolk County Department of Health Services that the public health will be protected by dredging for the particular year the channel is proposed to be dredged.

7. Open water shoals outside of navigation channels to improve general navigation.

8. Obtaining fill from navigation channels for the purpose of beach nourishment and shoreline construction.

9. Mitigating damage or shoaling caused by the County of Suffolk.

10. Reduction of a navigational hazard caused by shoaling at bay-canal interfaces.

C. A dredging project shall be deemed to be in the private interest in the following circumstances:

1. It does not provide direct access to or service for any of the uses or facilities mentioned in Subsection B of this section.

2. It provides service solely and exclusively to shoreline homeowners or a group of homeowners in a civic association, the membership of which is controlled by a residency requirement, regardless of the nature of the water body.

3. It dredges within privately owned facilities.

4. It only maintains privately owned boat slips or basins.

No proposed county dredging project shall be approved by the Dredging Project Screening Committee nor by the County Legislature unless the county shall have first conducted soundings or other reliable and accepted measurements in accordance with normal engineering practices and procedures of the area to be dredged to determine the estimated cost of such proposed work.

Appendix III
Aerial Images of Potential Upland Sites for Spoil Disposal

Area #1 Owner: Town of Islip (drainage reserve area)
Approx. 3 ac. 6,500' pumping distance

Area #2 Owner: County of Suffolk
Approx. 2 ac. 8,000' pumping distance

Area #3 Owner: St. John's University
Approx. 1.3 ac. 15,000' pumping distance

Appendix B

Grand Canal Historical Aerial Photographs

Historical Aerial Photographs

1947

1962

Historical Aerial Photographs

1978

1984

Historical Aerial Photographs

2001

2004

Historical Aerial Photographs

2006

2007

Historical Aerial Photographs

2010

2013

Appendix C

Grand Canal Public Health Evaluation Report

TASK 4:
PUBLIC HEALTH PROBLEM EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Submitted to:

Suffolk County Department of Health Services
Suffolk County, New York

Submitted by:

Tetra Tech, Inc.
661 Andersen Drive
Pittsburgh, PA 15220-2700
Tetra Tech Project Number 112C07442

Submitted under Subcontract to:

Cashin Associates, PC
1200 Veterans Memorial Highway
Hauppauge, New York 11788
Suffolk County Contract No. 525-5200-1180-00-00001

June 2016

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TABLES (continued)

FIGURES

FIGURES (continued)

ACRONYMS AND ABBREVIATIONS

ABDL	Arthropod-Borne Disease Laboratory
BEHP	bis(2-Ethyl hexyl) phthalate
BTEX	benzene, toluene, ethylbenzene, and xylenes
°C	degree Celsius
CDC	Center for Disease Control
CDPHE	Colorado Department of Public Health and Environment
cfu	colony forming unit
cis-1,2-DCE	cis-1,2-Dichloroethene
COPC	chemical of potential concern
CRR	Codes, Rules and Regulations
CSF	cancer slope factor
CSM	Conceptual Site Model
CWP	Center for Watershed Protection
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DO	dissolved oxygen
EPC	exposure point concentration
GCSWA	Grand Canal Surface Water Assessment
HHRA	human health risk assessment
HI	hazard index
IARC	International Agency for Research on Cancer
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System
mg/L	milligram per liter
MIR	minimum infection rate
ml	millimeter
N	nitrogen
NCCOS	National Center for Coastal Ocean Science
NTU	Nephelometric Turbidity Unit
NY DOH	New York Department of Health
OEHHA	Office of Environmental Health Hazard Assessment
OMWM	Open Marsh Water Management
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHE	Public Health Evaluation
ppt	part per thousand

PSU	practical salinity units
RBC	risk-based concentration
RfD	reference dose
RSL	Regional Screening Level
SCDHS	Suffolk County Department of Health Services
SCDPW	Suffolk County Department of Public Works
STORET	Storage and Retrieval
STV	statistical threshold value
SVOC	semi-volatile organic compound
SWRMS	Storm Water Run-off Monitoring Study
TCE	trichloroethene
TEQ	toxicity equivalence
UCL	upper confidence limit
µg/L	microgram per liter
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VI	vector index
VOC	volatile organic compound
WNV	West Nile Virus

1.0 INTRODUCTION

1.1 Purpose of Evaluation

Task 4 is the Public Health Evaluation (PHE) of the physical, chemical, and microbiological data collected from the Grand Canal and adjacent wetlands under Tasks 2 and 3 of Suffolk County Contract No. 525-5200-1180-00-00001. In addition, the PHE considers data (including vector data) provided by the Suffolk County Department of Health Services (SCDHS) and data readily available as a result of internet web searches. The primary objective of the PHE is to determine if such data indicates a potential for adverse human health impacts resulting from direct contact with surface waters and sediments, consumption of biota taken from the study area, and/or exposure to mosquitos (or other biological agents [e.g., bacteria]) within the Grand Canal study area, previously defined under Tasks 1, 2, and 3. Sections 2 through 4 present the data sources, methodology, and results for each facet of the PHE conducted, as follows:

- Section 2: Evaluation of Chemical Quality
- Section 3: Evaluation of Microbiological Quality
- Section 4: Evaluation of Potential For Vector-Borne Disease

Section 5 provides a summary and conclusions.

1.2 Study Area Location, Background, and Potential Human Receptors of Concern

The following overview of the Grand Canal study area (**Figure 1**) is based on information provided by Suffolk County and Cashin Associates in the following documents:

- The Grand Canal Environmental Assessment Final Report (SCDHS, 2005)
- The Draft Water Quality Monitoring Plan for Grand Canal, Oakdale, New York (Cashin Associates, 2015)

The Grand Canal is a shallow man-made waterway and tributary or branch of the Connetquot River located in Oakdale, New York, in the Town of Islip. The main channel of the Canal is approximately 8,000 feet in length and 20 feet wide and variable in terms of both width and depth. The canal system also includes a number of branch (“inner” finger) channels that extend into residential areas, providing access to the main channel. The Grand Canal is unique in that it has two interfaces that open into the Connetquot River. One opening is in the midsection of the tidal portion of the river, and the second opening is in the southern section of the tidal portion of the river. This creates a situation where the river flow may have an influence on the currents and tidal flow in the Canal. The Grand Canal is also integral to an extensive wetland system.

The Canal’s northern opening is surrounded by residential properties, and the southern opening is bordered on either side by commercial properties including a marina and restaurant. The land area surrounding the northern section of the main canal that runs east-west is residential. For the north-south section of the main channel, the land to the west is a mixture of residential properties and tidal wetlands. The adjacent land area to the east is dominated by an extensive tidal and freshwater wetland complex known as the Pickman-Remmer Wetlands owned by the State of New York and managed by the New York State Department of Environmental Conservation. All of these wetlands depend on the Canal for tidal circulation. Additional relevant information describing the Grand Canal area and its history are provided in reports prepared by Cashin Associates under Tasks 1, 2, 3, and 5 of Suffolk County Contract No. 525-5200-1180-00-00001.

For a number of years, the Grand Canal has been the subject of complaints by area residents reportedly concerned about progressive shoaling and reduction in tidal flushing. Residential areas adjoin the Grand Canal, and residents use the Canal for recreational purposes (e.g., boating). Issues raised by residents include the potential for mosquito breeding, potential West Nile Virus (WNV) and other epizootic activity, possible contamination of Grand Canal surface waters and sediments, and general water quality deterioration. The following is an outline or overview (often referred to as a Conceptual Site Model [CSM]) of human exposure pathways and receptor issues to be addressed in this PHE:

- Several anthropogenic sources of contamination contribute to the organic chemical, nutrient, and microbiological load in surface waters of the Grand Canal. These include, but are not limited to:
  - Surface water run-off from adjoining residential, commercial, and recreational areas
  - Discharges from septic systems within the study area
  - Discharges from boats operating within the study area
- Residents (and other recreational users) that use the Canal for recreational purposes may be exposed to agents in surface waters and sediments while wading or swimming in the Canal, while launching boats to or extracting boats from the Canal, or while constructing or repairing structures along the Canal. Additionally, such receptors may also be exposed if they consume fish taken from the Canal if such chemicals have been transferred from surface water or sediment to the fish.
- Residents or receptors may contact chemicals/microbiological agents in surface water and sediment by both direct and indirect exposure pathways:
  - The direct contact exposure pathways are dermal contact and incidental ingestion, for example, while swimming in the Canal.
  - The indirect exposure pathway is occasional consumption of fish taken from the Canal.
- Residents and recreational users are potentially exposed to viral agents spread by mosquitos breeding in the Grand Canal area and adjoining wetlands.

1.3 Overview of the Previous Environmental Assessment

In January 2005, the SCDHS and Suffolk County Department of Public Works (SCDPW) published the Grand Canal Environmental Assessment Final Report that was based primarily on environmental data (e.g., microbiological, chemistry, vector) collected by the county in 2004. The SCDHS concluded that:

- Water quality in the Canal was significantly impacted by nutrient enrichment and potentially by pathogen contamination.
- Potential sources of contamination to the Canal included storm water run-off from fertilized lawns and roadways, area wildlife, and improperly functioning residential septic systems.
- Dredging of the Canal, in conjunction with a comprehensive Open Marsh Water Management (OMWM) strategy to provide greater water flows to the adjacent wetlands, could be a major step toward decreasing the need for annual larviciding. The Grand Canal area currently requires multiple larvicide events annually. However, any such dredging activity must be conducted in a manner to avoid creating any problems with changes in the current fish and wildlife habitat, and dredging spoils must be removed to prevent foul odors from impacting residents of the community.

In many respects, the PHE contained herein is a follow-up to the SCDHS/SCDPW assessment published in the 2005 report. The following sections briefly summarize the data presented in the January 2005 report and provide results of environmental sampling conducted by Cashin Associates in 2015. **Figure 2** depicts the 2004 SCDHS/SCDPW sampling locations and several 2015 Cashin Associates sampling locations. **Figure 2** also depicts two continuous monitoring locations used by SCDHS/SCDPW to collect water quality data (temperature, dissolved oxygen [DO], salinity, water displacement) every 15 minutes via Sonde meters for the Grand Canal Study Area in 2013 and 2014. **Figure 3** depicts additional 2015 Cashin Associates sampling locations.

2.0 EVALUATION OF CHEMICAL QUALITY

Section 2 provides the PHE of chemical surface water and sediment data available for the Grand Canal study area. Data sources are identified in Section 2.1, chemical data are presented and discussed in Section 2.2, and the results of the evaluation are provided in Section 2.3.

2.1 Data Sources

The PHE of chemical data available for the study area is based primarily on surface water data collected on July 15, August 11, August 27, and September 3, 2015, by Cashin Associates in accordance with the *Draft Water Quality Monitoring Plan* (Cashin Associates, 2015). The Plan has two components:

- *Grand Canal Surface Water Assessment (GCSWA):* This study was conducted to investigate water quality during four distinct tidal conditions. Surface water samples were collected at 11 locations depicted on **Figure 2** at low, mid-incoming, high, and mid-outgoing tides during the July 15 and August 27, 2015, sampling events. The sampling locations mirror those used by the

SCDHS/SCDPW in 2004, with the exception of Grand Canal location 3 (i.e., GC3). As discussed in the referenced planning document, water quality samples were not collected from location GC3 "due to its lack of utility in providing a unique representative location of the Canal based on its close proximity to other sampling locations."

- *Storm Water Run-off Monitoring Study (SWRMS):* This study was conducted to determine the contaminant load from storm water run-off to the Grand Canal. One surface water run-off sample was collected from each of six locations depicted on **Figure 3** (SW-1 through SW-6) during the August 11 and September 3, 2015, sampling events. Chemical data were not collected from the other locations depicted on **Figure 3**. The August 11, 2015, surface water run-off sampling (hereafter referred to as the "wet sampling" event) was conducted within the first 3 hours of a significant rainfall event (defined as a least 0.5 inch of precipitation). The September 3, 2015, surface water run-off sampling (hereafter referred to as the "dry sampling" event) was a baseline sampling event conducted following a period of dry weather (defined as no rain for at least 72 hours).

Surface water samples from these sampling events were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), herbicides, pesticides, and several nutrients [total nitrogen, total dissolved nitrogen, phosphorous (total and dissolved), and total inorganic nitrogen (dissolved)]. Analytical data for the samples are presented in **Attachment A.** Descriptive statistics for any target analyte detected at least once are presented in **Tables 2-1A and B, 2-2A and B, 2-3A and B, and 2-4A and B. Tables 2-1A, 2-2A, 2-3A, and 2-4A** present comparisons of maximum detected concentrations to screening levels defined in Section 2.2, and **Tables 2-1B, 2-2B, 2-3B, and 2-4B** present comparisons of maximum detected concentrations to water quality criteria defined in Section 2.2. The sample identifier for low, mid-incoming, high, and mid-outgoing tide samples are appended with an A, B, C, and D, respectively. Data for the following field parameters were also collected during the surface water monitoring events: temperature, salinity, DO, turbidity, and hydrogen sulfide. Field notes and general water quality readings for the 2015 surface water monitoring events are included in **Attachment A**.

Surface water quality data from the following additional sources are also considered in the PHE:

- Environmental Assessment Final Report (SCDHS, 2005). A formal analytical database was not available at the time this PHE was prepared. The data discussed herein were provided in summary tables presented in the January 2005 report.
- Continuous monitoring data (temperature, DO, salinity, water displacement readings every 15 minutes [Sonde data]) collected in 2013 and 2014 by SCDHS/SCDPW at two locations in the Grand Canal study area. The monitoring data are included as **Attachment B**. Summary descriptive statistics are presented in **Tables 2-5 and 2-6.**
- The United States Environmental Protection Agency (USEPA) Storage and Retrieval (STORET) data warehouse for regional data. **Tables 2-7 and 2-8** provide summary statistics for target

analytes detected in surface water samples collected from 2008 to 2014 in Suffolk County and the Southern Long Island Watershed, respectively. Stations were located at beach, ocean, lake, estuary, and river/stream settings and are not specific to the Grand Canal study area. However, the data (available for metals, a few VOCs, nutrients, and general water quality parameters) are useful as points of reference.

In addition, sediment data collected on December 21 and 22, 2015, by Cashin Associates from 10 stations within the Grand Canal was also evaluated. Sediment samples were analyzed for select VOCs [benzene, toluene, ethylbenzene, and xylenes (BTEX)], SVOCs, pesticides, polychlorinated biphenyls (PCBs), and metals. In addition, two sediment samples were analyzed for dioxins. Analytical data for these samples are presented in **Attachment A**. Descriptive statistics for any target analyte detected at least once are presented in **Table 2-9**. **Table 2-9** also presents a comparison of maximum detected concentrations to screening levels defined in Section 2.2. Surface water data for the following field parameters were also collected during the 2015 sediment monitoring event: temperature, salinity, dissolved oxygen, and turbidity, and are included in Attachment A.

2.2 Chemical Data for the Grand Canal Study Area

The data sources identified in Section 2.1 provide information regarding the general water quality and nutrient profile for the Grand Canal study area and data regarding the nature and extent of chemicals in the surface waters and sediment of the Canal. The data are summarized and compared to the following USEPA and State of New York screening levels developed assuming that human receptors are exposed to the surface waters and sediment of the Canal while engaged in recreational activities along the Canal:

- ***Regional Screening Levels (RSLs) developed by USEPA for tap water and residential soil.*** The USEPA tap-water RSLs (2016) are developed assuming a water source is used as a domestic water supply (i.e., used for drinking/bathing on a daily basis). The USEPA residential soil RSLs (2016) are developed assuming residential exposure to soils. For chemicals considered to be known or potential carcinogens, these screening levels represent the one-in-one million cancer risk level (i.e., a human receptor has one-in-one million excess chance of developing cancer if exposed to a chemical at a concentration equal to the RSL). For chemicals capable of producing adverse non-cancer effects (e.g., kidney toxicity), these screening levels represent, conservatively, a concentration that is an order of magnitude *less than* the exposure concentrations below which adverse effects are not expected to occur. Adverse non-cancer effects are not anticipated when the hazard index (HI) is equal to or less than 1. The RSL for a chemical with non-cancer effects is set at an HI of 0.1 to account for the potential cumulative effect of multiple chemicals impacting the same target organ. The USEPA tap water RSLs (developed as detailed in **Attachment C**) are included as useful points of reference *only* because the Grand Canal is not currently used as a domestic water supply, and it is very unlikely that it would be developed as a domestic water supply source in the future. In addition, receptors are less frequently exposed to sediment than to soil, and the USEPA residential RSLs are based on exposure to soils. Consequently, chemical levels exceeding the tap water and residential soil RSLs do not necessarily present unacceptable levels of risk resulting from exposure to surface waters and sediments of the Grand Canal. The RSLs are however frequently used as screening levels for chemical of potential concern (COPC) selection in human health risk assessments (HHRAs).

- ***Recreational Screening Levels (Direct Contact and Fish Ingestion) calculated using the USEPA RSL calculator.*** Project-specific screening levels were developed assuming lifelong exposure to surface water and sediment (incidental ingestion of a small amount of surface water/sediment and dermal contact with surface water and sediment) while swimming in the Grand Canal or ingestion of fish taken from the Grand Canal. The screening levels are set at the one-in-one million cancer risk level (i.e., the $1x10^{-6}$ cancer risk level) and non-cancer HI of 0.1 and are based on the most current toxicity information published by USEPA in the RSL calculator (USEPA, 2016. The direct contact values conservatively assume that child and adult receptors are swimming 100 and 50 days per year, respectively. The fish ingestion screening levels assume that an adult consumes 12 meals per year of fish caught within the Canal. Note that fish sampling was not conducted as part of this assessment. Instead, surface water and sediment concentrations were compared to screening levels developed assuming a portion of the contaminants in surface water and sediment are retained in fish contacting those media. The specific exposure assumptions and calculations for the screening levels are presented in **Attachment D** and summarized in **Table 2-10.** All screening levels have been validated using the USEPA RSL calculator. Note that, only 10 percent of arsenic obtained from sediment is assumed to be present as inorganic arsenic (the more toxic form of arsenic) in fish (ATSDR, 2007). Therefore, the arsenic screening level developed for fish ingestion was multiplied by 10 to account for the percent inorganic arsenic in fish. Literature sources indicate that this value is conservative as inorganic arsenic levels in fish are likely less than 3 percent (Peshut, et al., 2008; Pétursdóttir, 2010). The development of screening levels for the fish ingestion pathway are discussed in more detail in Attachment D.
- ***New York State Criteria.*** New York Water Quality Standards are available for taste-, color- and odor-producing, toxic, and other deleterious substances [6 Codes, Rules and Regulations (CRR)-NY 703.5] and are health-, aquatic-, wildlife-, aesthetic-, or recreation-based values. In addition, ambient water quality standards and guidance values (New York State, 1998) are available for chemicals without standards in 6 CRR-NY 703.5 including a value of 20 microgram per liter (µg/L) for phosphorus for recreational exposure to freshwater water. Criteria for nutrients are also presented in the Nutrient Standards Plan (New York State, 2011). The value for phosphorus is applicable to ponds, lakes, and reservoirs and is based on aesthetic effects for primary and secondary contact recreation (New York State, 1998). Concentrations of phosphorus greater than 20 µg/L increase the potential for algae blooms, including algal blooms that could

generate cyanotoxins that are harmful to humans if contacted or ingested. These three New York guidance documents are included in **Attachment C**.

2.2.1 <u>Summary of Organic Chemical Data for Surface Water</u>

2.2.1.1 Organic Chemical Results for the Grand Canal Locations

VOCs and SVOCs were detected in surface water samples collected from 11 locations within the Grand Canal study area on July 15 and August 27, 2015. A total of 88 samples were collected at locations depicted on **Figure 2.** Summary statistics, including frequencies of detection, for these two sampling events are presented in **Tables 2-1A and B and 2-2A and B**. Of the chemicals detected, most were noted in less than 5 percent of the samples collected and most at maximum concentrations less than 1 µg/L. The following chemicals, detected in more than 5 percent of the samples (three or more samples in either sampling event), are discussed in detail in the following narrative:

- Acrolein
- cis-1,2-Dichloroethene (cis-1,2-DCE)
- bis(2-Ethyl hexyl) phthalate (BEHP)
- Ethylbenzene
- Toluene
- Benzene
- Fluoranthene
- Xylenes
- 1,2,4-Trimethylbenzene

BEHP was the only chemical of those listed above to exceed recreational screening levels developed for this PHE (see **Tables 2-1A and 2-2A**). Many detections also exceed the water quality criteria presented in **Tables 2-1B and 2-2B**. The maximum detected concentration exceeds the recreational screening level calculated assuming direct contact exposure with surface water (i.e., assuming the receptor is swimming in the Canal) *and* assuming consumption of fish from the Canal. However, BEHP concentrations only exceed the screening value based on consumption of fish from the Canal (estimated from surface water concentrations). BEHP was detected in approximately one-half of the samples collected in July and August 2015. It is a common laboratory contaminant and is also frequently found in environmental samples because of the widespread use (and disposal) of plastics in our modern society. Two other chemicals (n-nitroso-di-n-propylamine and 2,6-dinitrotoluene, not listed above) were also detected at concentrations exceeding recreational screening levels and water quality criteria. However, each chemical was detected in only one of 88 surface water samples collected in 2015. Neither chemical was detected in samples collected in 2004 (see **Table 3 of Attachment E).**

Acrolein, detected at maximum concentrations slightly exceeding water quality criteria, and toluene were the most frequently detected VOCs in the July and August 2015 surface water samples. Acrolein, detected in 7 of 44 July samples and in 23 of 44 August samples, is formed during the combustion of gasoline and oil. Toluene is a component of gasoline. All of the BTEX compounds were found in six or more of the 88 samples analyzed and are common indicators of fuel-related contamination. Toluene was the most frequently detected BTEX compound (identified in five July samples and 15 August samples), whereas other BTEX components were detected in no more than three July 2015 samples and five August 2015 samples. The BTEX detections reported for the 2015 sampling events are comparable to those reported for the surface water samples collected in 2004 (see **Table 3 of Attachment E).**

1,2,4-Trimethylbenzene was detected in three of the August 2015 samples. Trimethylbenzene compounds were also detected in two July 2015 samples and two surface water samples collected in 2004 (see **Table 3 of Attachment E)**. Trimethylbenzene is a component of gasoline and is released from vehicles, municipal waste treatment plants, and coal-fired power stations (OEHHA, 2001). cis-1,2-DCE, detected in eight August 2015 samples, is used as a solvent and is a biodegradation product of chlorinated organic chemicals such as trichloroethene (TCE). Trimethylbenzene compounds and chlorinated organic chemicals (TCE, tetrachlorothene, 1,2-dichloroethene, cis-1,2-DCE) were detected sporadically in surface water samples collected in 2004 and 2015. The maximum detected concentrations do not exceed 2 µg/L and suggest low-level, occasional releases to the Canal.

Fluoranthene, a polycyclic aromatic hydrocarbon (PAH), was detected in four August 2015 samples and two July 2015 samples. It was the only PAH detected in more than 5 percent of the samples analyzed; although a few other PAHs were detected sporadically in both July and August 2015 samples and in surface water samples collected in 2004 (see **Table 3 of Attachment E)**. PAHs are present in vehicle emissions and found in products such as coal tar-based pavement. The acrolein, BTEX, trimethylbenzene, and PAH detections reported for the 2015 and/or 2004 samples are likely associated with combustion sources and the widespread use of fuels within the Grand Canal study area (e.g., surface water run-off from roads, boat exhausts, etc.).

Field notes for the July and August 2015 sampling events (**Attachment A**) indicate that an oily sheen was observed in the water at Stations 2, 9, and 10 during the July sampling event and at Stations 2, 9, and 10 during the August sampling event. These observations may explain some of the BTEX and PAH detections discussed above. One or more PAHs were detected at Stations 4, 9, and 11 during the July 2015 sampling event and at Stations 2, 4, 7, and 10 during the August sampling event. Concentrations of individual PAHs were all less than 0.15 µg/L. Detected concentrations of two or more BTEX components (toluene, in particular) were reported at Stations 6 and 8 during the July 2015 sampling event and at Stations 10, 11, and 12 during the August 2015 sampling event.

2.2.1.2 Organic Data for the Surface Water Run-off Monitoring Study

Summary statistics for surface water run-off samples collected from six locations (**Figure 3**) during the August (wet sampling) and September (dry sampling) events are presented in **Tables 2-3A and 2-4A,** respectively. Analytical data for these samples is provided in **Attachment A**.

The SWRMS samples were collected to evaluate contaminant loading to the Canal as a consequence of surface water run-off. Several VOCs and SVOCs were detected in the samples. The chemical profile and concentrations are generally similar to those noted in the Grand Canal samples discussed above. With the exception of BEHP and acrolein (among the most frequently detected compounds reported if considering the data for both events), maximum concentrations reported did not exceed 5 µg/L. BEHP and acrolein concentrations for the dry sampling event generally exceed those for the wet sampling event, suggesting a possible dilution of loading concentrations as a consequence of the precipitation event. BTEX, PAH, and 1,2,4-trimethylbenzene detections are indicative of contributions from one or more anthropogenic sources of contamination (e.g., fuel-related or combustion sources, surface water run-off from asphalt-paved areas, etc.) Three organic chemicals (tert-butyl alcohol, chloromethane, and carbon disulfide) were detected in the SWRMS samples but not in the Grand Canal samples.

BEHP was the only chemical detected in SWRMS samples at concentrations exceeding recreational screening levels developed for the project. The BEHP recreational screening level was calculated assuming that a receptor was exposed via the fish ingestion pathway (the screening level was estimated from surface water concentrations).

2.2.2 <u>Summary of 2015 Nutrient Data</u>

Surface water samples from the four 2015 sampling events were also analyzed for nutrients indicative of water quality [total nitrogen, total dissolved nitrogen, phosphorous (total and dissolved), and total inorganic nitrogen (dissolved)]. **Tables 2-1A and B, 2-2A and B, 2-3A and B, and 2-4A and B** include summary statistics for the nutrient data, which are provided in detail in **Attachment A**. Total and dissolved nitrogen and phosphorus data for the July and August Grand Canal sampling events are also depicted on **Figures 4 through 11**. The following items summarize the data collected and compare detected concentrations to available criteria and benchmarks established for water quality (e.g., to mitigate the potential for harmful algal blooms, reduced water transparency, decreased levels of oxygen, and production of foul odors):

- Total nitrogen was detected in most of the surface water samples collected; concentrations ranged from 1,300 to 4,700 µg/L. Most of the detected concentrations (and the laboratory reporting limit of 1,200 µg/L) exceed one or more available federal or state water quality criteria or recommendation. For example, total nitrogen criteria for Florida estuaries range from 170 to

1,870 µg/L, with values for rivers and streams ranging from 670 to 1,870 µg/L (USEPA, 2015). Total nitrogen criteria for Massachusetts estuaries range for 380 to 552 µg/L (USEPA, 2015). As summarized in **Tables 2-1A and 2-2A**, mean and median dissolved nitrogen concentrations are less than mean and total nitrogen concentrations, suggesting that most of the nitrogen is present in the dissolved form. Total and dissolved nitrogen concentrations reported for samples collected in the 2004 sampling event conducted by the county are less than those reported for the 2015 sampling event (see Table 2 of **Attachment E**).

- Total phosphorus was detected in most surface water samples collected; concentrations ranged from 50 to 597 µg/L. All detected concentrations (and the laboratory reporting limit of 50 µg/L) exceed the New York State water quality criterion for recreational use of freshwaters of 20 µg/L (New York State, 2011). This criterion was developed for lakes and ponds and therefore is not strictly applicable to the Grand Canal. As an additional point of reference, the State of New Jersey has developed a total phosphorus criterion of 100 µg/L for non-tidal freshwater streams (USEPA, 2015). The State of Wisconsin also generally uses total phosphorus criteria of 100 and 75 µg/L for rivers and streams, respectively (USEPA, 2015). The total phosphorus results depicted on **Figures 8 and 9** indicate that concentrations for most high and mid-outgoing tidal samples exceed 100 µg/L; most concentrations for low and mid-incoming tidal samples do not. The data summarized in **Tables 2-1A and 2-2A** suggest that most phosphorus is present in the dissolved form. The total and dissolved phosphorus concentrations reported for samples collected during the 2004 sampling event conducted by the county are less than those reported for the 2015 sampling event.
- Total dissolved inorganic nitrogen (DIN) was detected infrequently in the July 2015 Grand Canal samples (three detections, 1.2 to 1.6 milligrams per liter [mg/L], in samples GC-11B, GC-12A, GC-12B) and was not detected in any surface water samples collected in August or September 2015. However, the laboratory reporting limit for the 2015 surface water samples, 1.05 mg/L, was elevated compared to the reporting limits for the county's 2004 sampling event. Total DIN was detected in the 2004 samples and levels were greatest at Stations 9 through 12. As a point of reference for the 2004 sampling event, total DIN levels in adjacent areas of Great South Bay averaged less than 0.05 mg/L (SCDHS, 2005). Total DIN is the nutrient most responsible for eutrophication in open estuarine and marine waters, whereas dissolved inorganic phosphorus (DIP), not a target analyte for the 2015 sampling events, is more likely to promote algal growth in tidal-fresh waters. DIP was not detected in samples collected in the county's 2004 sampling event. Total DIN detections and reporting limits exceed the following benchmarks published by the USEPA (2008).

Area: Northeast, Southeast, Gulf Coast	Benchmarks for Nutrients Indicating Water Quality		
	Good	**Fair**	**Poor**
DIN	< 0.1 mg/L	0.1 to 0.5 mg/L	> 0.5 mg/L
DIP	< 0.01 mg/L	0.01 to 0.05 mg/L	> 0.05 mg/L
DO	> 5 mg/L	2 to 5 mg/L	< 2 mg/L

Based on a comparison of average reported concentrations, the Grand Canal study area concentrations of total nitrogen and total phosphorous are generally greater than regional data reported for nitrogen and phosphorous (**Tables 2-7 and 2-8**):

- Regional phosphorous concentrations ranged from 3.6 to 2050 µg/L (with average concentrations of 50 µg/L for Suffolk County data and 70 µg/L for the Southern Long Island Watershed). Average total phosphorous concentrations for the study area data, presented in **Tables 2-1A through 2-4A**, exceed these average regional concentrations.
- Regional nitrogen concentrations ranged from 92 to 750 µg/L (average of 210 µg/L) for Suffolk County and 12 to 280,000 µg/L (average of 970 µg/L) for the Southern Long Island Watershed. Average total nitrogen concentrations for study area data exceed the regional average concentrations.
- Nitrogen data in the STORET database (accessed October 6, 2015; summarized in **Tables 2-7 and 2-8**), in addition to total nitrogen, are also reported as ammonia-nitrogen as nitrogen (N), inorganic nitrogen (nitrate and nitrite) as N, and Kjeldahl nitrogen. Some of these values are greater than the regional nitrogen values summarized above, indicating that nutrient concentrations may be elevated in the Grand Canal

2.2.3 <u>Summary of Water Quality Measurements</u>

2.2.3.1 General Water Quality Data for the 2015 July and August Tidal Sampling Events

Tables A-1 through A-4 in Attachment A-1 summarize the field notes and water quality monitoring data collected during the 2015 sampling events. **Figures 12 through 19** depict temperature, salinity, dissolved oxygen, and turbidity measurements collected at 11 stations monitored throughout the tidal cycle (low, mid-incoming, high, and mid-outgoing) for the two sampling events, July 15, 2015, and August 27, 2015, respectively. The following items summarize data collected and trends observed:

- Temperature (**Figures 12 and 16**): With a few exceptions, water temperature readings collected during high tide and mid-outgoing tide conditions generally exceed those reported for low tide and mid-incoming conditions. Water temperature readings were more variable and the temperature range was larger for samples collected during the August event compared to samples collected during the July event.

- Salinity (**Figures 14 and 18**): Salinity readings were more variable across monitoring stations in July than in August. Most salinity readings in July were between 16 and 20 practical salinity units (PSU) whereas most August readings were between 20 and 22 PSU. Readings at GC-01 and GC-12, located closest to the Connetquot River, were generally more variable than those reported for other stations and likely reflect tidal influences. The salinity readings reported indicate that surface waters of the Grand Canal are brackish.
- DO (**Figures 13 and 17**): DO readings were generally similar for both sampling events, except that July readings were more variable, and readings reported for Stations 2, 4, and 5 during the July sampling event exceed those reported for other July-event stations and all August-event readings. Most DO readings are less than the minimum allowable DO level of 4.8 mg/L stipulated in New York Water Quality Standards for saline surface waters Classes SA, SB, and SC (6 CRR-NY 703.3). With some exceptions, DO levels were generally slightly greater in high tide and mid-outgoing tide samples than in samples collected at low tide or mid-incoming tide.
- Turbidity (**Figures 15 and 19**): Turbidity levels were generally between 5 and 15 Nephelometric Turbidity Units (NTU) at most locations, with notable exceptions at Stations 4 and 7 during the August sampling event.

Based on water quality data collected as part of the tidal study, water temperature, salinity, and DO levels are somewhat related to tidal fluctuations. In general, higher water temperatures, salinities, and DO levels occur at high-tide and mid-outgoing tide conditions versus low-tide and mid-incoming tide conditions. However, with a few exceptions, the variations in readings over time and across the stations do not suggest that significant tidal flushing is occurring throughout the study area. Also, most DO levels were less than the minimum New York criterion of 4.8 mg/L, and several DO readings collected during the monitoring events were less than 2 mg/L. For saltwater, USEPA (2000) recommends a minimum DO level of 2.3 mg/L as a limit for continuous 24-hour exposure to protect juvenile and adult aquatic life (the value would be approximately 2 mg/L for a 12 hour exposure). Therefore, the low DO levels in the Grand Canal have the potential to impact the development and health of aquatic organisms.

2.2.3.2 General Water Quality Data for 2015 Wet and Dry Sampling Events

Tables A-3 and A-4 in Attachment A-1 summarize field notes and water quality monitoring data collected for the August 2015 wet and September 2015 dry sampling events. The following items summarize data collected and trends observed:

- Temperature: Temperature differences between the sampling events could not be evaluated because temperature readings were not available for the August 2015 sampling event.
- Salinity: Salinity was higher during the dry sampling event (20.78 to 24.07 PSU) compared to the wet sampling event (16.24 to 19.68 PSU).
- DO: DO readings were generally lower during the dry sampling event (1.06 to 2.36 mg/L) compared to the wet sampling event (2.33 to 4.21 mg/L).

- Turbidity: Turbidity levels were generally lower during the dry sampling event (5.1 to 8 NTU) compared to the wet sampling event (6.9 to 20.2 NTU).

The reduced salinity and increased DO and turbidity values in the August event were likely due to rainfall and storm water run-off. The introduction of freshwater from rainfall and run-off reduced salinity values within the Grand Canal. The turbidity would have increased with the additional water movement from rainfall and storm water run-off. Freshwater in rainfall is high in DO and likely contributed to the increased DO measurements during the wet sampling event.

2.2.3.3 General Water Quality Data for the 2015 December Sediment Sampling Event

Table A-5 in Attachment A-1 summarizes water quality monitoring data collected for the December sediment sampling event. The following items summarize data collected and trends observed:

- Temperature: Water temperature readings were between 7.7 and 9.8 degrees Celsius (ºC) for the two sampling days.
- Salinity: Salinity readings generally increased with depth. Salinity readings reported for surface samples from Stations 6 to 10 (0.8 to 1.8 PSU) were generally low because it was raining heavily on that sampling day. However, the bottom depth salinity readings were similar across the stations monitored. Only a surface salinity reading is available for Station 6 due to the shallow water depth at that location.
- DO: DO readings were generally similar across the stations monitored, except that a DO reading of less than 1 mg/L was reported for Station 1. DO readings between 2.3 and 4.1 mg/L were reported for the remaining stations.
- Turbidity: Turbidity levels were between 0.2 and 15.6 NTU.

2.2.3.4 General Water Quality Data for the 2013 and 2014 Continuous Monitoring Events

The continuous monitoring data collected at 15-minute intervals by the county using Sonde meters at Locations A and B (**Figure 2**) in 2013 and 2014 are provided in **Attachment B** in tabular and graphic formats. **Attachment B** plots show relationships, if present, between tidal fluctuation (as measured by water displacement) and water quality parameters (i.e., salinity, temperature, DO) and between the water quality parameters. **Attachment B** plots and descriptive statistics (for sample count, temperature, DO, and salinity) for data collected at 2-week intervals across the monitoring events (presented in **Table 2-5** and depicted on **Figures 20 through 22**) were evaluated to determine if the data indicate temporal or seasonal trends in DO, temperature, or salinity. **Table 2-6** provides summary statistics for DO compared to State of New York and USEPA Water Quality Standards and benchmarks. The 4.8 mg/L benchmark is the New York ambient water quality standard, and the 2.3 mg/L benchmark is the USEPA minimum value based on aquatic life. The following items summarize data collected and trends observed:

- Based on displacement data at Locations A and B (**Attachment B**), similar daily patterns for water quality parameters were noted at both locations with a 1-foot tidal influence at Location B and a 1.5-foot tidal influence at Location A.
- Some readings appear anomalous and/or likely indicate occasional meter malfunctions. For example, although average DO values presented in **Table 2-5** are generally similar to the 4.8 mg/L criterion, DO reported for several samples is greater than 10 mg/L. Based on water temperature (approximately 17 to 29 °C) and salinity (approximately 15 to 25 parts per thousand [ppt]), DO levels at 100-percent air saturation should be less than 10 mg/L (Kemker, 2013). It is possible for oxygen to be supersaturated but not at the levels recorded (i.e., greater than15 ppt) and not usually in tidal/brackish waters.
- Salinity levels do fluctuate from day to day but, as expected, tend to be greatest during high tide and lowest during low tide. **Figure 23** shows daily salinity fluctuation for a 5-day period in 2014. These observations are in general agreement with those of the 2015 tidal studies. Salinity readings at Location B tend to be somewhat less than those at Location A, and readings collected in the spring tend to be somewhat lower than those collected in the heat of summer.
- Temperature readings also demonstrate daily fluctuations with the tidal cycle (**Figure 24**), and as expected, mean readings in the spring are less than mean readings in the summer.
- Daily DO values range from fully saturated with oxygen (8 to 9 mg/L) to nearly anoxic (less than 2 mg/L). The DO levels appear to correlate with time of day and less so with tidal fluctuations. Maximum DO levels occur in mid-afternoon and lowest levels occur in early morning. **Figure 25** shows this daily DO fluctuation using data for a 5-day period in 2014. Maximum readings are near the second high tide of the day, and the lowest readings are generally near the first high tide of the day. The most likely reason for this is that in the evening, aquatic plants consume oxygen from the water rather than releasing it, as they do through photosynthesis during the daylight hours. Daily water temperature readings follow a similar pattern.

2.2.4 Sediment Chemical Data for the Grand Canal Study Area

2.2.4.1 Organic Chemical Results for Sediment

4,4'-DDT and its breakdown products 4,4'-DDD and 4,4'-DDE and one PCB mixture (Aroclor-1254) were detected in sediment samples collected from 10 locations within the Grand Canal study area on December 21 and 22, 2015. A total of 20 samples were collected from locations depicted on **Figure 2**. In addition, several dioxins/furans were detected in the two sediment samples analyzed for dioxins/furans. Summary statistics, including frequencies of detection, for this sampling event are presented in **Table 2-9**.

The low-level pesticide (less than 0.7 mg/kg), PCB (less than 0.2 mg/kg), and dioxin/furan (less than 5 ng/kg) detections in the sediment samples reflect contributions from a wide variety of anthropogenic sources (e.g., historical routine pesticide use, emissions from common combustion sources, etc.). Several dioxins/furans were detected in the two sediment samples analyzed for those chemicals. The toxicity equivalence (TEQ) concentrations of 2,3,7,8-TCDD, calculated based on the reported results for the individual congeners, are within background soil ranges reported in the literature (USEPA, 1994). One PCB, Aroclor-1254, was detected in the sediment samples. Concentrations of DDT and related breakdown products, 2,3,7,8-TCDD TEQ, and Aroclor-1254 exceeded the recreational screening level calculated assuming direct contact exposure with sediment (i.e., assuming the receptor is swimming/wading in the Canal) and consumption of fish from the Canal (estimated from sediment concentrations). However, Aroclor-1254 was only detected in one of 20 samples at a concentration of 0.171 mg/kg and 4,4'-DDT was only detected in 2 of 20 samples. None of the organic chemicals exceeded the recreational screening level based on direct contact exposure only.

2.2.4.2 Inorganic Chemical Results for Sediment

Seven metals were detected in all sediment samples. Concentrations of arsenic, chromium (evaluated as hexavalent chromium), copper, nickel, mercury, and zinc exceeded recreational screening levels calculated assuming direct contact exposure with sediment (i.e., assuming the receptor is swimming/wading in the Canal) and consumption of fish from the Canal (estimated from sediment concentrations). Concentrations of copper, nickel, mercury, and zinc exceed the recreational screening level based on an HQ of 0.1, but do not exceed based on an HI of 1. The detected arsenic concentrations (1.86 to 22.9 mg/kg) are within the range of sediment concentrations reported by the National Center for Coastal Ocean Science (NCCOS) for sediments in areas in the general vicinity of the Hudson River (**Table 2-11**). Arsenic concentrations of 20 mg/kg are not uncommon in that data set. Also, it should be noted that chromium concentrations (5.39 to 55.6 mg/kg) would not exceed screening criteria if it was assumed to be present as trivalent chromium. Toxicity criteria are available for different forms of chromium (trivalent and hexavalent), and the hexavalent form is considered to be more toxic. However, the sediments are likely to be anoxic, and therefore, hexavalent chromium is unlikely to be present in study area sediment at significant concentrations (relative to total chromium concentrations) unless a recent source/release(s) contributed to the sediment concentrations. As noted above for organic data, metals concentrations in sediments likely reflect contributions from a wide variety anthropogenic sources (e.g., septic system discharge, emissions from combustion sources, discharges from boats, surface water run-off from adjoining properties, etc.) that have contributed (over the long term) to the sediment profile. As points of reference, data extracted from the United States Geological Survey (USGS) and STORET data sources listed in **Tables 2-12 and 2-13** indicate that total chromium concentrations range from 2 to 88 mg/kg based on samples collected from sediments collected across the general region.

2.3 Human Health Risk Methodology and Results

Section 2.3 presents the methodology for and results of the HHRA conducted for chemical concentrations detected in surface water and sediment samples collected from the Grand Canal study area in 2015. The assessment is based on standard USEPA risk assessment methodology and project-specific risk-based screening levels. These levels were developed (as detailed in Section 2.2 and in **Attachment D**) based on the CSM considerations discussed in Section 1. However, it should be noted that site-specific data are not currently available regarding the frequency at which residents may contact the surface water and sediment of the Canal or consume fish taken from the Canal. Risk estimates presented herein assume that child and adult recreational receptors are swimming/wading in the Grand Canal 100 and 50 days per year, respectively, and an adult is consuming fish taken from the Canal 12 days per year over the course of a lifetime. In addition, fish sampling was not conducted for this assessment. Risk estimates based on fish ingestion were calculated by comparing chemical concentrations in surface waters and sediments to risk-based concentrations (RBCs) developed assuming a portion of the contaminants are retained in fish contacting those media. However, considerable uncertainty is associated with estimating fish tissue concentrations from surface water and sediment concentrations. For example, the method used to estimate fish tissue concentrations assumes that fish taken by recreational fishermen are routinely in contact with the sediments (i.e., are likely to be bottom dwelling species), and that bioaccumulation occurs from contaminated sediments to fish. However, this assumption may significantly overestimate risk if species typically taken by recreational fishermen do not routinely contact the sediments. The estimated fish tissue concentrations also assume that the fish within the study area have a home range limited to the surface water and sediment sampling area. In reality, fish may swim to other nearby waterways. Therefore, there is uncertainty in predicting chemical concentrations in fish tissue from chemical concentrations in surface water and sediment. The uncertainty associated with estimating fish tissue concentrations needs to be considered when interpreting the overall conclusions because a few metals were identified as primary risk drivers for recreational users exposed via the fish ingestion exposure pathway.

The estimates are based on the current toxicity information published by USEPA. The HHRA was conducted as follows:

- Step 1: COPCs were selected
- Step 2: Exposure point concentrations (EPCs) were calculated for the COPCs
- Step 3: Cancer and non-cancer risk estimates were developed using the “sum of ratios” approach for calculating risk (Section 5.15.2 of the USEPA RSL Table User’s Guide [USEPA, 2016])

Step 1: Selection of COPCs

All analytical data evaluated in the HHRA are presented in **Attachment A** and summarized in **Tables 2-1A** through **2-4A** for surface water and **Table 2-5** for sediment. The following chemicals were detected in surface water at maximum concentrations exceeding the project-specific risk-based screening levels presented in **Tables 2-1A** through **2-4A**:

- July 2015 Grand Canal Sampling Event: BEHP and n-nitroso-di-n-propylamine
- August 2015 Grand Canal Sampling Event: BEHP and 2,6-dinitrotoluene
- August 2015 SWRMS Wet Sampling Event: BEHP
- September 2015 SWRMS Dry Sampling Event: BEHP

As indicated in Section 2.2, the screening levels represent the $1x10^{-6}$ cancer risk level or a HI of 0.1. N-nitroso-di-n-propylamine and 2,6-dinitrotoluene were eliminated as COPCs in surface water because they were each detected in only one of the 88 surface water samples collected in 2015. BEHP was the only chemical selected as a COPC for surface water and further evaluated in the HHRA.

4,4'-DDT and its breakdown products (4,4'-DDD and 4,4'-DDE), 2,3,7,8-TCDD TEQ, Aroclor-1254, and several metals were detected in sediment at maximum concentrations exceeding the project-specific risk-based screening levels presented in **Table 2-9**: However, Aroclor-1254 was eliminated as a COPC in sediment because it was detected in only one of 20 sediment samples. DDT and related breakdown products, 2,3,7,8-TCDD TEQ, and metals were selected as COPCs for sediment and further evaluated in the HHRA.

Toxicity criteria (cancer slope factors [CSFs] and reference doses [RfDs]) are available in USEPA's Integrated Risk Information System (IRIS) and are indicators of the strength or potency of BEHP, arsenic, and chromium in terms of producing adverse cancer or non-cancer effects. The IRIS print-outs for BEHP, arsenic, and chromium are provided in **Attachment F**. Toxicity criteria and the exposure assumptions discussed above for the recreational user are the basis of the aforementioned project-specific screening levels.

Step 2: Calculation of EPCs

The EPC is the concentration to which a receptor is exposed. Per USEPA guidance, the 95 -percent upper confidence limit (UCL) on the arithmetic mean is generally recommended as the EPC for data sets evaluated in HHRAs. EPCs were calculated following USEPA's Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (2002) and using USEPA's ProUCL Version 5.0 (2013). Conservatively, an evaluation using the maximum concentrations of these chemicals as the EPCs is also included in **Attachment F**. However, given the size of the July and August Grand Canal surface water data sets (44 surface water samples each event) and the December Grand Canal sediment data set (20 sediment samples), risk management decisions for the Grand Canal data sets should be based on the 95-percent UCLs as the EPCs. ProUCL outputs are presented in **Attachment F**. The EPCs are presented in **Table 2-14** for surface water and **Table 2-15** for sediment.

Step 3: Calculation of Cancer and Non-cancer Risk Estimates

Cancer and non-cancer risk estimates for BEHP in surface water and for DDT and related breakdown products, 2,3,7,8-TCDD TEQ, and metals in sediment were calculated using RBCs for the direct contact while swimming/wading and fish ingestion exposures (estimated from surface water and sediment concentrations), EPCs, and a simple risk-ratio equation. RBCs used represent HIs of 1 (i.e., the concentration not expected to result in adverse effects) for non-carcinogens and 1×10^{-6} (i.e., a one-in-one million probability) cancer risk levels for carcinogens. The RBCs *are the same as* the project-specific screening levels referenced above except that the non-cancer-based RBC values represent HIs of 1 (not HIs of 0.1 as is used in the development of the screening levels). The RBCs, all associated receptor exposure assumptions, and the toxicity criteria used to develop the RBCs are presented in **Attachment D**. Risk estimates were developed using the following equation, which calculates an HI or incremental lifetime cancer risk (ILCR) for a particular chemical based on the EPC and RBC for that same chemical:

$$\text{HI or ILCR} = \frac{\text{EPC x Target HI of 1 or Target ILCR of 1E - 06}}{\text{Risk - based Concentrat ion for Receptor}}$$

This simple risk-ratio approach is possible because all equations used to estimate exposure and risk are linear equations. Therefore, if the RBC is the concentration associated with a one-in-one million excess probability of developing cancer (or, alternatively, a HI of 1), one may simply scale off that known relationship to predict risks for other concentrations detected or predicted in an environmental medium. This approach is presented in Section 5.15.2 of the USEPA's RSL User Guide.

Cancer and non-cancer risk estimates were compared to the following USEPA risk management benchmarks (i.e., acceptable risk levels):

- ***A target-organ-specific HI of 1.*** Adverse non-cancer effects are not anticipated when the HI is equal to or less than 1. This is the non-cancer risk management benchmark typically used by USEPA to evaluate environmental contamination.

- ***USEPA's target risk range of 1×10^{-6} to 1×10^{-4}*** (*a one-in-one million to one-in-10,000 chance of developing cancer).* This is the cancer risk management range typically used by USEPA to evaluate environmental contamination.

Risk estimates developed for BEHP concentrations in the four surface water data sets collected in 2015 are presented in **Table 2-14** and summarized below in **Table 2-16**:

Table 2-16

Summary of Non-Cancer Hazard Indices and Cancer Risk Estimates for Surface Water

Data Set	Exposure	EPC = 95-Percent UCL on the Arithmetic Mean	
		Hazard Index	Cancer Risk Estimate
Grand Canal Sampling Events			
July 2015 Grand Canal Samples	Direct Contact	0.003	8E-08
	Fish Ingestion	0.1	1E-05
	Combined(1)	0.1	1E-05
August 2015 Grand Canal Samples	Direct Contact	0.0004	1E-08
	Fish Ingestion	0.02	2E-06
	Combined(1)	0.02	2E-06
Sampling of Discharge to Grand Canal (not the Canal)			
August 2015 Wet Sampling Event (SWRMS samples)	Direct Contact	0.0008	2E-08
	Fish Ingestion	0.04	4E-06
	Combined(1)	0.04	4E-06
September 2015 Dry Sampling Event (SWRMS samples)(2)	Direct Contact	0.02	5E-07
	Fish Ingestion	0.7	7E-05
	Combined(1)	0.7	8E-05

1 Exposure occurs by both direct contact with surface water and fish ingestion exposure pathways.
2 Based on maximum concentration; UCL exceeds maximum detected concentration.

It should be noted that each of the surface water data sets was evaluated separately to estimate cancer risks based on a lifetime exposure to each data set EPC. None of the cancer risk estimates exceed the USEPA's target risk range of $1x10^{-4}$ to $1x10^{-6}$ (i.e., a one-in-10,000 to one-in-one million probability of developing cancer). However, all of the cancer risk estimates for the fish ingestion exposure pathway and the combined direct contact and fish ingestion exposure scenario exceed $1x10^{-6}$ (the conservative end of the USEPA cancer risk management range). In contrast, none of the risk estimates for the direct contact exposure pathways exceed $1x10^{-6}$.

Non-cancer risks were considered to not be a concern because none of the HIs exceed the benchmark of 1. It should be noted that the August and September 2015 SWRMS data sets represent surface water run-off flowing into the Grand Canal, not the concentrations in the Canal. The July and August 2015 Grand Canal data sets are likely more representative of surface water quality in the Canal.

In addition, BEHP concentrations in the Grand Canal are generally within the concentration range (less than 0.1 to 10 µg/L) reported in the scientific literature for other surface water data sets (IARC, 2012). BEHP concentrations in the 2015 Grand Canal surface water samples ranged from 0.54 to 101 µg/L. Mean concentrations were 6.6 µg/L in July and 2.3 µg/L in August 2015. Median concentrations were 3.6 µg/L in July and 0.62 µg/L in August 2015. Concentrations exceeded 10 µg/L in 3 of 44 samples from July (15.1, 28.1, and 101 µg/L) and in 2 of 44 samples from August (11.6 and 11.9 µg/L).

Based on data from the National Stormwater Quality Database, the national median detected BEHP concentration in storm water was 9.5 µg/L (CWP, 2004). In general, BEHP concentrations were greater (around 100 µg/L) when water basins are located near industrial plants (IARC, 2012). An evaluation of national data found BEHP in 24 percent of surface water supplies at a median concentration of 10 µg/L based on data from the USEPA STORET database (Staples et al., 1985). A comparison of the Grand Canal data set to USEPA STORET data for the area could not be conducted because a review of the USEPA STORET database (2008 to 2014) indicated that phthalate data was not available for Suffolk County or the Southern Long Island Watershed (STORET database accessed October 6, 2015). However, based on comparison to national data, the BEHP concentrations in the Grand Canal appear to be comparable to BEHP concentrations reported for other surface water resources. Therefore, risks from fish consumption (based on Grand Canal surface water concentrations) are expected to be similar to those predicted based on surface water concentrations detected nationally.

Risk estimates developed for COPCs in the sediment data set collected in 2015 with chromium concentrations assumed present as hexavalent and, then, as trivalent chromium are presented in **Table 2-15** and summarized below in **Table 2-17**:

Table 2-17

Summary of Non-Cancer Hazard Indices and Cancer Risk Estimates for Sediment

Data Set	Exposure	EPC = 95-Percent UCL on the Arithmetic Mean	
		Hazard Index(1)	Cancer Risk Estimate(1)
Grand Canal Sediment Samples	Direct Contact	0.09/0.08	2E-05/3E-06
	Fish Ingestion	3/2(3)	3E-04/7E-05
	Combined(2)	3/2(3)	3E-04/7E-05

1 The first risk estimate presented assumes chromium is present as hexavalent chromium. The second risk estimate presented assumes chromium is present as trivalent chromium.
2 Assumes both direct contact and fish ingestion exposures.
3 Hazard index for individual target organs are less than or equal to 1.

Cancer risk estimates do not exceed the USEPA's target risk range of $1x10^{-4}$ to $1x10^{-6}$ (i.e., a one-in-10,000 to one-in-one million probability of developing cancer) when evaluating chromium as trivalent chromium. However, cancer risk estimates for the direct contact and combined direct contact and fish ingestion exposure pathways do exceed $1x\text{-}10^{-4}$ (i.e., a one-in-10,000 probability of developing cancer) when it is assumed that chromium is present as hexavalent chromium. Regional data presented in Tables 2-11 to 13 was reviewed for sediment COPCs. Data was only available for the inorganics selected as COPCs. As discussed above in Section 2.2.4.2, arsenic and chromium concentrations detected in study area sediments, which are the main risk drivers, are within the ranges of concentrations reported for sediments within the region (as are the other inorganic COPCs), and it is unlikely that chromium is present as hexavalent chromium.

Non-cancer risks were considered to not be a concern because none of the target organ HIs exceed the benchmark of 1.

3.0 EVALUATION OF MICROBIOLOGICAL QUALITY

This section provides the PHE of the bacteriological data collected for the Grand Canal study area. The data sources and sampling locations are those described for the evaluation of chemical quality (Section 2), except that the locations in the following table were sampled in 2015 for bacteriological quality (**Figure 2**) but were not sampled and analyzed for VOCs, SVOCs, herbicides, or pesticides in 2015,

Table 3-1

2015 Bacteriological Quality Sample Locations Not Analyzed for Chemical Parameters

Sampling Location Identifier	Description
WL-1	Sample collected from the north-south mosquito ditch depicted on Figure 2.
WL-2	Sample collected at the three-way intersection of the mosquito ditches depicted on Figure 2.
GC-South	Sample collected from the Connetquot River west of the southern entrance to the Grand Canal.
GC-North	Sample collected from the Connetquot River north of the northern entrance to the Grand Canal.
WL-Ref1	Reference location sample collected from the center of the canal depicted on Figure 2, near the southwestern corner of a golf course.
WL-Ref2	Reference location sample collected from a culvert discharging from a wetland area east of the canal depicted on Figure 2.

All of the water samples collected during the following four sampling events conducted by Cashin Associates in 2015 were analyzed for the presence of three bacterial indicators (*Enterococci,* Total Coliform, and Fecal Coliforms):

- The July 15, 2015, GCSWA Tidal Cycle Sampling Event (four samples at each of 11 locations; low tide, mid-incoming tide, high tide, mid-outgoing tide).
- The August 27, 2015, GCSWA Tidal Cycle Sampling Event (two samples at each of 11 locations; high tide and mid-outgoing tide).
- The September 3, 2015, SWRMS Dry Sampling Event (samples from the six locations described in **Table 3-1** and surface water run-off samples from locations SW-1 through SW-6, **Figure 2**).
- The August 11, 2015, SWRMS Wet Sampling Event (surface water run-off samples from locations SW-1 through SW-6, **Figure 2**).

Analytical results for all four sampling events are presented in **Tables 3-2 through 3-5** and depicted on **Figures 26 to 28**. Data for each type of indicator bacteria are compared to state and nationally recommended standard values to evaluate whether exceedances of bacterial standards were likely to occur. It should be noted that compliance is typically determined using results for multiple samples taken throughout a month. Consequently, because only one to two samples were collected per month during the sampling events, the water quality standard values are used here as benchmarks for comparison only.

The New York Water Quality Standards for coliforms (6 CRR-NY 703.4) state that:

- For Total Coliforms (measured as number per 100 millimeters [ml]) "the monthly median value and more than 20 percent of the samples from a minimum of five examinations, shall not exceed 2,400 and 5,000, respectively."
- For Fecal Coliforms (measured as number per 100 ml) "the monthly geometric mean from a minimum of five examinations shall not exceed 200."

Additionally, USEPA's 2012 Recreational Water Quality Criteria recommend that Enterococci should not exceed a geometric sample mean of 30 to 35 colony forming units (cfu) per 100 ml or a statistical threshold value (STV; a value that should not be exceed by more than 10 percent of samples) of 110 to 130 cfu per 100 ml. The ranges of values represent two recommendations based on differing acceptable illness rates from recreational activities in contaminated waters.

The analyses indicate that results for the locations sampled frequently exceeded the standard values for all indicators in all months. In many cases, exceedances were orders of magnitude greater than the recommended standard values (**Figures 26 through 28**). The following items summarize the results:

- **Fecal Coliforms:** With the exception of the results for location SW-3, data reported for all sampling locations, including the reference locations, exceed the value of 200 colonies per 100 ml (**Figure 26**). Data ranged from 130 to 16,000 colonies per 100 ml. The data displayed on **Figure 26** indicate that results for samples collected from the Grand Canal during the tidal studies tend to be greater than those reported for other locations. However, the perceived difference may be a function, in part, of the significant difference in the sizes of the data sets evaluated. The interpretation of the fecal coliform data set for the July 15, 2015, sampling event is complicated by the fact that the analytical laboratory reported most results as “>1600 cfu/100 ml.”

- **Total Coliforms:** August samples often exceeded 2,400 and frequently 5,000 colonies per 100 ml (**Figure 27**). Data ranged from 130 to 16,000 colonies per 100 ml. The data displayed on **Figure 27** indicate that results for samples collected from the Grand Canal during the tidal studies tend to be greater than those reported for other locations. The data for most of the Canal locations exceed the benchmarks presented, whereas data for most of the other locations do not. However, again, the perceived difference may be a function, in part, of the significant difference in the sizes of the data sets evaluated. The data reported for GC-North and GC-South (the Connequot River locations) and WL-Ref-2 do not exceed the benchmarks presented. The interpretation of the total coliforms data for the July 15, 2015, sampling event is complicated by the fact that the analytical laboratory reported most results as “>1600 cfu/100 ml.”
- **Enterococci:** The majority of samples exceeded 35 and 130 colonies per 100 ml (**Figure 28**). Data ranged from 10 to 13,000 colonies per 100ml. The data reported for GC-North and GC-South (the Connequot River locations) do not exceed the benchmarks presented; however, the results for the reference stations do exceed the benchmarks. The interpretation of the Enterococci data for the July 15, 2015, sampling event is complicated by the fact that the analytical laboratory reported most results as “>2419.6 cfu/100 ml.”
- The data plotted on **Figures 26, 27, and 28** for the dry and wet sampling events do not suggest a significant difference (i.e., dry versus wet conditions) in the bacteriological loading in surface water run-off to the Canal.
- Field sampling notes (**Attachment A**) indicate that the smell of sewage was present at some locations.
- The fecal coliforms and total coliforms results for samples collected from the Grand Canal during the 2015 tidal studies exceed those reported for samples collected by the county in 2004 (see Table 2 of **Attachment E**).

These results suggest that bacterial contamination is a significant issue throughout the Grand Canal. Although the data for the Connequet River locations (GC North and GC South) are limited, the results for the Canal are significantly greater than those reported for the river. However, results for the reference locations also indicate that the issue is not unique to the Canal area. Additional follow-up investigations would be necessary to determine, more definitely, the potential sources of contamination. The sewage odor observed during field sampling could be indicative of failing septic systems. Other potential sources may include fecal contamination from waterfowl or run-off from non-point sources. In terms of bacteriological quality, neither the Grand Canal nor the reference area surface waters are likely to be safe for recreational uses involving direct contact with those waters.

4.0 EVALUATION OF POTENTIAL FOR VECTOR-BORNE DISEASE

This section provides the PHE of the WNV data collected for the Grand Canal study area by the SCDHS Arthropod-Borne Disease Laboratory (ABDL) in 2013 and 2014. Section 4.1 discusses the depth and quality of the available data sets, Section 4.2 presents the methodology for the WNV risk assessment, and Section 4.3 provides the results of the HHRA conducted based on the available data sets.

4.1 Depth and Quality of 2013 and 2014 WNV Surveillance Data

In 2013 and 2014, the SCDHS-ABDL collected mosquitoes on a weekly basis using Center for Disease Control (CDC) light and CDC gravid traps during the peak WNV season (August through October) at two trap sites near the Grand Canal (**Figure 29**). The Byron Lake site is located 0.79 mile east of the Canal, and the Fernwood site 0.28 mile east of the Canal. In 2014, mosquitoes were also collected in June and July. *Culex spp.* mosquito pools were tested for WNV. A pool represents a group of mosquitoes (from 10 to 60) from one trap or site that is tested as one sample for WNV. In 2013, *Culex spp.* mosquitoes were separated into *Culex salinarius* and *Culex pipiens/restuans* pools, but in 2014 they were processed as *Cx. pipiens/restuans/salinarius* pools.

The WNV surveillance data for all Suffolk County trap sites for the years 2013 and 2014 were compared to data from the years 2000 to 2012. In addition, the WNV surveillance data for the Byron Lake and Fernwood sites were compared to all other Suffolk County sites for the years 2013 and 2014. The results of the evaluation are provided in the following narrative.

For all of Suffolk County, the extent of mosquito collecting and testing activities as well as the number of WNV positive pools and the minimum infection rate (MIR) values for 2013 and 2014 were relatively high compared to the years 2000 to 2012. The largest and second largest number of *Culex spp.* mosquitoes were collected during 2013 and 2014, respectively (**Table 4-1**). The number of *Culex spp.* pools tested, number of *Culex spp.* mosquitoes tested, number of positive pools, and MIR values were ranked for the years 2000 to 2014 (**Table 4-2**). The number of *Culex spp.* pools tested in the years 2013 and 2014 were in the top 10 for the years 2000 to 2014; the number of Culex *spp*. mosquitoes tested, number of positive pools, and MIR values for 2013 and 2014 were all in the top five for the years 2000 to 2014.

Table 4-1

Summary Data for Mosquito Surveillance Activities from All Suffolk County Mosquito Trap Sites from 2000 to 2014

Year	Total *Culex spp.* Mosquitoes Collected	Total *Culex spp.* Mosquitoes Tested	Total *Culex spp.* Pools Tested	Total *Culex spp.* Positive Pools	MIR(1)
2000	96,244	90,968	2,415	121	1.330
2001	115,953	54,731	1,911	68	1.242
2002	ND	ND	ND	ND	ND

Year	Total *Culex spp.* Mosquitoes Collected	Total *Culex spp.* Mosquitoes Tested	Total *Culex spp.* Pools Tested	Total *Culex spp.* Positive Pools	MIR(1)
2003	105,895	49,845	1,884	40	0.80
2004	63,670	28,066	952	8	0.29
2005	59,517	46,633	2,054	16	0.34
2006	76,304	49,634	1,480	57	1.15
2007	51,678	29,570	918	12	0.41
2008	47,772	47,491	1,526	41	0.86
2009	75,271	48,538	1,465	17	0.35
2010	118,457	65,571	2,323	292	4.45
2011	139,167	69,562	1,801	81	1.16
2012	102,455	55,347	1,438	210	3.79
2013	233,190	59,259	1,515	177	2.99
2014	185,376	62,591	1,476	186	2.97

1 Minimum infection rate equals number of positive pools per total specimens tested multiplied by 1,000.
No data.

Table 4-2

Ranking of Mosquito Surveillance Activities from All Suffolk County Mosquito Trap Sites for 2013 and 2014 Compared to All Years from 2000 to 2014

Surveillance and Testing Activity	2013	2014
Total *Culex spp.* mosquitoes collected	1	2
Total *Culex spp.* mosquitoes tested	5	4
Total *Culex spp.* mosquito pools tested	10	8
Total *Culex spp.* positive pools	4	3
MIR(1)	3	4

1 Minimum infection rate equals number of positive pools per total specimens tested multiplied by 1,000.

The 2013 and 2014 mosquito collecting and testing activities for the Byron Lake and Fernwood trap sites are reported in **Table 4-3**. The collection and testing activities at these two sites compared to other sites in Suffolk County is relatively high. In 2013 the number of *Culex spp*. mosquitoes collected and the number of mosquitoes and pools tested ranked in the top 10 of 45 trap sites (**Table 4-4**). In 2014 they ranked in the top 25 of 42 trap sites (**Table 4-4**). Note that the rankings for the 2013 season are based on data collected from August 5 to October 23 whereas the rankings for 2014 are based on data collected from June 3 to October 2. Because 75 percent of the WNV positive pools for all Suffolk County trap sites in 2014 occurred during the August 4 to October 2 surveillance period, and only 25 percent during the June 3 to August 1 period, the lack of 2013 data from June and July should not bias the surveillance data for the Byron Lake and Fernwood trap sites.

Table 4-3

Summary Data for Mosquito Surveillance Activities at the Byron Lake and Fernwood Trap Sites in 2013 and 2014

Trap Site	2013		2014	
	Byron Lake	Fernwood	Byron Lake	Fernwood
Number of trap nights	11	11	36	36
Total *Culex spp*. mosquitoes collected	594	585	2246	1179
Light trap	534	437	672	244
Gravid trap	60	148	672	244
Total *Culex spp*. mosquitoes tested for WNV	594	585	1610	1021
Cx. pipiens/restuans	505	510	ND(1)	ND(1)
Cx. salinarius	89	75	ND(1)	ND(1)
Total *Culex spp.* pools tested for WNV	16	14	31	25
Cx. pipiens/restuans	13	11	ND(1)	ND(1)
Cx. salinarius	3	3	ND(1)	ND(1)
Number of positive pools	1	1	0	0

1 No data. In 2014, *Cx. salinarius* were not separated from *Cx. pipiens/restuans* mosquitoes, and they were processed together.

Table 4-4

Ranking of Mosquito Surveillance Activities at the Byron Lake and Fernwood Sites Compared to All 45 Suffolk County Sites in 2013 and 42 Sites in 2014 that had Mosquito Pools Testing Positive for WNV

Trap Site	2013		2014	
	Byron Lake	Fernwood	Byron Lake	Fernwood
Total *Culex spp.* mosquitoes collected	9	8	16	23
Total *Culex spp.* mosquitoes tested for WNV	9	10	17	25
Total *Culex spp.* pools tested for WNV	6	9	21	25

Rankings for 2013 based on August 5 through October 23 sampling season.
Rankings for 2014 based on June 3 through October 2 sampling season.

In 2013, there was only one WNV positive pool for the Byron Lakes and one for the Fernwood trap sites (**Table 4-3**), placing them in the bottom one-half of all 55 Suffolk County sites. In 2014, there were no WNV positive pools for the Byron Lakes and Fernwood trap sites, placing them in the bottom one-third of all 51 Suffolk County sites (**Table 4-5**). Furthermore, because none of the mosquito pools in 2014 for the Byron Lake and Fernwood trap sites tested positive for WNV, the testing of *Cx. pipiens/restuans/salinarius* together, rather than testing *Cx. pipiens/salinarius* and *Cx. salinarius* separately as in 2013 (**Table 4-3**), would not have biased the surveillance data for 2014.

Table 4-5

The Number of Mosquito Surveillance Sites in Suffolk County During 2013 and 2014 Matched with the Number of WNV Positive Pooled Samples from the Sites

	2013	
	Number of Trap Sites	**Number of WNV Positive Pools**
	1	19
	1	14
	1	13
	2	11
	1	10
	1	8
	1	7
	3	6
	1	5
	6	4
	4	3
	7	2
	12[1]	1
	14	0
Totals	**55**	**178**

	2014	
	Number of Trap Sites	**Number of WNV Positive Pools**
	1	20
	1	18
	1	17
	1	15
	1	12
	1	11
	1	10
	1	9
	1	7
	2	6
	5	4
	5	3
	6	2
	8	1
	16[1]	0
Totals	**51**	**186**

1 The Byron Lake and Fernwood sites are included these categories.

4.2 WNV Risk Assessment Methodology

Risk Model

Relative human risk of WNV in the Grand Canal area was estimated using the risk model outlined by Kilpatrick et al. (2005). This risk model uses abundance, fraction of blood meals taken from mammals, vector competence, and MIR to determine WNV risk to humans by mosquito species. Kilpatrick et al. (2005) employed the following model using Suffolk and Rockland County data (New York) from a 1999 outbreak:

$$\textbf{WNV Risk} = A \times F_m \times MIR \times C_v$$

Where:

A is the relative abundance of the species,

F_m is the fraction of blood meals taken from mammals,

MIR is the minimum infection rate or WNV infection prevalence, and

C_v is the vector competence (the percentage of WNV-infected mosquitoes that will transmit WNV in in a subsequent bite) (Kilpatrick et al., 2005).

The species-specific values for vector competence and blood meal fraction are taken from Kilpatrick et al. (2005). Abundance and MIR were calculated using 2013 and 2014 vector data for the Byron Lake and Fernwood trap sites in the Grand Canal area of Suffolk County (see **Attachment G).** Abundance was calculated by combining data for both gravid and light trap sample data at the Byron Lake and Fernwood locations. MIR was calculated for *Culex spp.* using the following formula: MIR = 1,000 × (pools testing positive for WNV/total number of mosquitoes tested) (Kilpatrick et al., 2005). MIRs were calculated for all sampling locations in Suffolk County and compared to the Byron Lake and Fernwood locations.

The values for vector competence were taken from Kilpatrick et al. (2005). The literature indicates that mosquitoes can carry WNV but not transmit the virus when the virus is not present in the salivary glands at the time of feeding (Kilpatrick et al., 2005). Vector competence varies by species but is similar for *Cx. pipiens/restuans* and *Cx. salinarius*. The values for fraction of blood meals taken from mammals were identical to those used by Kilpatrick et al. (2005). Kilpatrick et al. (2005) calculated the fraction of *Cx. pipiens/restuans*' and *Cx. salinarius*' "blood meals that came from mammals as a relative estimate of the probability that the species would feed on humans" based on information available in the literature (Apperson et al., 2002; Apperson et al., 2004).

Because the 2014 data from the Byron Lake and Fernwood locations are not separated for *Cx. pipiens/restuans* and *Cx. salinarius*, it was assumed that the abundance of the species for the 2014 data was the same as for the 2013 data. This enabled estimation of risk separately for *Cx. pipiens/restuans* and *Cx. salinarius* for 2014.

Vector Index

Vector index (VI) is defined by the CDC as "an estimate of the abundance of infected mosquitoes in an area and incorporates information describing the vector species that are present in the area, relative abundance of those species, and the WNV infection rate in each species into a single index" (CDC, 2013). The CDC also indicates predictive ability of the VI as surges in VI reflect increases in risk of WNV disease among humans (CDC, 2013). The VI has been effective in establishing human risk of WNV in Colorado (Bolling et al., 2009; Barker et al., 2009). Bolling et al. (2009) report that VI data were strongly associated with weekly WNV cases 1 to 2 weeks later. Kilpatrick and Pape (2013) report that VI "should theoretically provide a quantitative measure of the risk of human WNV infection." The equation for VI is defined by the CDC (2013) as follows:

$$\textbf{VI} = \textbf{Average Density} \times \textbf{Estimated Infection Rate}$$

Where:

Average density is defined as the average number of mosquitoes collected per trap night and

Estimated infection rate is the proportion of the mosquito population that tests positive for WNV.

The available sampling data for the Byron Lake and Fernwood locations provided sufficient information to calculate VIs for 2013 and 2014 for all *Culex* species combined. Calculations are provided in **Attachment G**.

WNV Cases

Human WNV case data for Suffolk County covering the 2001 to 2014 time period were evaluated. Information including date of onset, town, zip code, and township are described.

4.3 WNV Risk Assessment Results

Risk (as defined by Kilpatrick et al., 2005) is an estimate of the relative number of WNV-infectious bites on humans by each mosquito species. Because it was not possible to calculate the risk estimates for all mosquito species sampled at the Byron Lake and Fernwood locations, percent risk (as calculated in Kilpatrick et al., 2005) could not be estimated. However, the data in **Table 4-6** do provide relative estimates of WNV risk in the Grand Canal area. In 2013, risk of WNV was greater to humans near the Byron Lake sampling location compared to the Fernwood location. Risk was greater in both locations from *Cx. pipiens/restuans* mosquitoes compared to *Cx. salinarius* mosquitoes. The risk of WNV in 2014 at both sampling locations is estimated to be 0 for both *Cx. salinarius* and *Cx. pipiens/restuans* because the MIRs are calculated to be 0. Across all sampling locations in Suffolk County, the MIRs for 2013 and 2014 were 3.71 and 3.42, respectively. The highest MIR calculated in 2013 was 20 (New Highway, Commack) and the lowest was 0 (several sampling locations). In 2014, the highest MIR calculated was 11.02 (June Avenue, Northport) and the lowest was 0 (several sampling locations including Fernwood and Byron Lake). The MIRs for Byron Lake and Fernwood were much lower than the MIRs calculated for all sampling locations for both 2013 and 2014, indicating that the infection rate is lower in the Grand Canal area.

Table 4-6

WNV Risk for 2013 and 2014 Based on the Grand Canal Area of Suffolk County

Year	Location	Species	Relative Abundance (A)[1]	WNV MIR (P)	Vector Competence (C_v)	Fraction Mammal (F_m)	WNV Risk
2013	Byron Lake	*Culex salinarius*	5.945	1.69	0.36	0.67	2.42
		Culex pipiens/restuans	33.734	1.69	0.38	0.19	4.12
	Fernwood	*Culex salinarius*	4.183	1.71	0.36	0.67	1.73
		Culex pipiens/restuans	29.225	1.71	0.38	0.19	3.61
2014	Byron Lake	*Culex salinarius*	5.945	0	0.36	0.67	0
		Culex pipiens/restuans	33.734	0	0.38	0.19	0
	Fernwood	*Culex salinarius*	4.183	0	0.36	0.67	0
		Culex pipiens/restuans	29.225	0	0.38	0.19	0

1 In 2014, samples of *Culex salinarius and Culex pipiens/restuans* were not separated. Therefore, the relative abundance data for 2013 was used for risk calculations for 2014.

Vector Index

According to the Colorado Department of Public Health and Environment (CDPHE) (2014), a VI of 0.50 suggests “some risk of local WNV activity,” and a VI of 0.75 indicates that WNV risk to humans is on the rise, and prevention efforts should begin (CDPHE, 2014). When the VI increases to greater than 0.75, local transmission of WNV is likely occurring, and an epidemic may be starting (CDPHE, 2014). The VI calculated for all *Culex* species in the Grand Canal area are very low for both 2013 and 2014 and are significantly less than the value of 0.50 that indicates risk of WNV activity (**Table 4-7**). Additionally, the VI decreased from 2013 to 2014, indicating a reduction in WNV risk to humans from *Culex* species.

Table 4-7

WNV Vector Indices for 2013 and 2014 in the Grand Canal Area of Suffolk County

Year	Total Trap Nights	Total Culex Collected	Total Culex ÷ Trap Nights	Proportion Infected	Vector Index
2013	22	1179	22÷1179 = 53.59	0.0017	53.59×0.0017 = 0.09
2014	72	3425	72÷3425 = 47.57	0.00	47.57×0.00 = 0.00

WNV Cases

The Grand Canal area is located in the Town of Oakdale, New York, in the Township of Islip. According to Suffolk County data, there was only one case of WNV in Oakdale during the years of 2001 to 2014; the date of onset was August 28, 2012. In comparison, there were 15 WNV cases in other towns in the Township of Islip (including six in the town of Bayshore) over the 2001 to 2014 time period. There were 88 WNV cases reported for Suffolk County during this time frame. Because only one case of WNV was reported during this entire 14-year period in the Grand Canal area and no cases were reported in 2013 and 2014, the risk of WNV in this area is considered low.

In summary, the large amount of surveillance data collected for the Byron Lake and Fernwood trap sites as well as that for Suffolk County is more than adequate for evaluating the WNV risk in the Grand Canal area. The data calculated by the risk model and the VIs indicate that the risk of WNV to humans decreased from 2013 to 2014 in the Grand Canal area. The WNV risk to humans was greater in the Byron Lake area compared to the Fernwood area and greater for *Cx. pipiens/restuans* than for *Cx. salinarius* because *Cx. pipiens/restuans* species were more abundant. VI has been shown to be a good predictor for human risk of WNV. The VIs calculated for 2013 and 2014 in the Grand Canal area were very low (0.09 and 0, respectively). There were no WNV cases identified in the Grand Canal area during the 2013 to 2014 time frame. When the risk and VI data are taken together with the case data, it appears that the risk of WNV in the Grand Canal area is very low. Nevertheless, as a public health measure, weekly calculations of VI for the Grand Canal area and Suffolk County as a whole could be performed. If the VI is increasing or goes above a certain threshold, emergency spraying may be recommended.

The CDC (2013) suggests the following community-level actions to mitigate WNV risk:

1) **Community protection measures**
   a) Encourage the community to report dead birds and nuisance mosquitoes
   b) Inform the community about sources of mosquitoes, including standing water and trash
   c) Encourage the concept that health departments and mosquito control requires community assistance
2) **Communicate with the community regarding mosquito control**
   a) Communicate to the public the importance of adult mosquito control using insecticides; provide information regarding the insecticide schedule
   b) Inform the community about surveillance measures
3) **Engage and educate the community**
   a) Understand how targeted audiences communicate with each other and government officials
   b) Identify key audiences and best methods for communication
   c) Translate technical and scientific information into lay terms
   d) Create a partnership with the media and ensure at least one staff member has media training and can serve as a spokesperson
   e) Use social media outlets such as Twitter and Facebook to communicate with the community

5.0 SUMMARY AND CONCLUSIONS

A PHE was conducted based on physical, chemical, microbiological, and vector (mosquito) data collected from the Grand Canal and adjacent wetlands. Most data were collected between 2013 and 2015 either by Suffolk County (mosquito surveillance data) or by Cashin Associates, PC, under contract to the county (microbiological data or surface water quality data). In many respects, results of this evaluation are in agreement with the findings presented in the 2005 Grand Canal Environmental Assessment Final Report (SCDHS, 2005). Water quality in the Canal has been significantly impacted by nutrient enrichment (nitrogen and phosphorus levels exceed recommended benchmarks). DO readings are frequently less than levels necessary for healthy aquatic life. In terms of bacteriological quality, neither the Grand Canal nor the reference area surface waters (east of the Grand Canal Study area) are likely to be safe for recreational uses involving direct contact with those waters. Additionally, the quality of the fish inhabiting the Grand Canal may be compromised (e.g., for purposes of human consumption) by the microbiological contamination. It should be noted that the bacterial levels in the Canal significantly exceed those reported for the reference area locations.

As noted in the 2005 Grand Canal Environmental Assessment Final Report, sources of contamination to the Canal likely include storm water run-off from fertilized lawns and roadways, area wildlife, and residential septic systems. Evidence of a malfunctioning septic system was noted by the environmental sampling teams collecting surface water samples in 2015. (Although suspected septic odors were noted by the field team, no direct evidence or observation of failing septic systems was observed during the field work.) Dredging the Canal, in conjunction with a comprehensive OMWM strategy, may provide greater water flows to (flushing of) the Canal and adjacent wetlands. However, the ability of any such program to improve water quality may be somewhat limited if the aforementioned contaminant sources are not addressed as well.

In contrast, based on chemical monitoring for standard-list volatile and semi-volatile organic chemicals and pesticides, the chemical profile of the surface water and sediment of the Grand Canal indicates concentration of contaminants generally consistent with other surface water bodies in the general vicinity of Southern Long Island and typical of local anthropogenic sources (e.g., surface water run-off and septic system sources). Based on the PHE, direct contact with surface water and sediment was not determined to be a concern for non-cancer effects. Estimated fish concentrations that could result from contaminants in surface water and sediment were also not a concern for non-cancer effects if fish from the Canal were consumed (based on an estimate of 12 meals per year)

Cancer risk estimates for direct contact with actual surface water within the Canal (not discharges to the canal) and sediment ranged from 1×10^{-8} to 3×10^{-6} (taking into consideration the most likely metal species found in sediments). This risk range does not exceed USEPA's target risk range of 1×10^{-6} to 1×10^{-4}. Potential cancer risks estimated based on consumption of fish from the Canal and using fish tissue concentrations estimated from surface water and sediment concentrations, range from 2×10^{-6} to 7×10^{-5}. These estimates take into consideration the metals species most likely to be found in sediments. The resulting cancer risk estimates are within the USEPA target risk range.

This PHE indicates that consumption of fish from the Canal represents the greatest source of potential risk to residents along the Grand Canal. The analysis conducted also indicates that sediment was the source of contaminants that posed the greatest risk from fish consumption. It should be noted that for this analysis, fish tissue concentrations were estimated based on surface water and sediment concentrations as opposed to actual fish tissue sampling. In addition, there is a New York State fish consumption advisory in place for the Long Island South Shore, which recommends that consumption be limited to up to one meal per month for high-risk populations (women under 50 and children under 15) for American eel, bluefish (greater than 20 inches), striped bass, and weakfish (less than 25 inches) (NY DOH, 2015). The New York State fish advisory also recommends that weakfish (greater than 25 inches) and crab/lobster tomalley should not be consumed (NY DOH). A review of the mosquito surveillance data reported for the past 2 years indicates that it is more than adequate for calculating WNV disease risk for the Grand Canal area. The results of the risk assessment of such data indicates the risk of WNV in the Grand Canal area is very low.

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TABLES

TABLE 2-1A

SUMMARY OF DETECTED RESULTS FOR SURFACE WATER SAMPLES COLLECTED FROM THE GRAND CANAL DURING THE JULY 15, 2015 TIDAL SURFACE WATER SAMPLING EVENT (COMPARISON TO SCREENING LEVELS)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

CAS Number	Chemical	Units	Frequency of Detection	Mean of All Samples	Mean of Detected Samples	Median	Standard Deviation	Minimum Concentration(1)	Maximum Concentration(1)	Sample of Maximum Concentration	Range of Nondetects(2)	Concentration Used for Screening(3)	Recreational Screening Value(4)	Recreational and Fish Ingestion Screening Value(4)	USEPA RSL Tapwater(4, 5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																	
95-63-6	1,2,4-Trimethylbenzene	ug/L	2/44	0.130	0.750	0.100	0.147	0.5	1	GC-6A	0.2-0.2	1	NA	NA	1.5 N	No	BSL
108-67-8	1,3,5-Trimethylbenzene	ug/L	1/44	0.10	0.30	0.10	0.030	0.3 J	0.3 J	GC-6A	0.2-0.2	0.3	28 N	23 N	12 N	No	BSL
107-02-8	Acrolein	ug/L	7/44	0.64	3.51	0.10	1.46	2 J	7.5	GC-4C	0.2-0.2	7.5	12 N	12 N	**0.0042 N**	No	BSL
71-43-2	Benzene	ug/L	3/44	0.125	0.473	0.100	0.097	0.4 J	0.57	GC-6A	0.2-0.2	0.57	8.7 C	7.3 C	**0.46 C**	No	BSL
100-41-4	Ethyl Benzene	ug/L	2/44	0.116	0.445	0.100	0.078	0.31 J	0.58	GC-6A	0.2-0.2	0.58	15 C	11 C	1.5 C	No	BSL
95-47-6	o-Xylene	ug/L	3/44	0.136	0.623	0.100	0.164	0.23 J	1.1	GC-6A	0.2-0.2	1.1	730 N	610 N	19 N	No	BSL
179601-23-1	p- m- Xylenes	ug/L	2/44	0.314	1.650	0.250	0.318	1.1	2.2	GC-6A	0.5-0.5	2.2	660 N	560 N	19 N	No	BSL
108-88-3	Toluene	ug/L	5/44	0.225	1.200	0.100	0.477	0.37 J	2.9	GC-6A	0.2-0.2	2.9	410 N	360 N	110 N	No	BSL
79-01-6	Trichloroethylene	ug/L	2/44	0.109	0.29	0.100	0.043	0.22 J	0.36 J	GC-12A	0.2-0.2	0.36	7.3 C	6 C	**0.28 N**	No	BSL
1330-20-7	Xylenes, Total	ug/L	3/44	0.405	1.840	0.300	0.477	0.72 J	3.2	GC-6A	0.6-0.6	3.2	690 N	590 N	19 N	No	BSL
Semi-Volatiles																	
117-81-7	**Bis(2-ethylhexyl)phthalate**	ug/L	23/44	6.63	10.9	3.60	15.3	0.589	101	GC-7B	0.5-8.28	101	200 C	**1.2 C**	**5.6 C**	**Yes**	ASL
206-44-0	Fluoranthene	ug/L	2/44	0.0299	0.105	0.026	0.017	0.0865	0.123	GC-4C	0.05-0.0571	0.123	1100 N	35 N	80 N	No	BSL
91-20-3	Naphthalene	ug/L	2/44	0.0288	0.0805	0.026	0.012	0.0686	0.0923	GC-4C	0.05-0.0571	0.0923	69 N	57 N	0.17 C	No	BSL
621-64-7	**N-nitroso-di-n-propylamine**	ug/L	1/44	1.38	4.32	1.28	0.456	4.32 J	4.32 J	GC-11D	2.5-2.86	4.32	**0.21 C**	**0.18 C**	**0.011 C**	**Yes**	ASL
85-01-8	Phenanthrene	ug/L	2/44	0.0297	0.102	0.026	0.017	0.0778	0.126	GC-9A	0.05-0.0571	0.126	NA	NA	NA	No	NTX
129-00-0	Pyrene	ug/L	2/44	0.0280	0.0632	0.026	0.008	0.0615	0.0649	GC-11A	0.05-0.0571	0.0649	19 N	13 N	12 N	No	BSL
Miscellaneous																	
--	Total Nitrogen	ug/L	43/44	2098	2133	2100	658	1300	4700	GC-2A	1200-1200	4700	NA	NA	NA	No	NTX
--	Nitrogen, Total-Dissolved	ug/L	33/44	1389	1652	1300	723	1300	3700	GC-12B	1200-1200	3700	NA	NA	NA	No	NTX
--	Phosphorous, Dissolved As P	ug/L	24/44	49	69	56	24.4	53	100	GC-11D	50-50	100	NA	NA	NA	No	NTX
--	Phosphorous, Total As P	ug/L	36/44	98	114	83	69.2	50	329	GC-7C	50-50	329	NA	NA	NA	No	NTX
--	Total Inorganic Nitrogen, Dissolved	ug/L	3/44	585	1400	525	227.2	1200	1600	GC-12B	1050-1050	1600	NA	NA	NA	No	NTX

Footnotes:

1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Recreational screening levels and fish ingestion values were calculated with USEPA's Regional Screening Level Calculator. Tap water RSLs are from the May 2016 USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. The noncarcinogenic values (denoted with a "N" flag) correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1E-06 (carcinogens denoted with a "C" flag).
5 - Presented for informational purposes. Grand Canal is not a drinking water source.
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the recreational screening level or recreational and fish ingestion screening level.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples

GC-1A	GC-8B	GC-5D
GC-2A	GC-9B	GC-6D
GC-4A	GC-10B	GC-7D
GC-5A	GC-1C	GC-8D
GC-6A	GC-2C	GC-9D
GC-7A	GC-4C	GC-10D
GC-8A	GC-5C	GC-11A
GC-9A	GC-6C	GC-11B
GC-10A	GC-7C	GC-11C
GC-1B	GC-8C	GC-11D
GC-2B	GC-9C	GC-12A
GC-4B	GC-10C	GC-12B
GC-5B	GC-1D	GC-12C
GC-6B	GC-2D	GC-12D
GC-7B	GC-4D	

Definitions:

C Carcinogen
COPC Chemical Of Potential Concern
J Estimated value
N Noncarcinogen
NA Not Applicable/Not Available

Rationale Codes:

For selection as a COPC:
ASL Above Screening Level.

For elimination as a COPC:
BSL Below COPC Screening Level
NTX No toxicity criteria

TABLE 2-1B

SUMMARY OF DETECTED RESULTS FOR SURFACE WATER SAMPLES COLLECTED FROM THE GRAND CANAL DURING THE JULY 15, 2015 TIDAL SURFACE WATER SAMPLING EVENT (COMPARISON TO WATER QUALITY CRITERIA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

CAS Number	Chemical	Units	Frequency of Detection	Mean of All Samples	Mean of Detected Samples	Median	Standard Deviation	Minimum Concentration(1)	Maximum Concentration(1)	Sample of Maximum Concentration	Range of Nondetects(2)	Concentration Used for Screening(3)	National Water Quality Criteria - Human Health, Consumption of Organism(4)	NY Water Quality Standards 6 NYCRR part 703(5)	NY Ambient Water Quality Standards(6)
Volatile Organics															
95-63-6	1,2,4-Trimethylbenzene	ug/L	2/44	0.130	0.750	0.100	0.147	0.5	1	GC-6A	0.2-0.2	1	NA	NA	19 s
108-67-8	1,3,5-Trimethylbenzene	ug/L	1/44	0.10	0.30	0.10	0.030	0.3 J	0.3 J	GC-6A	0.2-0.2	0.3	NA	NA	5 f
107-02-8	**Acrolein**	ug/L	7/44	0.64	3.51	0.10	1.46	2 J	7.5	GC-4C	0.2-0.2	7.5	400	**5 g**	**5 f**
71-43-2	Benzene	ug/L	3/44	0.125	0.473	0.100	0.097	0.4 J	0.57	GC-6A	0.2-0.2	0.57	16	10 s	10 s
100-41-4	Ethyl Benzene	ug/L	2/44	0.116	0.445	0.100	0.078	0.31 J	0.58	GC-6A	0.2-0.2	0.58	130	5 f	4.5 s
95-47-6	o-Xylene	ug/L	3/44	0.136	0.623	0.100	0.164	0.23 J	1.1	GC-6A	0.2-0.2	1.1	NA	5 f	19 s
179601-23-1	p- m- Xylenes	ug/L	2/44	0.314	1.650	0.250	0.318	1.1	2.2	GC-6A	0.5-0.5	2.2	NA	5 f	19 s
108-88-3	Toluene	ug/L	5/44	0.225	1.200	0.100	0.477	0.37 J	2.9	GC-6A	0.2-0.2	2.9	520	6000 s	92 s
79-01-6	Trichloroethylene	ug/L	2/44	0.109	0.29	0.100	0.043	0.22 J	0.36 J	GC-12A	0.2-0.2	0.36	7	40 s	40 s
1330-20-7	Xylenes, Total	ug/L	3/44	0.405	1.840	0.300	0.477	0.72 J	3.2	GC-6A	0.6-0.6	3.2	NA	5 f	19 s
Semi-Volatiles															
117-81-7	**Bis(2-ethylhexyl)phthalate**	ug/L	23/44	6.63	10.9	3.60	15.3	0.589	101	GC-7B	0.5-8.28	101	**0.37**	**5 f**	**0.6 f**
206-44-0	Fluoranthene	ug/L	2/44	0.0299	0.105	0.026	0.017	0.0865	0.123	GC-4C	0.05-0.0571	0.123	20	NA	50 f
91-20-3	Naphthalene	ug/L	2/44	0.0288	0.0805	0.026	0.012	0.0686	0.0923	GC-4C	0.05-0.0571	0.0923	NA	10 f	16 s
621-64-7	**N-nitroso-di-n-propylamine**	ug/L	1/44	1.38	4.32	1.28	0.456	4.32 J	4.32 J	GC-11D	2.5-2.86	4.32	**0.51**	NA	NA
85-01-8	Phenanthrene	ug/L	2/44	0.0297	0.102	0.026	0.017	0.0778	0.126	GC-9A	0.05-0.0571	0.126	NA	NA	1.5 s
129-00-0	Pyrene	ug/L	2/44	0.0280	0.0632	0.026	0.008	0.0615	0.0649	GC-11A	0.05-0.0571	0.0649	30	NA	4.6 f
Miscellaneous															
--	Total Nitrogen	ug/L	43/44	2098	2133	2100	658	1300	4700	GC-2A	1200-1200	4700	NA	NA	NA
--	Nitrogen, Total-Dissolved	ug/L	33/44	1389	1652	1300	723	1300	3700	GC-12B	1200-1200	3700	NA	NA	NA
--	Phosphorous, Dissolved As P	ug/L	24/44	49	69	56	24.4	53	100	GC-11D	50-50	100	NA	NA	NA
--	**Phosphorous, Total As P**	ug/L	36/44	98	114	83	69.2	50	329	GC-7C	50-50	329	NA	NA	**20 f**
--	Total Inorganic Nitrogen, Dissolved	ug/L	3/44	585	1400	525	227.2	1200	1600	GC-12B	1050-1050	1600	NA	NA	NA

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - USEPA National Recommend Water Quality Criteria (USEPA, 2015). Protective of fish consumption.
5 - New York Water Quality Standards, 6 NYCRR Part 703. Accessed September 30, 2015. Saline values presented if available.
6 - New York Division of Water Technical and Operational Guidance. Compilation of ambient water quality guidance values where there are no standards. Saline values presented if available.

Definitions:
J Estimated value
NA Not Applicable/Not Available
g groundwater
f freshwater
s saline

Shaded criterion and chemical name indicates that the maximum detected concentration exceeds one or more screening criteria.

Associated Samples

GC-1A	GC-8B	GC-5D
GC-2A	GC-9B	GC-6D
GC-4A	GC-10B	GC-7D
GC-5A	GC-1C	GC-8D
GC-6A	GC-2C	GC-9D
GC-7A	GC-4C	GC-10D
GC-8A	GC-5C	GC-11A
GC-9A	GC-6C	GC-11B
GC-10A	GC-7C	GC-11C
GC-1B	GC-8C	GC-11D
GC-2B	GC-9C	GC-12A
GC-4B	GC-10C	GC-12B
GC-5B	GC-1D	GC-12C
GC-6B	GC-2D	GC-12D
GC-7B	GC-4D	

TABLE 2-2A

SUMMARY OF DETECTED RESULTS FOR SURFACE WATER SAMPLES COLLECTED FROM THE GRAND CANAL DURING THE AUGUST 27, 2015 TIDAL SURFACE WATER SAMPLING EVENT (COMPARISON TO SCREENING LEVELS)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

CAS Number	Chemical	Units	Frequency of Detection	Mean of All Samples	Mean of Detected Samples	Median	Standard Deviation	Minimum Concentration(1)	Maximum Concentration(1)	Sample of Maximum Concentration	Range of Nondetects(2)	Concentration Used for Screening(3)	Recreational Screening Value(4)	Recreational and Fish Ingestion Screening Value(4)	USEPA RSL Tapwater(4, 5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																	
95-63-6	1,2,4-Trimethylbenzene	ug/L	3/44	0.119	0.380	0.100	0.073	0.31 J	0.46 J	GC-11C	0.2-0.2	0.46	NA	NA	1.5 N	No	BSL
78-93-3	2-Butanone	ug/L	1/44	0.11	0.33	0.10	0.035	0.33 J	0.33 J	GC-7D	0.2-0.2	0.33	14,000 N	13000 N	560 N	No	BSL
107-02-8	Acrolein	ug/L	23/44	2.26	4.22	2.15	2.35	2.1	7.8	GC-7D	0.2-0.8	7.8	12 N	12 N	0.0042 N	No	BSL
71-43-2	Benzene	ug/L	3/44	0.121	0.407	0.100	0.080	0.32 J	0.47 J	GC-11C	0.2-0.2	0.47	8.7 C	7.3 C	0.46 C	No	BSL
156-59-2	cis-1,2-Dichloroethylene	ug/L	8/44	0.170	0.483	0.100	0.171	0.27 J	0.91	GC-10B	0.2-0.2	0.91	21 N	19 N	3.6 N	No	BSL
100-41-4	Ethyl Benzene	ug/L	5/44	0.126	0.326	0.100	0.077	0.25 J	0.46 J	GC-11C	0.2-0.2	0.46	15 C	11 C	1.5 C	No	BSL
95-47-6	o-Xylene	ug/L	4/44	0.125	0.370	0.100	0.084	0.24 J	0.49 J	GC-11C	0.2-0.2	0.49	730 N	610 N	19 N	No	BSL
179601-23-1	p- m- Xylenes	ug/L	5/44	0.319	0.860	0.250	0.207	0.69 J	1.2	GC-11C	0.5-0.5	1.2	660 N	560 N	19 N	No	BSL
108-88-3	Toluene	ug/L	15/44	0.367	0.88	0.100	0.579	0.21 J	2.7	GC-11C	0.2-0.2	2.7	410 N	360 N	110 N	No	BSL
1330-20-7	Xylenes, Total	ug/L	5/44	0.397	1.156	0.300	0.300	0.69 J	1.7	GC-11C	0.6-0.6	1.7	690 N	590 N	19 N	No	BSL
Semi-Volatiles																	
606-20-2	**2,6-Dinitrotoluene**	ug/L	1/44	1.62	16.0	1.28	2.2	16	16	GC-12D	2.5-2.78	16	**0.69 C**	**0.49 C**	**0.049 C**	**Yes**	ASL
83-32-9	Acenaphthene	ug/L	1/44	0.0265	0.062	0.026	0.005	0.0615	0.0615	GC-4A	0.05-0.0556	0.0615	110 N	86 N	53 N	No	BSL
117-81-7	**Bis(2-ethylhexyl)phthalate**	ug/L	27/44	1.5215	2.3171	0.619	2.580	0.54 J	11.9 J	GC-7D	0.5-0.556	11.9	200 C	**1.2 C**	**5.6 C**	**Yes**	ASL
206-44-0	Fluoranthene	ug/L	4/44	0.03	0.08	0.03	0.017	0.0718	0.1	GC-10A	0.05-0.0556	0.1	1100 N	35 N	80 N	No	BSL
86-73-7	Fluorene	ug/L	1/44	0.0267	0.072	0.026	0.007	0.0718	0.0718	GC-4B	0.05-0.0556	0.0718	57 N	42 N	29 N	No	BSL
129-00-0	Pyrene	ug/L	2/44	0.0300	0.1220	0.026	0.021	0.1	0.144	GC-2C	0.05-0.0556	0.144	19 N	13 N	12 N	No	BSL
Miscellaneous																	
--	Total Nitrogen	ug/L	42/44	1936	2000	1850	619	1400	4600	GC-7B	1200-1200	4600	NA	NA	NA	No	NTX
--	Nitrogen, Total-Dissolved	ug/L	42/44	1777	1833	1800	395	1300	2900	GC-4D	1200-1200	2900	NA	NA	NA	No	NTX
--	Phosphorous, Dissolved As P	ug/L	36/44	143	169	128	94.9	87	432	GC-12C	50-50	432	NA	NA	NA	No	NTX
--	Phosphorous, Total As P	ug/L	35/44	113	135	114	70.5	53	301	GC-12C	50-50	301	NA	NA	NA	No	NTX

Footnotes:

1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Recreational screening levels and fish ingestion values were calculated with USEPA's Regional Screening Level Calculator. Tap water RSLs are from the May 2016 USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. The noncarcinogenic values (denoted with a "N" flag) correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1E-06 (carcinogens denoted with a "C" flag).
5 - Presented for informational purposes. Grand Canal is not a drinking water source.
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the recreational screening level or recreational and fish ingestion screening level.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples

GC-1A	GC-8B	GC-5D
GC-2A	GC-9B	GC-6D
GC-4A	GC-10B	GC-7D
GC-5A	GC-1C	GC-8D
GC-6A	GC-2C	GC-9D
GC-7A	GC-4C	GC-10D
GC-8A	GC-5C	GC-11A
GC-9A	GC-6C	GC-11B
GC-10A	GC-7C	GC-11C
GC-1B	GC-8C	GC-11D
GC-2B	GC-9C	GC-12A
GC-4B	GC-10C	GC-12B
GC-5B	GC-1D	GC-12C
GC-6B	GC-2D	GC-12D
GC-7B	GC-4D	

Definitions:

C Carcinogen
COPC Chemical Of Potential Concern
J Estimated value
N Noncarcinogen
NA Not Applicable/Not Available

Rationale Codes:

For selection as a COPC:
ASL Above Screening Level.

For elimination as a COPC:
BSL Below COPC Screening Level
NTX No toxicity criteria

TABLE 2-2B

SUMMARY OF DETECTED RESULTS FOR SURFACE WATER SAMPLES COLLECTED FROM THE GRAND CANAL DURING THE AUGUST 27, 2015 TIDAL SURFACE WATER SAMPLING EVENT (COMPARISON TO WATER QUALITY CRITERIA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

CAS Number	Chemical	Units	Frequency of Detection	Mean of All Samples	Mean of Detected Samples	Median	Standard Deviation	Minimum Concentration[1]	Maximum Concentration[1]	Sample of Maximum Concentration	Range of Nondetects[2]	Concentration Used for Screening[3]	National Water Quality Criteria - Human Health, Consumption of Organism[4]	NY Water Quality Standards 6 NYCRR part 703[5]	NY Ambient Water Quality Standards[6]
Volatile Organics															
95-63-6	1,2,4-Trimethylbenzene	ug/L	3/44	0.119	0.380	0.100	0.073	0.31 J	0.46 J	GC-11C	0.2-0.2	0.46	NA	NA	19 s
78-93-3	2-Butanone	ug/L	1/44	0.11	0.33	0.10	0.035	0.33 J	0.33 J	GC-7D	0.2-0.2	0.33	NA	NA	50 f
107-02-8	**Acrolein**	ug/L	23/44	2.26	4.22	2.15	2.35	2.1	7.8	GC-7D	0.2-0.8	7.8	400	**5 g**	**5 f**
71-43-2	Benzene	ug/L	3/44	0.121	0.407	0.100	0.080	0.32 J	0.47 J	GC-11C	0.2-0.2	0.47	16-58	10 s	10 s
156-59-2	cis-1,2-Dichloroethylene	ug/L	8/44	0.170	0.483	0.100	0.171	0.27 J	0.91	GC-10B	0.2-0.2	0.91	NA	5 f	5 f
100-41-4	Ethyl Benzene	ug/L	5/44	0.126	0.326	0.100	0.077	0.25 J	0.46 J	GC-11C	0.2-0.2	0.46	130	5 f	4.5 s
95-47-6	o-Xylene	ug/L	4/44	0.125	0.370	0.100	0.084	0.24 J	0.49 J	GC-11C	0.2-0.2	0.49	NA	5 f	19 s
179601-23-1	p- m- Xylenes	ug/L	5/44	0.319	0.860	0.250	0.207	0.69 J	1.2	GC-11C	0.5-0.5	1.2	NA	5 f	19 s
108-88-3	Toluene	ug/L	15/44	0.367	0.88	0.100	0.579	0.21 J	2.7	GC-11C	0.2-0.2	2.7	520	6000 s	92 s
1330-20-7	Xylenes, Total	ug/L	5/44	0.397	1.156	0.300	0.300	0.69 J	1.7	GC-11C	0.6-0.6	1.7	NA	5 f	19 s
Semi-Volatiles															
606-20-2	**2,6-Dinitrotoluene**	ug/L	1/44	1.62	16.0	1.28	2.2	16	16	GC-12D	2.5-2.78	16	NA	**5 g**	**0.07 f**
83-32-9	Acenaphthene	ug/L	1/44	0.0265	0.062	0.026	0.005	0.0615	0.0615	GC-4A	0.05-0.0556	0.0615	90	20 f	6.6 s
117-81-7	**Bis(2-ethylhexyl)phthalate**	ug/L	27/44	1.5215	2.3171	0.619	2.580	0.54 J	11.9 J	GC-7D	0.5-0.556	11.9	**0.37**	**5 f**	**0.6 f**
206-44-0	Fluoranthene	ug/L	4/44	0.03	0.08	0.03	0.017	0.0718	0.1	GC-10A	0.05-0.0556	0.1	20	NA	50 f
86-73-7	Fluorene	ug/L	1/44	0.0267	0.072	0.026	0.007	0.0718	0.0718	GC-4B	0.05-0.0556	0.0718	70	NA	2.5 s
129-00-0	Pyrene	ug/L	2/44	0.0300	0.1220	0.026	0.021	0.1	0.144	GC-2C	0.05-0.0556	0.144	30	NA	4.6 f
Miscellaneous															
--	Total Nitrogen	ug/L	42/44	1936	2000	1850	619	1400	4600	GC-7B	1200-1200	4600	NA	NA	NA
--	Nitrogen, Total-Dissolved	ug/L	42/44	1777	1833	1800	395	1300	2900	GC-4D	1200-1200	2900	NA	NA	NA
--	Phosphorous, Dissolved As P	ug/L	36/44	143	169	128	94.9	87	432	GC-12C	50-50	432	NA	NA	NA
--	**Phosphorous, Total As P**	ug/L	35/44	113	135	114	70.5	53	301	GC-12C	50-50	301	NA	NA	**20 f**

Footnotes:

1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - USEPA National Recommend Water Quality Criteria (USEPA, 2015). Protective of fish consumption.
5 - New York Water Quality Standards, 6 NYCRR Part 703. Accessed September 30, 2015. Saline values presented if available.
6 - New York Division of Water Technical and Operational Guidance. Compilation of ambient water quality guidance values where there are no standards. Saline values presented if available.

Definitions:

J Estimated value
NA Not Applicable/Not Available
g groundwater
f freshwater
s saline

Shaded criterion and chemical name indicates that the maximum detected concentration exceeds one or more screening criteria.

Associated Samples

GC-1A	GC-8B	GC-5D
GC-2A	GC-9B	GC-6D
GC-4A	GC-10B	GC-7D
GC-5A	GC-1C	GC-8D
GC-6A	GC-2C	GC-9D
GC-7A	GC-4C	GC-10D
GC-8A	GC-5C	GC-11A
GC-9A	GC-6C	GC-11B
GC-10A	GC-7C	GC-11C
GC-1B	GC-8C	GC-11D
GC-2B	GC-9C	GC-12A
GC-4B	GC-10C	GC-12B
GC-5B	GC-1D	GC-12C
GC-6B	GC-2D	GC-12D
GC-7B	GC-4D	

TABLE 2-3A

SUMMARY OF DETECTED RESULTS FOR STORM WATER SURFACE WATER RUN-OFF SAMPLES COLLECTED DURING THE AUGUST 11, 2015 WET SAMPLING EVENT (COMPARISON TO SCREENING LEVELS)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

CAS Number	Chemical	Units	Frequency of Detection	Mean of All Samples	Mean of Detected Samples	Median	Standard Deviation	Minimum Concentration(1)	Maximum Concentration(1)	Sample of Maximum Concentration	Range of Nondetects(2)	Concentration Used for Screening(3)	Recreational Screening Value(4)	Recreational and Fish Ingestion Screening Value(4)	USEPA RSL Tapwater(4, 5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																	
78-93-3	2-Butanone	ug/L	1/6	0.118	0.210	0.100	0.045	0.21 J	0.21 J	SW-3	0.2 - 0.2	0.21	14,000 N	13000 N	560 N	No	BSL
67-64-1	Acetone	ug/L	4/6	1.65	2.23	1.85	1.003	1.8 J	3.1	SW-4	1 - 1	3.1	23,000 N	21000 N	1400 N	No	BSL
107-02-8	Acrolein	ug/L	2/6	0.72	1.35	0.40	0.52	1.1 J	1.6 J	SW-3	0.8 - 0.8	1.6	12 N	12 N	**0.0042 N**	No	BSL
71-43-2	Benzene	ug/L	1/6	0.160	0.460	0.100	0.147	0.46 J	0.46 J	SW-2	0.2 - 0.2	0.46	8.7 C	7.3 C	0.46 C	No	BSL
75-15-0	Carbon disulfide	ug/L	2/6	0.142	0.225	0.100	0.065	0.21 J	0.24 J	SW-1	0.2 - 0.2	0.24	1000 N	880 N	81 N	No	BSL
74-87-3	Chloromethane	ug/L	6/6	0.325	0.325	0.335	0.042	0.27 J	0.37 J	SW-3	-	0.37	NA	NA	19 N	No	BSL
108-88-3	Toluene	ug/L	1/6	0.238	0.930	0.100	0.339	0.93	0.93	SW-2	0.2 - 0.2	0.93	410 N	360 N	110 N	No	BSL
Semi-Volatiles																	
117-81-7	**Bis(2-ethylhexyl)phthalate**	ug/L	5/6	2.4	2.8	1.04	2.6	0.533	5.89	SW-2	0.513 - 0.513	5.89	200 C	**1.2 C**	**5.6 C**	**Yes**	ASL
206-44-0	Fluoranthene	ug/L	2/6	0.046	0.087	0.026	0.032	0.0821	0.0923	SW-1	0.0513 - 0.0513	0.0923	1100 N	35 N	80 N	No	BSL
85-01-8	Phenanthrene	ug/L	1/6	0.044	0.13	0.026	0.044	0.133	0.133	SW-1	0.0513 - 0.0513	0.133	NA	NA	NA	No	NTX
129-00-0	Pyrene	ug/L	1/6	0.035	0.082	0.026	0.023	0.0821	0.0821	SW-1	0.0513 - 0.0513	0.0821	19 N	13 N	12 N	No	BSL
Miscellaneous																	
--	Total Nitrogen	ug/L	2/6	1650	2950	1000	1065	2400	3500	SW-1	2000 - 2000	3500	NA	NA	NA	No	NTX
--	Phosphorous, Dissolved As P	ug/L	6/6	89	89	83	21.5	72	132	SW-4	-	132	NA	NA	NA	No	NTX
--	Phosphorous, Total As P	ug/L	6/6	220	220	128	198.0	85	597	SW-4	-	597	NA	NA	NA	No	NTX

Footnotes:

1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Recreational screening levels were calculated with USEPA's Regional Screening Level Calculator. Tap water RSLs are from the May 2016 USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. The noncarcinogenic values (denoted with a "N" flag) correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1E-06 (carcinogens denoted with a "C" flag).
5 - Presented for informational purposes. Grand Canal is not a drinking water source.
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the recreational screening level or recreational and fish ingestion screening level.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples
SW 1
SW 2
SW 3
SW 4
SW 5
SW 6

Definitions:

C Carcinogen
COPC Chemical Of Potential Concern
J Estimated value
N Noncarcinogen
NA Not Applicable/Not Available

Rationale Codes:

For selection as a COPC:
ASL Above Screening Level.

For elimination as a COPC:
BSL Below COPC Screening Level
NTX No toxicity criteria

TABLE 2-3B

SUMMARY OF DETECTED RESULTS FOR STORM WATER SURFACE WATER RUN-OFF SAMPLES COLLECTED DURING THE AUGUST 11, 2015 WET SAMPLING EVENT (COMPARISON TO WATER QUALITY CRITERIA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

CAS Number	Chemical	Units	Frequency of Detection	Mean of All Samples	Mean of Detected Samples	Median	Standard Deviation	Minimum Concentration[1]	Maximum Concentration[1]	Sample of Maximum Concentration	Range of Nondetects[2]	Concentration Used for Screening[3]	National Water Quality Criteria - Human Health, Consumption of Organism[4]	NY Water Quality Standards 6 NYCRR part 703[5]	NY Ambient Water Quality Standards[6]
Volatile Organics															
78-93-3	2-Butanone	ug/L	1/6	0.118	0.210	0.100	0.045	0.21 J	0.21 J	SW-3	0.2 - 0.2	0.21	NA	NA	50 f
67-64-1	Acetone	ug/L	4/6	1.65	2.23	1.85	1.003	1.8 J	3.1	SW-4	1 - 1	3.1	NA	NA	50 f
107-02-8	Acrolein	ug/L	2/6	0.72	1.35	0.40	0.52	1.1 J	1.6 J	SW-3	0.8 - 0.8	1.6	400	5 g	5 f
71-43-2	Benzene	ug/L	1/6	0.160	0.460	0.100	0.147	0.46 J	0.46 J	SW-2	0.2 - 0.2	0.46	16-58	10 s	10 s
75-15-0	Carbon disulfide	ug/L	2/6	0.142	0.225	0.100	0.065	0.21 J	0.24 J	SW-1	0.2 - 0.2	0.24	NA	60 f	60 f
74-87-3	Chloromethane	ug/L	6/6	0.325	0.325	0.335	0.042	0.27 J	0.37 J	SW-3	-	0.37	NA	5 f	5 f
108-88-3	Toluene	ug/L	1/6	0.238	0.930	0.100	0.339	0.93	0.93	SW-2	0.2 - 0.2	0.93	520	6000 s	92 s
Semi-Volatiles															
117-81-7	**Bis(2-ethylhexyl)phthalate**	ug/L	5/6	2.4	2.8	1.04	2.6	0.533	5.89	SW-2	0.513 - 0.513	5.89	**0.37**	**5 f**	**0.6**
206-44-0	Fluoranthene	ug/L	2/6	0.046	0.087	0.026	0.032	0.0821	0.0923	SW-1	0.0513 - 0.0513	0.0923	20	NA	50
85-01-8	Phenanthrene	ug/L	1/6	0.044	0.13	0.026	0.044	0.133	0.133	SW-1	0.0513 - 0.0513	0.133	NA	NA	1.5
129-00-0	Pyrene	ug/L	1/6	0.035	0.082	0.026	0.023	0.0821	0.0821	SW-1	0.0513 - 0.0513	0.0821	30	NA	4.6
Miscellaneous															
--	Total Nitrogen	ug/L	2/6	1650	2950	1000	1065	2400	3500	SW-1	2000 - 2000	3500	NA	NA	NA
--	Phosphorous, Dissolved As P	ug/L	6/6	89	89	83	21.5	72	132	SW-4	-	132	NA	NA	NA
--	Phosphorous, Total As P	ug/L	6/6	220	220	128	198.0	85	597	SW-4	-	597	NA	NA	NA

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - USEPA National Recommend Water Quality Criteria (USEPA, 2015). Protective of fish consumption.
5 - New York Water Quality Standards, 6 NYCRR Part 703. Accessed September 30, 2015. Saline values presented if available.
6 - New York Division of Water Technical and Operational Guidance. Compilation of ambient water quality guidance values where there are no standards. Saline values presented if available.

Definitions:
J Estimated value
NA Not Applicable/Not Available
g groundwater
f freshwater
s saline

Shaded criterion and chemical name indicates that the maximum detected concentration exceeds one or more screening criteria.

Associated Samples
SW 1
SW 2
SW 3
SW 4
SW 5
SW 6

TABLE 2-4A

SUMMARY OF DETECTED RESULTS FOR STORM WATER SURFACE WATER RUN-OFF SAMPLES COLLECTED DURING THE SEPTEMBER 3, 2015 DRY SAMPLING EVENT (COMPARISON TO SCREENING LEVELS)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

CAS Number	Chemical	Units	Frequency of Detection	Mean of All Samples	Mean of Detected Samples	Median	Standard Deviation	Minimum Concentration[1]	Maximum Concentration[1]	Sample of Maximum Concentration	Range of Nondetects[2]	Concentration Used for Screening[3]	Recreational Screening Value[4]	Recreational and Fish Ingestion Screening Value[4]	USEPA RSL Tapwater[4, 5]	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
Volatile Organics																	
95-63-6	1,2,4-Trimethylbenzene	ug/L	1/6	0.127	0.260	0.100	0.065	0.26 J	0.26 J	SW 4	0.2 - 0.2	0.26	NA	NA	1.5 N	No	BSL
67-64-1	Acetone	ug/L	3/6	1.18	1.87	1.15	0.752	1.8 J	2	SW 5	1 - 1	2	23,000 N	21000 N	1400 N	No	BSL
107-02-8	Acrolein	ug/L	4/6	2.45	3.63	2.30	2.60	2.2	7.2	SW 1	0.2 - 0.2	7.2	12 N	12 N	0.0042 N	No	BSL
71-43-2	Benzene	ug/L	1/6	0.125	0.250	0.100	0.061	0.25 J	0.25 J	SW 4	0.2 - 0.2	0.25	8.7 C	7.3 C	0.46 C	No	BSL
95-47-6	o-Xylene	ug/L	1/6	0.127	0.260	0.100	0.065	0.26 J	0.26 J	SW 4	0.2 - 0.2	0.26	730 N	610 N	19 N	No	BSL
179601-23-1	p- m- Xylenes	ug/L	1/6	0.318	0.660	0.250	0.167	0.66 J	0.66 J	SW 4	0.5 - 0.5	0.66	660 N	560 N	19 N	No	BSL
75-65-0	Tert-Butyl Alcohol (TBA)	ug/L	3/6	0.523	0.797	0.480	0.304	0.71 J	0.87 J	SW 2	0.5 - 0.5	0.87	NA	NA	NA	No	NTX
108-88-3	Toluene	ug/L	2/6	0.433	1.10	0.100	0.520	1	1.2	SW 4	0.2 - 0.2	1.2	410 N	360 N	110 N	No	BSL
1330-20-7	Xylenes, Total	ug/L	1/6	0.403	0.920	0.300	0.253	0.92 J	0.92 J	SW 4	0.6 - 0.6	0.92	690 N	590 N	19 N	No	BSL
Semi-Volatiles																	
117-81-7	Bis(2-ethylhexyl)phthalate	ug/L	6/6	18.4	18.4	4.56	35.2	2.53	90.3	SW 3	-	90.3	200 C	1.2 C	5.6 C	Yes	ASL
91-20-3	Naphthalene	ug/L	3/6	0.400	0.775	0.311	0.422	0.595	0.867	SW 6	0.0513 - 0.0526	0.867	69 N	57 N	0.17 C	No	BSL
Miscellaneous																	
--	Total Nitrogen	ug/L	6/6	2433	2433	2250	455	2000	3100	SW 1	-	3100	NA	NA	NA	No	NTX
--	Nitrogen, Total-Dissolved	ug/L	6/6	2400	2400	2350	329	2000	3000	SW 1	-	3000	NA	NA	NA	No	NTX
--	Phosphorous, Dissolved As P	ug/L	6/6	160	160	152	34.0	128	224	SW 1	-	224	NA	NA	NA	No	NTX
--	Phosphorous, Total As P	ug/L	6/6	148	148	111	90.1	87	320	SW 3	-	320	NA	NA	NA	No	NTX

Footnotes:

1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Recreational screening levels were calculated with USEPA's Regional Screening Level Calculator. Tap water RSLs are from the May 2016 USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. The noncarcinogenic values (denoted with a "N" flag) correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1E-06 (carcinogens denoted with a "C" flag).
5 - Presented for informational purposes. Grand Canal is not a drinking water source.
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the recreational screening level or recreational and fish ingestion screening level.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples
SW 1
SW 2
SW 3
SW 4
SW 5
SW 6

Definitions:
C Carcinogen
COPC Chemical Of Potential Concern
J Estimated value
N Noncarcinogen
NA Not Applicable/Not Available

Rationale Codes:
For selection as a COPC:
ASL Above Screening Level.

For elimination as a COPC:
BSL Below COPC Screening Level
NTX No toxicity criteria

TABLE 2-4B

SUMMARY OF DETECTED RESULTS FOR STORM WATER SURFACE WATER RUN-OFF SAMPLES COLLECTED DURING THE SEPTEMBER 3, 2015 DRY SAMPLING EVENT (COMPARISON TO WATER QUALITY CRITERIA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

CAS Number	Chemical	Units	Frequency of Detection	Mean of All Samples	Mean of Detected Samples	Median	Standard Deviation	Minimum Concentration[1]	Maximum Concentration[1]	Sample of Maximum Concentration	Range of Nondetects[2]	Concentration Used for Screening[3]	National Water Quality Criteria - Human Health, Consumption of Organism[4]	NY Water Quality Standards 6 NYCRR part 703[5]	NY Ambient Water Quality Standards[6]
Volatile Organics															
95-63-6	1,2,4-Trimethylbenzene	ug/L	1/6	0.127	0.260	0.100	0.065	0.26 J	0.26 J	SW 4	0.2 - 0.2	0.26	NA	NA	19 s
67-64-1	Acetone	ug/L	3/6	1.18	1.87	1.15	0.752	1.8 J	2	SW 5	1 - 1	2	NA	NA	50 f
107-02-8	**Acrolein**	ug/L	4/6	2.45	3.63	2.30	2.60	2.2	7.2	SW 1	0.2 - 0.2	7.2	400	**5 g**	**5 f**
71-43-2	Benzene	ug/L	1/6	0.125	0.250	0.100	0.061	0.25 J	0.25 J	SW 4	0.2 - 0.2	0.25	16-58	10 s	10 s
95-47-6	o-Xylene	ug/L	1/6	0.127	0.260	0.100	0.065	0.26 J	0.26 J	SW 4	0.2 - 0.2	0.26	NA	5 f	19 s
179601-23-1	p- m- Xylenes	ug/L	1/6	0.318	0.660	0.250	0.167	0.66 J	0.66 J	SW 4	0.5 - 0.5	0.66	NA	5 f	19 s
75-65-0	Tert-Butyl Alcohol (TBA)	ug/L	3/6	0.523	0.797	0.480	0.304	0.71 J	0.87 J	SW 2	0.5 - 0.5	0.87	NA	NA	NA
108-88-3	Toluene	ug/L	2/6	0.433	1.10	0.100	0.520	1	1.2	SW 4	0.2 - 0.2	1.2	520	6000 s	92 s
1330-20-7	Xylenes, Total	ug/L	1/6	0.403	0.920	0.300	0.253	0.92 J	0.92 J	SW 4	0.6 - 0.6	0.92	NA	5 f	19 s
Semi-Volatiles															
117-81-7	**Bis(2-ethylhexyl)phthalate**	ug/L	6/6	18.4	18.4	4.56	35.2	2.53	90.3	SW 3	-	90.3	**0.37**	**5 f**	**0.6 f**
91-20-3	Naphthalene	ug/L	3/6	0.400	0.775	0.311	0.422	0.595	0.867	SW 6	0.0513 - 0.0526	0.867	NA	10 f	16 s
Miscellaneous															
--	Total Nitrogen	ug/L	6/6	2433	2433	2250	455	2000	3100	SW 1	-	3100	NA	NA	NA
--	Nitrogen, Total-Dissolved	ug/L	6/6	2400	2400	2350	329	2000	3000	SW 1	-	3000	NA	NA	NA
--	Phosphorous, Dissolved As P	ug/L	6/6	160	160	152	34.0	128	224	SW 1	-	224	NA	NA	NA
--	**Phosphorous, Total As P**	ug/L	6/6	148	148	111	90.1	87	320	SW 3	-	320	NA	NA	**20 f**

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - USEPA National Recommend Water Quality Criteria (USEPA, 2015). Protective of fish consumption.
5 - New York Water Quality Standards, 6 NYCRR Part 703. Accessed September 30, 2015. Saline values presented if available.
6 - New York Division of Water Technical and Operational Guidance. Compilation of ambient water quality guidance values where there are no standards. Saline values presented if available.

Shaded criterion and chemical name indicates that the maximum detected concentration exceeds one or more screening criteria.

Definitions:
J Estimated value
NA Not Applicable/Not Available
g groundwater
f freshwater
s saline

Associated Samples
SW 1
SW 2
SW 3
SW 4
SW 5
SW 6

TABLE 2-5

SUMMARY STATISTICS FOR GENERAL WATER QUALITY PARAMETERS - CONTINUOUS MONITORING DATA
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Location - Date	Time Interval[(1)]		Parameter	Descriptive Statistics			
				Count	Min	Max	Mean
Location A - 2014	7/30/2014	8/12/2014	Temp	1289	22.78	27.89	25.80
	8/13/2014	8/26/2014	Temp	1343	11.97	27.39	24.33
	8/27/2014	9/9/2014	Temp	1343	21.6	29	25.49
	9/10/2014	9/23/2014	Temp	1343	17.6	23.87	21.06
	7/30/2014	8/12/2014	D.O.	1289	1.45	10.22	4.99
	8/13/2014	8/26/2014	D.O.	1343	1.14	13.32	5.41
	8/27/2014	9/9/2014	D.O.	1343	0.36	11.06	4.22
	9/10/2014	9/23/2014	D.O.	1343	1.72	11.47	5.91
	7/30/2014	8/12/2014	Salinity	1289	18.39	27.57	22.92
	8/13/2014	8/26/2014	Salinity	1343	0.28	25.75	19.38
	8/27/2014	9/9/2014	Salinity	1343	3.77	26.44	20.53
	9/10/2014	9/23/2014	Salinity	1343	18.53	25.72	22.28

Location - Date	Time Interval[(1)]		Parameter	Descriptive Statistics			
				Count	Min	Max	Mean
Location B - 2014	8/15/2014	8/28/2014	Temp	1305	20.83	27.68	24.22
	8/29/2014	9/11/2014	Temp	1343	20.06	28.26	24.77
	9/12/2014	9/25/2014	Temp	1344	18.44	23.67	20.78
	9/26/2014	10/2/2014[(2)]	Temp	672	17.99	21.59	19.84
	8/15/2014	8/28/2014	D.O.	1305	0.79	13.8	5.64
	8/29/2014	9/11/2014	D.O.	1343	0.22	11.7	5.16
	9/12/2014	9/25/2014	D.O.	1344	1.36	11.76	5.84
	9/26/2014	10/2/2014[(2)]	D.O.	672	2.77	11.04	5.64
	8/15/2014	8/28/2014	Salinity	1305	7.34	24.2	16.13
	8/29/2014	9/11/2014	Salinity	1343	3.92	24.42	15.48
	9/12/2014	9/25/2014	Salinity	1344	8.8	24.72	18.90
	9/26/2014	10/2/2014[(2)]	Salinity	672	13.17	23.85	18.66

Location - Date	Time Interval[(1)]		Parameter	Descriptive Statistics			
				Count	Min	Max	Mean
Location A - 2013	5/15/2013	5/28/2013	Temp	1296	11.17	25.66	18.80
	5/29/2013	6/11/2013	Temp	1344	16.75	26.79	21.94
	6/12/2013	6/25/2013	Temp	1344	17.15	28.54	22.98
	6/26/2013	7/9/2013	Temp	1344	23.64	30.98	26.69
	7/10/2013	7/23/2013	Temp	1341	24.45	32.34	28.36
	7/24/2013	8/6/2013	Temp	1344	21.51	29.1	25.26
	8/7/2013	8/20/2013	Temp	1343	21.55	27.38	24.54
	8/21/2013	9/3/2013	Temp	1344	21.42	26.73	24.53
	5/15/2013	5/28/2013	D.O.	1296	4.6	10.83	7.81
	5/29/2013	6/11/2013	D.O.	1344	2.51	13.37	6.73
	6/12/2013	6/25/2013	D.O.	1344	1.85	10.82	5.55
	6/26/2013	7/9/2013	D.O.	1026	0.51	10.95	4.37
	7/10/2013	7/23/2013	D.O.	1109	1.45	12.31	5.82
	7/24/2013	8/6/2013	D.O.	1344	1.13	12.05	4.73
	8/7/2013	8/20/2013	D.O.	1343	1.06	12.97	4.85
	8/21/2013	9/3/2013	D.O.	1344	1.39	13.40	5.16

TABLE 2-5

SUMMARY STATISTICS FOR GENERAL WATER QUALITY PARAMETERS - CONTINUOUS MONITORING DATA
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Location - Date	Time Interval(1)		Parameter	Descriptive Statistics			
				Count	Min	Max	Mean
Location A - 2013	5/15/2013	5/28/2013	Salinity	1296	6.7	26.69	18.27
Continued	5/29/2013	6/11/2013	Salinity	1344	5.65	23.97	14.77
	6/12/2013	6/25/2013	Salinity	1344	9.31	23.65	17.30
	6/26/2013	7/9/2013	Salinity	1344	7.45	25.38	15.63
	7/10/2013	7/23/2013	Salinity	1341	13.84	24.86	19.82
	7/24/2013	8/6/2013	Salinity	1344	18.14	25.3	22.15
	8/7/2013	8/20/2013	Salinity	1343	11.43	24.68	20.37
	8/21/2013	9/3/2013	Salinity	1344	14.67	25.3	21.11

Location - Date	Time Interval(1)		Parameter	Descriptive Statistics			
				Count	Min	Max	Mean
Location B - 2013	5/16/2013	5/29/2013	Temp	1345	9.96	24.25	18.63
	7/13/2013	7/26/2013	Temp	1343	22.09	32.51	27.77
	7/27/2013	8/9/2013	Temp	1343	22.39	29.03	25.29
	8/10/2013	8/23/2013	Temp	1344	22.63	27.42	24.77
	8/24/2013	9/6/2013	Temp	1344	21.24	27.08	24.26
	5/16/2013	5/29/2013	D.O.	1345	2.09	12.33	7.26
	7/13/2013	7/26/2013	D.O.	1343	0.47	19.21	5.57
	7/27/2013	8/9/2013	D.O.	1343	-3.61	39.32	7.18
	8/10/2013	8/23/2013	D.O.	1344	0.57	37.58	4.22
	8/24/2013	9/6/2013	D.O.	1344	0.5	13.81	5.17
	5/16/2013	5/29/2013	Salinity	1345	0	24.97	12.98
	7/13/2013	7/26/2013	Salinity	1201	9.14	25.46	18.42
	7/27/2013	8/9/2013	Salinity	data not available			
	8/10/2013	8/23/2013	Salinity	717	11.43	24.1	20.18
	8/24/2013	9/6/2013	Salinity	1344	6.89	24.63	18.61

Footnotes:
1 - Approximately two-week intervals, unless otherwise noted.
2 - One-week interval.

Abbreviations:
Count - Number of data points evaluated
Min - Minimum value
Max - Maximum value
Mean - arithmetic mean
Temp - Temperature
D.O. - Dissolved oxygen

TABLE 2-6

SUMMARY STATISTICS FOR DISSOLVED OXYGEN - CONTINUOUS MONITORING DATA
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Location - Date	Time Interval[1]		Dissolved Oxygen	
			4.8 mg/L	2.3 mg/L
Location A - 2014	7/30/2014	8/12/2014	46.16	7.68
	8/13/2014	8/26/2014	47.36	6.03
	8/27/2014	9/9/2014	63.44	15.26
	9/10/2014	9/23/2014	35.96	1.04
		Average	44.4	6.4
Location B - 2014	8/15/2014	8/28/2014	50.50	13.33
	8/29/2014	9/11/2014	41.62	18.32
	9/12/2014	9/25/2014	41.44	1.04
	9/26/2014	10/2/2014[2]	36.76	0.00
		Average	45.6	11.4
Location A - 2013	5/15/2013	5/28/2013	0.39	0.00
	5/29/2013	6/11/2013	16.52	0.00
	6/12/2013	6/25/2013	40.70	0.74
	6/26/2013	7/9/2013	64.04	15.59
	7/10/2013	7/23/2013	40.49	5.86
	7/24/2013	8/6/2013	56.62	14.36
	8/7/2013	8/20/2013	56.81	9.68
	8/21/2013	9/3/2013	46.88	4.02
		Average	39.5	5.9
Location B - 2013	5/16/2013	5/29/2013	6.39	0.15
	7/13/2013	7/26/2013	56.07	24.27
	7/27/2013	8/9/2013	42.59	14.22
	8/10/2013	8/23/2013	69.42	35.71
	8/24/2013	9/6/2013	50.30	17.78
		Average	45.1	18.1

Footnotes:
1 - Approximately two-week intervals, unless otherwise noted.
2 - One-week interval.

TABLE 2-7

SUMMARY STATISTICS FOR DETECTED PARAMETERS ANALYZED IN SURFACE WATER SAMPLES
FROM SUFFOLK COUNTY
COLLECTED 2008-2014 (USEPA STORET DATA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Parameter, sorted by units	Count	Maximum	Minimum	Average
#/100ml				
Enterococcus	15880	1940	2.87	41.9
Escherichia coli	1	40	40	40
%				
Cloud cover	699	100	0	46.1
cfu/100ml				
Total Coliform	80	5000	11	600
deg C				
Temperature, air	438	33.2	-10.2	16.9
Temperature, water	67445	27.5	0.13	13.3
kg/m3				
Density	65756	25.25	-10.9	20.3
m				
Depth, bottom	695	92.2	9.2	29.3
Depth, Secchi disk depth	463	6.1	-2.4	2.61
mg/l				
Alkalinity, total	38	45	3.9	24.7
Alkalinity, total as CaCO3	66	58	3	19.4
Ammonia	478	0.098	0.002	0.01
Ammonia-nitrogen	76	4.73	0.01	0.12
Ammonia-nitrogen as N	32	1.62	0.011	0.28
Biochemical oxygen demand, standard conditions	277	4.2	0.6	2.06
Biogenic Silica	774	3.31	0.021	0.53
Chloride	92	78.6	4.5	23.2
Dissolved oxygen (DO)	67924	13.15	-2.37	7.89
Dissolved oxygen saturation	130888	163	-28.71	47.5
Fluoride	21	0.11	0.1	0.10
Hardness, Calcium	18	176	11.5	63.0
Hardness, carbonate as CaCO3	40	70.7	11	42.7
Inorganic nitrogen (nitrate and nitrite)	788	3.89	0.0021	0.20
Inorganic nitrogen (nitrate and nitrite) as N	28	3.61	0.0026	0.41
Kjeldahl nitrogen	73	5.89	0.18	0.79
Nitrate	58	3.88	0.026	1.76
Nitrite	31	0.063	0.01	0.02
Nitrogen	806	0.75	0.092	0.21
Nitrogen dioxide	807	0.234	0.004	0.07
Organic carbon	935	14.6	0.90	2.04
Orthophosphate	818	0.133	0.004	0.03
Phosphorus	931	2.05	0.0036	0.05
Phosphorus, Particulate Organic	760	0.082	0.001	0.01
Silica	765	10.6	0.003	1.04
Sulfate	79	25.5	2	11.7
Total dissolved solids	58	158	43	103
Total Particulate Carbon	766	1.85	0.096	0.45
Total Particulate Nitrogen	762	0.22	0.01	0.06
Total solids	58	165	59	116
Total suspended solids	801	61	1.1	6.25
Total volatile solids	58	53	10	32.1

TABLE 2-7

SUMMARY STATISTICS FOR DETECTED PARAMETERS ANALYZED IN SURFACE WATER SAMPLES FROM SUFFOLK COUNTY COLLECTED 2008-2014 (USEPA STORET DATA) PUBLIC HEALTH EVALUATION GRAND CANAL, OAKDALE, NEW YORK

Parameter, sorted by units	Count	Maximum	Minimum	Average
Mole/l				
pH	35781	8.706	6.06	7.86
MPN				
Enterococcus	388	4110	1	56.9
ng/l				
Mercury	18	4.4	0.5	1.25
None				
pH	914	9.03	5.88	7.81
NTU				
Turbidity	58	9.98	0.8	3.44
PCU				
True color	44	72	5	25.6
ppm				
Biochemical oxygen demand, standard conditions	192	6.1	0.5	2.39
Dissolved oxygen (DO)	1384	12.4	4	7.61
Nitrogen dioxide	549	0.268	0.002	0.07
psi				
Pressure	69256	43.54	-2.95E-08	15.7
PSU				
Salinity	67389	31.99	-9.76	27.6
S/m				
Conductivity	65825	4.38	-1.58	3.34
uE/m2/sec				
Light, photosynthetic active radiation (PAR)	67636	3988	-961	64.5
ug/l				
Aluminum	112	147	3.7	41.3
Arsenic	34	2.1	0.211	0.41
Cadmium	49	0.163	0.008	0.03
Calcium	92	37700	3.12	5051
Chlorophyll a	830	125	0.20	4.70
Chlorophyll a (probe relative fluorescence)	65830	82.88	-3.1	8.55
Copper	116	3.4	0.318	1.00
Iron	82	4350	58.2	734
Lead	116	3.3	0.061	0.64
Magnesium	84	15200	1.29	1698
Manganese	85	1490	10.3	253
Mercury	2	0.028	0.023	0.03
Nickel	116	3.1	0.322	1.10
Potassium	79	6980	0.695	1038
Silver	50	0.212	0.005	0.03
Sodium	84	52900	5.48	7915
Tetrachloroethylene	1	0.34	0.34	0.34
Trichloroethylene	1	0.31	0.31	0.31
Zinc	76	11.3	1	4.88
umho/cm				
Specific conductance	112	481	62.7	217

Source: USEPA STORET Data Warehouse. Suffolk County, New York. Accessed October 6, 2015.
Summary statistics are for detected results only.

TABLE 2-8

SUMMARY STATISTICS FOR DETECTED PARAMETERS ANALYZED IN SURFACE WATER SAMPLES FROM THE SOUTHERN LONG ISLAND WATERSHED COLLECTED 2008-2014 (USEPA STORET DATA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Parameter, sorted by units	Count	Maximum	Minimum	Average
#/100ml				
Enterococcus	13947	17329	1	49.8
Escherichia coli	1	40	40	40
Fecal Coliform	1	230	230	230
Total Coliform	1	230	230	230
%				
Cloud cover	57	100	0	51.8
cfu/100ml				
Enterococcus	224	18000	1	300
Fecal Coliform	378	2900000	9	16766
Total Coliform	489	18800000	10	72371
deg C				
Temperature, air	42	24.2	-7.3	11.0
Temperature, water	9455	28.3	2.59	11.0
ft				
Depth, bottom	435	71.3	3	24.0
kg/m3				
Density	8347	25.3	19.4	23.2
m				
Altitude	9	36.4	1.32	18.8
Depth	42	39.2	9	22.5
Depth, bottom	54	92.2	58	77.5
Depth, Secchi disk depth	580	15	-2.4	1.4
mg/l				
Alkalinity, total	47	88.4	3.9	29.0
Alkalinity, total as CaCO3	92	96	3	24.4
Ammonia	97	0.034	0.002	0.01
Ammonia as N	203	7.6	0.011	0.23
Ammonia-nitrogen	86	5.75	0.01	0.17
Ammonia-nitrogen as N	55	1.62	0.011	0.19
Biochemical oxygen demand, standard conditions	60	3	0.6	1.87
Biogenic Silica	146	0.595	0.042	0.24
Chloride	127	10500	4.5	236
Dissolved oxygen (DO)	9598	17.78	0.49	8.90
Dissolved oxygen saturation	16524	114	7.6	53.0
Fluoride	27	0.11	0.1	0.10
Hardness, Calcium	24	176	11.5	67.6
Hardness, carbonate as CaCO3	40	70.7	11	42.7
Inorganic nitrogen (nitrate and nitrite)	227	3.89	0.002	0.58
Inorganic nitrogen (nitrate and nitrite) as N	603	280	0.0012	0.99
Kjeldahl nitrogen	107	6.69	0.15	0.86
Nitrate	64	3.88	0.026	1.73
Nitrate as NO3	496	1.73	0.01	0.24
Nitrite	37	0.063	0.01	0.02
Nitrogen	714	280	0.012	0.97
Nitrogen dioxide	178	0.145	0.005	0.05

TABLE 2-8

SUMMARY STATISTICS FOR DETECTED PARAMETERS ANALYZED IN SURFACE WATER SAMPLES FROM THE SOUTHERN LONG ISLAND WATERSHED COLLECTED 2008-2014 (USEPA STORET DATA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Parameter, sorted by units	Count	Maximum	Minimum	Average
Organic carbon	1593	14.6	0.13	1.42
Orthophosphate	727	0.64	0.005	0.15
Orthophosphate as P	637	0.29	0.025	0.07
Phosphorus	1006	2.05	0.0036	0.07
Phosphorus, Particulate Organic	143	0.069	0.001	0.01
Silica	157	10.6	0.038	0.84
Sulfate	112	1500	2	43.1
Total dissolved solids	64	293	43	116
Total Particulate Carbon	144	0.65	0.14	0.32
Total Particulate Nitrogen	142	0.090	0.01	0.04
Total solids	64	336	59	130
Total suspended solids	191	23	1	4.89
Total volatile solids	64	53	10	32.3
Mole/l				
pH	4397	8.2	6.1	7.78
MPN				
Enterococcus	283	4110	1	56.9
mS/cm				
Specific conductance	690	50.4	20.2	43.5
ng/l				
Mercury	24	4.4	0.5	1.39
None				
pH	875	8.88	5.88	7.58
NTU				
Turbidity	762	74	0	10.5
Pascal				
Barometric pressure	120	37.1	0.80	11.1
PCU				
True color	72	84	5	25.1
ppm				
Biochemical oxygen demand, standard conditions	48	5	0.8	2.21
Dissolved oxygen (DO)	376	12.2	5.2	7.83
Nitrogen dioxide	141	0.176	0.004	0.05
ppth				
Salinity	804	36	12.2	28.9
psi				
Pressure	8562	43.5	0.119	21.3
PSS				
Salinity	120	33.1	19.7	30.0
PSU				
Salinity	8460	32.0	23.8	30.2
S/m				
Conductivity	8347	4.24	2.53	3.32
uE/m2/sec				
Light, photosynthetic active radiation (PAR)	8578	2190	0.0024	34.4

TABLE 2-8

SUMMARY STATISTICS FOR DETECTED PARAMETERS ANALYZED IN SURFACE WATER SAMPLES FROM THE SOUTHERN LONG ISLAND WATERSHED COLLECTED 2008-2014 (USEPA STORET DATA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Parameter, sorted by units	Count	Maximum	Minimum	Average
ug/l				
Aluminum	124	258	3.7	43.4
Ammonia as N	3	7.6	1.4	5.43
Arsenic	40	2.1	0.211	0.39
Boron	1	20.4	20.4	20.4
Cadmium	61	5.6	0.008	0.11
Calcium	127	226000	3.12	12083
Chlorophyll a	718	375.41	0	41.3
Chlorophyll a (probe relative fluorescence)	8347	23.8665	1.3592	4.91
Copper	128	4.2	0.318	1.14
Iron	116	4350	58.2	715
Lead	128	13.5	0.061	0.87
Magnesium	117	727000	1.29	16946
Manganese	119	1490	10.3	235
Mercury	2	0.028	0.023	0.03
Nickel	128	3.1	0.322	1.14
Potassium	112	240000	0.695	6368
Silicon	1124	810	1.5	120
Silver	56	0.212	0.005	0.03
Sodium	117	5450000	5.48	135536
Tetrachloroethylene	1	0.34	0.34	0.34
Trichloroethylene	1	0.31	0.31	0.31
Zinc	88	45.8	1	6.48
umho/cm				
Specific conductance	122	673	62.7	240

Source: USEPA STORET Data Warehouse. Drainage Basin 02030202- Southern Long Island. Accessed October 6, 2015.
Summary statistics are for detected results only.

TABLE 2-9

SUMMARY OF DETECTED RESULTS FOR SEDIMENT SAMPLES COLLECTED FROM THE GRAND CANAL DURING THE DECEMBER 2015 SAMPLING EVENT (COMPARISON TO SOIL SCREENING LEVELS)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

CAS Number	Chemical	Units	Frequency of Detection	Mean of All Samples	Mean of Detected Samples	Median	Standard Deviation	Minimum Concentration[1]	Maximum Concentration[1]	Sample of Maximum Concentration	Range of Nondetects[2]	Concentration Used for Screening[3]	Recreational Screening Value[4]	Recreational and Fish Ingestion Screening Value[4]	USEPA RSL Residential[4, 5]	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
Dioxins																	
67562-39-4	1,2,3,4,6,7,8-HpCDF	ng/kg	2/2	28.89	28.9	28.9	NA	9.68	48.1	Dioxin A	-	48.1	NA	NA	NA	No	NTX
39001-02-0	OCDF	ng/kg	2/2	148.9	149	149	NA	32.8	265	Dioxin A	-	265	NA	NA	NA	No	NTX
35822-46-9	1,2,3,4,6,7,8-HpCDD	ng/kg	2/2	148.35	148	148	NA	42.7	254	Dioxin A	-	254	NA	NA	NA	No	NTX
3268-87-9	OCDD	ng/kg	2/2	1957	1957	1957	NA	384	3530	Dioxin A	-	3530	NA	NA	NA	No	NTX
--	Totals-Tetrafurans	ng/kg	1/2	12.425	17.7	12.4	NA	17.7	17.7	Dioxin A	14.3	17.7	NA	NA	NA	No	NTX
--	Totals-Pentafurans	ng/kg	1/2	12.575	18	12.6	NA	18	18	Dioxin A	14.3	18	NA	NA	NA	No	NTX
--	Totals-Pentadioxins	ng/kg	1/2	29.075	51	29.1	NA	51	51	Dioxin A	14.3	51	NA	NA	NA	No	NTX
--	Totals-Hexafurans	ng/kg	1/2	15.975	24.8	16.0	NA	24.8	24.8	Dioxin A	14.3	24.8	NA	NA	NA	No	NTX
--	Totals-Hexadioxins	ng/kg	1/2	86.075	165	86.1	NA	165	165	Dioxin A	14.3	165	NA	NA	NA	No	NTX
--	Totals-Heptafurans	ng/kg	1/2	265.075	523	265	NA	523	523	Dioxin A	14.3	523	NA	NA	NA	No	NTX
--	Totals-Heptadioxins	ng/kg	1/2	44.8	81.3	44.8	NA	81.3	81.3	Dioxin B	16.6	81.3	NA	NA	NA	No	NTX
--	TEQ	ng/kg	2/2	2.405	2.41	2.41	NA	0.65	4.16	Dioxin A	-	4.16	30 C	2.7 C	4.8 C	Yes	ASL
Pesticides																	
72-54-8	4,4'-DDD	mg/kg	11/20	0.156	0.281	0.041	0.228	0.0149	0.651	GC 6A	0.00224 - 0.00658	0.651	11.5 C	0.14 C	2.3 C	Yes	ASL
72-55-9	4,4'-DDE	mg/kg	14/20	0.036	0.051	0.022	0.044	0.00653	0.143	GC 6A	0.0027 - 0.00497	0.143	8.1 C	0.0037 C	2 C	Yes	ASL
50-29-3	4,4'-DDT	mg/kg	2/20	0.007	0.052	0.002	0.020	0.0118	0.0913	GC 4A	0.00224 - 0.00763	0.0913	11.4 C	0.017 C	1.9 C	Yes	ASL
Polychlorinated Biphenyls (PCB)																	
11097-69-1	Aroclor 1254	mg/kg	1/20	0.031	0.171	0.021	0.034	0.171	0.171	GC 5A	0.0227 - 0.077	0.171	0.66 N	0.0026 C	0.12 N	Yes	ASL
Metals																	
7440-38-2	Arsenic	mg/kg	20/20	10.1	10.1	9.07	5.35	1.86	22.9	GC 4B	--	22.9	3.9 C	0.26 C	0.68 C	Yes	ASL
7440-47-3	Chromium	mg/kg	20/20	23.2	23.2	20.7	13.7	5.39	55.6	GC 3A	--	55.6	2.1 C[7]	0.12 C[7]	0.30 C[7]	Yes	ASL
7440-50-8	Copper	mg/kg	20/20	62.4	62.4	53.2	40.0	14.7	152	GC 4A	--	152	2190 N	8.1 N	310 N	Yes	ASL
7439-92-1	Lead	mg/kg	20/20	52.7	52.7	53.7	25.8	9.09	119	GC 6A	--	119	NA	NA	400	No	BSL
7440-02-0	Nickel	mg/kg	20/20	13.6	13.6	13.0	7.52	3.76	32.2	GC 3A	--	32.2	1095 N	9.2 N	150 N	Yes	ASL
7440-66-6	Zinc	mg/kg	20/20	90.4	90.4	88.6	46.6	15.2	180	GC 2A	--	180	16400 N	43 N	2300 N	Yes	ASL
7439-97-6	Mercury	mg/kg	20/20	0.367	0.367	0.312	0.290	0.0506	1.29	GC 6B	--	1.29	16 N[8]	0.11 N[8]	2.3 N[8]	Yes	ASL
Total Solids																	
--	Solids		20/20	39.8	39.8	39.2	14.3	21.6	73.5	GC 1B	--	73.5	NA	NA	NA	No	NTX

Footnotes:

1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Recreational screening levels and fish ingestion values were calculated with USEPA's Regional Screening Level Calculator.
Residential Soil Regional Screening Levels (RSLs) are from USEPA RSLs for Chemical Contaminants at Superfund Sites (May 2016).
The noncarcinogenic values (denoted with a "N" flag) correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1E-06 (carcinogens denoted with a "C" flag).
5 - Presented for informational purposes.
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the screening criteria. Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.
7 - Value is for hexavalent chromium. Screening level for trivalent chromium is 12,000 mg/kg.
8 - Value is for mercuric chloride (and other mercury salts).

Associated Samples

GC 1A	GC 6B
GC 1B	GC 7A
GC 2A	GC 7B
GC 2B	GC 8A
GC 3A	GC 8B
GC 3B	GC 9A
GC 4A	GC 9B
GC 4B	GC 10A
GC 5A	GC 10B
GC 5B	Dioxin A
GC 6A	Dioxin B

Definitions:

C Carcinogen
COPC Chemical Of Potential Concern
J Estimated value
N Noncarcinogen

NA Not Applicable/Not Available

Rationale Codes:

For selection as a COPC:
ASL Above Screening Level.

For elimination as a COPC:
BSL Below COPC Screening Level
NTX No toxicity criteria

TABLE 2-10

SUMMARY OF EXPOSURE ASSUMPTIONS
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Parameter Code	Exposure Parameter	Child Recreational User	Adolescent Recreational User[(1)]	Adult Recreational User
All Exposures				
BW	Body Weight (kg)	15[(2)]	45[(6)]	80[(2)]
AT-N	Averaging Time (Non-Cancer) (days)	2,190[(2)]	3,650[(2)]	3,650[(2)]
AT-C	Averaging Time (Cancer) (days)	25,550[(2)]	25,550[(2)]	25,550[(2)]
Incidental Ingestion/Dermal Contact with Surface Water				
C_{sw}	Exposure concentration for surface water (g/L)	Maximum or 95 UCL[(3)]	Maximum or 95 UCL[(3)]	Maximum or 95 UCL[(3)]
ED	Exposure Duration (years)	6[(2)]	10[(2)]	10[(2)]
CR	Contact Rate (L/hour)	0.05[(4)]	0.01[(4)]	0.01[(4)]
EF	Exposure Frequency (days/year)	100[(5)]	100[(5)]	50[(5)]
ET, t_{event}	Exposure Time (hours/day)	4[(5)]	4[(5)]	4[(5)]
EV	Event Frequency (events/day)	1[(5)]	1[(5)]	1[(5)]
SA	Skin Surface Available for Contact (cm^2)	6,365[(2)]	13,400[(6)]	19,652[(2)]
--	Kp (cm/hour), t (hour/event), t (hour), and B (unitless)	chemical specific	chemical specific	chemical specific
CF	Conversion Factor (L/m^3)	1E-03	1E-03	1E-03
Ingestion of Fish				
IR	Ingestion Rate (kg/meal)	0	0	0.227[(7)]
BCF	Bioconcentration Factor [(mg/kg/mg/L)]	chemical specific	chemical specific	chemical specific
FI	Fraction Ingested (unitless)	0	0	1[(8)]
EF	Exposure Frequency (meals/year)	0	0	12[(8)]
Incidental Ingestion/Dermal Contact with Sediment				
C_{sed}	Exposure concentration for sediment (mg/kg)	Maximum or 95 UCL[(3)]	Maximum or 95 UCL[(3)]	Maximum or 95 UCL[(3)]
ED	Exposure Duration (years)	6[(2)]	10[(2)]	10[(2)]
IR	Ingestion Rate (mg/day)	200[(2)]	100[(2)]	100[(2)]
RBA	Relative bioavailability (unitless)	chemical specific	chemical specific	chemical specific
EF	Exposure Frequency (days/year)	100[(5)]	100[(5)]	50[(5)]
FI	Fraction Ingested (unitless)	0.5[(9)]	0.5[(9)]	0.5[(9)]
SA	Skin Surface Available for Contact (cm^2)	2,373[(2)]	3,750[(10)]	6,032[(2)]
AF	Soil to Skin Adherence Factor (mg/cm^2/event)	0.2[(11)]	0.2[(11)]	0.07[(11)]
ABS	Absorption Factor (unitless)	chemical specific	chemical specific	chemical specific
CF	Conversion Factor (kg/mg)	1E-06	1E-06	1E-06

1 - Adolescent ages 6 to 16 years old.
2 - USEPA, 2014: Human Health Evaluation Manual, Supplement Guidance, Update of Standard Default Exposure Factors. OSWER 9200.1-120.
3 - USEPA, 2002. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.
4 - USEPA Region 4, 2014: Region 4 Human Health Risk Assessment Supplement Guidance.
5 - Professional Judgment. Child and adolescent recreational users are assumed to be exposed four hours a day two days a week, and adult recreational users are assumed to be exposed four hours a day one day a week.
6 - USEPA, 2011: Exposure Factors Handbook: 2011 Edition. Mean total body surface area for combined male and females ages 6 to 16, Table 7-9 (USEPA, 2011).
7 - Assumes a serving size of 8 ounces.
8 - Professional judgment. Assumes one meal per month. Frequency is consistent with the Long Island South Shore Fish Advisory for women under 50 and children under 15 (http://www.health.ny.gov/publications/6532.pdf).
9 - Professional judgment. Assumes intake of sediments is 50 of the predicted daily intake of soils.
10 - Assumes face, forearms, hands, and lower legs are exposed (USEPA, 2011). USEPA, 2011: Exposure Factors Handbook: 2011 Edition. Derivation of surface area included in Attachment F.
11 - USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

TABLE 2-11

SUMMARY STATISTICS FOR DETECTED METALS PARAMETERS ANALYZED IN SEDIMENT SAMPLES IN THE VICINITY OF SOUTHERN LONG ISLAND (NCCOS DATA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

	Benthic Surveillance (1984 to 1989)[1]				Hudson Raritan Estuary (1991)				Long Island Sound (1991)			
Parameter (mg/kg)	Count	Maximum	Minimum	Average	Count	Maximum	Minimum	Average	Count	Maximum	Minimum	Average
Aluminum	8	55500	37800	45900	27	790	210	548	54	7000	3880	5840
Antimony	5	0.48	0	0.23	27	7.8	0.16	2.3	54	2.24	0.13	0.80
Arsenic	8	21.7	2.6	8.2	23	41	4.2	20.9	53	12.3	1.7	8.5
Cadmium	8	1.7	0.061	0.62	26	6.4	0.18	1.9	54	3.99	0.43	1.8
Chromium	8	138	30.3	68	26	420	50	136	54	461	62	134
Copper	8	112	4.4	42.7	27	520	11	168	54	246	19.7	146
Iron	8	46200	21200	29800	27	490	72	358	54	4170	1480	3690
Lead	8	160	15.1	60.8	27	510	30	186	54	461	34.5	136
Manganese	8	1790	479	1040	27	1700	270	748	54	1370	480	695
Mercury	8	1.94	0	0.53	27	15	0.14	2.67	54	1.5	0.10	0.79
Nickel	8	36.1	8.8	19.1	26	130	8.5	43.2	54	227	13.8	43.6
Selenium	8	0.542	0	0.18	27	4.3	0.21	1.2	53	1.35	0.29	0.77
Silicon	3	388000	337000	361000					54	34.3	18.5	24
Silver	8	3.6	0.03	1.3	27	3	0.2	2.1	54	4.96	0.328	2.8
Thallium	3	0.33	0.055	0.20								
Tin	8	15.9	0.75	5.7	26	100	3.2	25.3	54	28.9	2.84	18.2
Zinc	8	309	40.8	145	27	1400	43	321	54	507	65	260

	Mussel Watch (1986-1997)[2]				Newark Bay (1993)				WTC Special Study (2002-2004)[3]			
Parameter (mg/kg)	Count	Maximum	Minimum	Average	Count	Maximum	Minimum	Average	Count	Maximum	Minimum	Average
Aluminum	29	60000	15300	42600	20	65200	32100	52000	13	66500	35800	54800
Antimony					20	8.2	0	0.41	10	282000	0.64	81000
Arsenic	29	23.2	0	8.1	20	16.7	1.94	10.4	13	17.9	8.3	14.6
Cadmium	29	2.47	0.0567	0.864	20	5.7	0.19	2.9	13	147	0.584	29.4
Chromium	29	180	0	84.9	20	277	29.8	133	13	139	60.2	103
Copper	29	170	4.3	71	20	232	14.7	128	13	40900	55.1	8350
Iron	29	42300	5470	24000					13	41400	343	24900
Lead	29	197	9.1	77.9	20	353	31.7	184	13	186	50.1	93
Manganese	25	1220	186	682					13	901	31.7	501
Mercury	29	3.29	0.012	0.66	20	4.3	0.14	2.22	13	2.2	0.48	1
Nickel	29	43.7	3	24.9	20	74.4	17.5	40.8	13	373	15.2	88
Selenium	29	1.4	0	0.45	20	1.3	0.10	0.81	13	0.84	0.35	0.63
Silicon									10	315000	0.898	195000
Silver	29	5.57	0.041	1.8	20	5.7	0	3.0	13	5.7	0.52	2.3
Thallium												
Tin	29	30	0	5.9	20	82.9	4.9	40.4	13	25.7	9.7	14.3
Zinc	29	367	23.3	150	20	720	55.9	356	13	378	3.0	161

Source: National Centers for Coastal Ocean Science (NCCOS) National Status and Trends (NS&T) Data Portal. Accessed March 3, 2016.
Data listed by studies conducted in the general vincity of the Southern Long Island Sound.
1 - Data from Long Island Sound and Raitan Bay.
2 - Data from Huson/Raritan estuary, Long Island, Long Island Sound, and Moriches Bay.
3 - Data from Hudson/Raritan estuary.

TABLE 2-12

SUMMARY STATISTICS FOR DETECTED PARAMETERS ANALYZED IN SEDIMENT SAMPLES FROM LONG ISLAND BAYS
COLLECTED IN 2013 (USGS DATA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Parameter	Western Bays Region				Great South Bay Region			
	Count	Maximum	Minimum	Average	Count	Maximum	Minimum	Average
Semi-Volatile Organics (ug/kg)								
1-Methyl-naphthalene	4	1.5	1	1.2	ND	ND	ND	ND
1-Methyl-phenanthrene	4	5.2	1.2	2.8	3	1.9	1.1	1
2,3,5-Trimethylnaphthalene	2	1.5	1.3	1.4	ND	ND	ND	ND
2,6-Dimethylnaphthalene	3	1.6	1.5	1.5	1	10	10	10
2-Methyl-naphthalene	4	3	1.3	2.3	2	1.4	1.1	1.3
Acenaphthene	3	2.5	1.2	1.8	ND	ND	ND	ND
Acenaphthylene	3	3.6	1.2	2.3	ND	ND	ND	ND
Anthracene	5	11.2	2.3	4.6	4	1.3	1	1.2
benz[a]-Anthracene	5	58.1	9.7	22.1	10	11.4	1.1	3.8
benzo[a]Pyrene	5	60.7	4.1	22.1	10	11	1	3.7
benzo[b]-Fluoranthene	6	77.6	1.05	25.2	10	13.7	1.3	5.2
benzo[e]Pyrene	5	51	7.2	21.1	10	9.9	1.1	3.9
benzo[g,h,i]-Perylene	5	28.9	5.3	13.0	10	6.9	1.3	3.0
benzo[k]-Fluoranthene	5	66.5	8.7	26.1	10	14	1	4.7
Biphenyl	2	1.2	1	1.1	ND	ND	ND	ND
Chrysene	6	88.5	1.05	26.9	10	11.1	1.1	4.2
dibenz[a,h]-Anthracene	4	7.6	2.4	4.6	2	3.3	2.2	2.8
dibenzo-Thiophene	4	2.8	1.5	2.1	7	1.8	1	1.2
Fluoranthene	6	84.6	2	32.8	10	20.3	1.8	7.9
Fluorene	5	4.3	1.3	2.3	2	1.1	1	1.1
indeno[1,2,3-c,d]-Pyrene	5	38.1	6.1	16.4	10	8.1	1.3	3.7
Naphthalene	5	5.6	1.5	3.8	10	2.5	1.1	1.7
Perylene	4	9.5	1.7	4.9	4	2	1.1	1.6
Phenanthrene	6	34.1	1.42	14.1	10	6.8	1.7	4.2
Pyrene	6	59.5	2.05	26.1	10	18	1.7	7.1
Inorganics (mg/kg)								
Aluminum	6	70735	29135	44542	12	40420	8154	18125
Antimony	4	0.9	0.2	0.5	1	0.1	0.1	0.1
Arsenic	6	14.6	1.5	7.6	11	9.2	0.1	3.0
Barium	6	449	234	308	12	297	77.4	156
Beryllium	6	2.05	0.3	1.2	9	0.9	0.1	0.4
Cadmium	4	0.95	0.2	0.58	1	0.1	0.1	0.10
Chromium	6	88.6	28.2	53.5	12	48.5	4.5	17.1
Cobalt	6	10.5	2.5	5.9	11	6.2	0.1	1.8
Copper	6	42.9	6.8	25.6	12	31.8	0.8	8.5
Iron	6	40509	14618	24093	12	22500	2118	8579
Lead	6	54.3	17.1	31.9	12	36.5	2	11.9
Manganese	6	784	400	575	12	1867	142	524
Mercury	6	0.72	0.05	0.33	11	0.25	0.01	0.06
Molybdenum	4	3.4	0.8	2.2	3	0.7	0.2	0.5
Nickel	6	26.8	5.9	14.5	12	13.7	0.1	4.0

TABLE 2-12

SUMMARY STATISTICS FOR DETECTED PARAMETERS ANALYZED IN SEDIMENT SAMPLES FROM LONG ISLAND BAYS
COLLECTED IN 2013 (USGS DATA)
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Parameter	Western Bays Region				Great South Bay Region			
	Count	Maximum	Minimum	Average	Count	Maximum	Minimum	Average
Selenium	4	0.95	0.2	0.69	1	0.1	0.1	0.10
Silver	6	0.7	0.2	0.44	8	0.3	0.1	0.15
Strontium	6	219	108	148	12	162	38.5	79
Thallium	4	0.55	0.2	0.36	1	0.1	0.1	0.10
Tin	6	9.85	1.5	4.6	7	3.8	0.1	1.3
Titanium	6	6449	4016	5044	12	4626	948	1959
Vanadium	6	110	36.9	65.7	12	65.5	7.3	24.1
Zinc	6	120	32.6	76.8	12	120	3.9	32.2

ND - not detected in any sample.
Source: USGS, 2015. Estuarine bed-sediment-quality data collected in New Jersey and New York after Hurricane Sandy, 2013.

TABLE 2-13

SUMMARY STATISTICS FOR DETECTED PARAMETERS ANALYZED IN SEDIMENT SAMPLES FROM SOUTHERN LONG ISLAND WATERSHED COLLECTED 2009 (USEPA STORET DATA) PUBLIC HEALTH EVALUATION GRAND CANAL, OAKDALE, NEW YORK

Parameter	Count	Maximum	Minimum	Average
Semi-Volatile Organics (ug/kg)				
Acenaphthylene	1	22	22	22
Anthracene	2	28	9.7	18.9
Benz[a]anthracene	3	110	26	60.7
Benzo(b)fluoranthene	3	97	37	58
Benzo[a]pyrene	3	110	32	63
Benzo[ghi]perylene	3	65	22	39.3
Benzo[k]fluoranthene	3	87	26	51
Chrysene	3	120	47	76
Dibenz[a,h]anthracene	1	22	22	22
Fluoranthene	3	270	26	132
Indeno[1,2,3-cd]pyrene	3	65	21	38
Phenanthrene	2	91	41	66
Pyrene	3	240	28	126
Inorganics (mg/kg)				
Aluminum	4	953	258	646
Ammonia-nitrogen	4	17	7.5	11.1
Arsenic	1	1.5	1.5	1.5
Barium	4	57	9.7	25.4
Calcium	4	950	146	411
Chromium	4	3	2	2.5
Copper	2	4.9	2.9	3.9
Iron	4	2930	1100	2210
Lead	2	8.1	7.8	8.0
Magnesium	2	604	143	374
Manganese	4	2630	40.3	993
Phosphorus	4	122	47.8	79.2
Selenium	1	1.6	1.6	1.6
Zinc	3	16.8	12.8	14.9
Miscellaneous (%)				
Particle size, Sieve No. 200, 200 mesh, (0.075mm)	4	7.2	3.7	5.0
Carbon, Total Organic (Toc)	1	1.2	1.2	1.2
Total solids	4	75.2	61.6	70.9
Total volatile solids	1	4.6	4.6	4.6
Organic carbon	4	1.58	0.43	0.80

Source: USEPA STORET DataWarehouse. Suffolk County, New York. Accessed May 26, 2016.
Summary statistics are for detected results only.
Searched years 2008 to 2014. Data only available for 4 locations collected in 2009.

TABLE 2-14

SUMMARY OF RECREATIONAL RISKS AND HAZARD INDICES FOR EXPOSURES TO SURFACE WATER
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Direct Contact

Chemical	95 UCL (µg/L)	Incremental Lifetime Carcinogenic Risk (ILCR)		Estimated Non-Carcinogenic Hazard Quotient (HQ)		
		Direct Contact[1] (g/L)	Estimated ILCR	Primary Target Organs	Direct Contact[1] (g/L)	Estimated HQ
July 2015 samples						
Bis(2-ethylhexyl)phthalate	16.7	200	8E-08	Liver	5500	0.003
August 2015 samples						
Bis(2-ethylhexyl)phthalate	2.3	200	1E-08	Liver	5500	0.0004
August 2015 samples (WET)						
Bis(2-ethylhexyl)phthalate	4.5	200	2E-08	Liver	5500	0.0008
September 2015 samples (DRY)						
Bis(2-ethylhexyl)phthalate[2]	90.3	200	5E-07	Liver	5500	0.02

Fish Ingestion

Chemical	95 UCL (µg/L)	Incremental Lifetime Carcinogenic Risk (ILCR)		Estimated Non-Carcinogenic Hazard Quotient (HQ)		
		Fish Ingestion[1] (g/L)	Estimated ILCR	Primary Target Organs	Fish Ingestion[1] (g/L)	Estimated HQ
July 2015 samples						
Bis(2-ethylhexyl)phthalate	16.7	1.21	1E-05	Liver	125	0.1
August 2015 samples						
Bis(2-ethylhexyl)phthalate	2.3	1.21	2E-06	Liver	125	0.02
August 2015 samples (WET)						
Bis(2-ethylhexyl)phthalate	4.5	1.21	4E-06	Liver	125	0.04
September 2015 samples (DRY)						
Bis(2-ethylhexyl)phthalate[2]	90.3	1.21	7E-05	Liver	125	0.7

Direct Contact Fish Ingestion

Chemical	95 UCL (µg/L)	Incremental Lifetime Carcinogenic Risk (ILCR)		Estimated Non-Carcinogenic Hazard Quotient (HQ)		
		Direct Contact Fish Ingestion[1] (g/L)	Estimated ILCR	Primary Target Organs	Direct Contact Fish Ingestion[1] (g/L)	Estimated HQ
July 2015 samples						
Bis(2-ethylhexyl)phthalate	16.7	1.2	1E-05	Liver	123	0.1
August 2015 samples						
Bis(2-ethylhexyl)phthalate	2.3	1.2	2E-06	Liver	123	0.02
August 2015 samples (WET)						
Bis(2-ethylhexyl)phthalate	4.5	1.2	4E-06	Liver	123	0.04
September 2015 samples (DRY)						
Bis(2-ethylhexyl)phthalate[2]	90.3	1.2	8E-05	Liver	123	0.7

1 - Recreational screening levels and fish ingestion values were calculated with USEPA's Regional Screening Level Calculator (see Attachment D).
2 - Maximum concentration presented; UCL exceeds maximum detection.
HQ Hazard Quotient
ILCR Incremental Lifetime Carcinogenic Risk
UCL Upper Confidence Limit

Target Risk Levels: cumulative ILCR 1E-04 for carcinogens, cumulative HI 1 for noncarcinogens

TABLE 2-15

SUMMARY OF RECREATIONAL RISKS AND HAZARD INDICES FOR EXPOSURES TO SEDIMENT
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

Direct Contact

Chemical	95 UCL (mg/kg)	Incremental Lifetime Carcinogenic Risk (ILCR)		Estimated Non-Carcinogenic Hazard Quotient (HQ)		
		Direct Contact[1] (mg/kg)	Estimated ILCR	Primary Target Organs	Direct Contact[1] (mg/kg)	Estimated HQ
2,3,7,8-TCDD Equivalents	0.0000042 [2]	0.000030	1E-07	Reproductive	0.00034	0.01
4,4'-DDD	0.25	12	2E-08	NA	NA	NA
4,4'-DDE	0.062	8.1	8E-09	NA	NA	NA
4,4'-DDT	0.0913 [2]	11	8E-09	Liver	240	0.0004
Arsenic	12.2	3.9	3E-06	Skin, CVS	220	0.06
Chromium (hexavalent)	28.5	2	1E-05	None Specified	1600	0.02
Chromium (trivalent)	28.5	NA	NA	None Specified	820,000	0.00003
Copper	77.8	NA	NA	Gastrointestinal	22000	0.004
Nickel	16.6	NA	NA	Body weight	11000	0.002
Zinc	108	NA	NA	Blood	160000	0.0007
Mercury	0.51	NA	NA	Central Nervous System	160	0.003
		Risk assuming chromium is present in hexavalent form	**2E-05**		HI assuming chromium is present in hexavalent form	**0.09**
		Risk assuming chromium is present in trivalent form	**3E-06**		HI assuming chromium is present in trivalent form	**0.08**

Fish Ingestion

Chemical	95 UCL (mg/kg)	Incremental Lifetime Carcinogenic Risk (ILCR)		Estimated Non-Carcinogenic Hazard Quotient (HQ)		
		Fish Ingestion[1] (mg/kg)	Estimated ILCR	Primary Target Organs	Fish Ingestion[1] (mg/kg)	Estimated HQ
2,3,7,8-TCDD Equivalents	0.0000042 [2]	0.0000030	1E-06	Reproductive	0.00010	0.04
4,4'-DDD	0.25	0.14	2E-06	NA	NA	NA
4,4'-DDE	0.062	0.0037	2E-05	NA	NA	NA
4,4'-DDT	0.0913 [2]	0.017	5E-06	Liver	1.1	0.08
Arsenic	12.2	0.28	4E-05	Skin, CVS	47	0.3
Chromium (hexavalent)	28.5	0.12	2E-04	None Specified	69	0.4
Chromium (trivalent)	28.5	NA	NA	None Specified	34,000	0.0008
Copper	77.8	NA	NA	Gastrointestinal	82	0.9
Nickel	16.6	NA	NA	Body weight	92	0.2
Zinc	108	NA	NA	Blood	430	0.3
Mercury	0.51	NA	NA	Central Nervous System	1.1	0.5
		Risk assuming chromium is present in hexavalent form	**3E-04**		HI assuming chromium is present in hexavalent form	**3** [3]
		Risk assuming chromium is present in trivalent form	**7E-05**		HI assuming chromium is present in trivalent form	**2** [3]

Direct Contact Fish Ingestion

Chemical	95 UCL (mg/kg)	Incremental Lifetime Carcinogenic Risk (ILCR)		Estimated Non-Carcinogenic Hazard Quotient (HQ)		
		Direct Contact Fish Ingestion[1] (mg/kg)	Estimated ILCR	Primary Target Organs	Direct Contact Fish Ingestion[1] (mg/kg)	Estimated HQ
2,3,7,8-TCDD Equivalents	0.0000042 [2]	0.0000027	2E-06	Reproductive	0.000077	0.05
4,4'-DDD	0.25	0.14	2E-06	NA	NA	NA
4,4'-DDE	0.062	0.0037	2E-05	NA	NA	NA
4,4'-DDT	0.0913 [2]	0.017	5E-06	Liver	1.1	0.08
Arsenic	12.2	0.26	5E-05	Skin, CVS	38	0.3
Chromium (hexavalent)	28.5	0.12	2E-04	None Specified	66	0.4
Chromium (trivalent)	28.5	NA	NA	None Specified	33,000	0.0009
Copper	77.8	NA	NA	Gastrointestinal	81	1.0
Nickel	16.6	NA	NA	Body weight	92	0.2
Zinc	108	NA	NA	Blood	430	0.3
Mercury	0.51	NA	NA	Central Nervous System	1.1	0.5
		Risk assuming chromium is present in hexavalent form	**3E-04**		HI assuming chromium is present in hexavalent form	**3** [3]
		Risk assuming chromium is present in trivalent form	**7E-05**		HI assuming chromium is present in trivalent form	**2** [3]

1 - Recreational screening levels and fish ingestion values were calculated with USEPA's Regional Screening Level Calculator (see Attachment D).
2 - Maximum concentration presented. UCL was not calculated as there were less than 4 detections.
3 - Target organs less than or equal to HI of 1.
CVS Cardiovascular System
HI Hazard Index
HQ Hazard Quotient
ILCR Incremental Lifetime Carcinogenic Risk
NA Not Applicable
Target Risk Levels: cumulative ILCR 1E-04 for carcinogens, cumulative HI 1 for noncarcinogens

TABLE 3-2

BACTERIOLOGICAL RESULTS FOR SURFACE WATER SAMPLES COLLECTED FROM THE GRAND CANAL DURNG THE JULY 15, 2015 TIDAL SURFACE WATER SAMPLING EVENT
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

SAMPLE ID	**2012 Recreational Water Quality Criteria (cfu/100 mL)(1)**		**New York State Standards (number/100 mL)(2)**		GC-1C	GC-2C	GC-4C	GC-5C	GC-6C	GC-7C	GC-8C	GC-9C	GC-10C
SAMPLE DATE	**GM**	**STV**	**Water Quality**	**Shellfish**	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015
ANALYTE (MPN/100 mL)													
Enterococci	35	130	NA	NA	>2419.6	>2419.6	2420	1730	>2419.6	>2419.6	2420	866	1550
Total Coliform	NA	NA	2400	70	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600
Fecal Coliforms	NA	NA	200	14	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600

SAMPLE ID	**2012 Recreational Water Quality Criteria (cfu/100 mL)(1)**		**New York State Standards (number/100 mL)(2)**		GC-12C	GC-11C	GC-11D	GC-12D	GC-1D	GC-2D	GC-4D	GC-5D	GC-6D
SAMPLE DATE	**GM**	**STV**	**Water Quality**	**Shellfish**	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015
ANALYTE (MPN/100 mL)													
Enterococci	35	130	NA	NA	261	553	770	548	1200	>2419.6	1120	1300	>2419.6
Total Coliform	NA	NA	2400	70	1600	900	>1600	>1600	>1600	>1600	>1600	>1600	>1600
Fecal Coliforms	NA	NA	200	14	1600	900	>1600	>1600	>1600	>1600	>1600	>1600	>1600

SAMPLE ID	**2012 Recreational Water Quality Criteria**		**New York State Standards (number/100 mL)(2)**		GC-7D	GC-8D	GC-9D	GC-10D	Replicate	GC-12A	GC-11a	GC-1a	GC-2a
SAMPLE DATE	**GM**	**STV**	**Water Quality**	**Shellfish**	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015
ANALYTE (MPN/100 mL)													
Enterococci	35	130	NA	NA	>2419.6	>2419.6	>2419.6	1410	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6
Total Coliform	NA	NA	2400	70	>1600	>1600	>1600	>1600	>1600	1600	900	>1600	>1600
Fecal Coliforms	NA	NA	200	14	>1600	>1600	>1600	>1600	>1600	1600	900	>1600	>1600

SAMPLE ID	**2012 Recreational Water Quality Criteria**		**New York State Standards (number/100 mL)(2)**		GC-4a	GC-5a	GC-6A	GC-7A	GC-8A	GC-9A	GC-10A	GC-1B	GC-2B
SAMPLE DATE	**GM**	**STV**	**Water Quality**	**Shellfish**	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015
ANALYTE (MPN/100 mL)													
Enterococci	35	130	NA	NA	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6
Total Coliform	NA	NA	2400	70	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600
Fecal Coliforms	NA	NA	200	14	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600

SAMPLE ID	**2012 Recreational Water Quality Criteria**		**New York State Standards (number/100 mL)(2)**		GC-4B	GC-5B	GC-6B	GC-7B	GC-8B	GC-9B	GC-10B	GC-12B	GC-11B
SAMPLE DATE	**GM**	**STV**	**Water Quality**	**Shellfish**	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015
ANALYTE (MPN/100 mL)													
Enterococci	35	130	NA	NA	2420	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6	579	1050
Total Coliform	NA	NA	2400	70	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600
Fecal Coliforms	NA	NA	200	14	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600	>1600

1 - USEPA, 2012. Based on estimated illness rate of 36 per 1,000 primary contact recreators.
2 - 6 CRR NY 703.4.

cfu - Colony forming units
GM - Geometric mean
MPN - Most probable number
STV - Statistical threshold value

TABLE 3-3

BACTERIOLOGICAL RESULTS FOR SURFACE WATER SAMPLES COLLECTED FROM THE GRAND CANAL DURING THE AUGUST 27, 2015 TIDAL SURFACE WATER SAMPLING EVENT
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

SAMPLE ID	2012 Recreational Water Quality Criteria (cfu/100 mL)(1)		New York State Standards (number/100 mL)(2)		GC-1C	GC-2C	GC-4C	GC-5C	GC-6C	GC-7C	GC-8C	GC-9C	GC-10C	GC-11C	GC-12C
SAMPLE DATE	GM	STV	Water Quality	Shellfish	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015
ANALYTE (MPN/100 mL)															
Enterococci	35	130	NA	NA	3080	2600	1580	805	2280	3650	1670	1130	691	63.0	60.0
Total Coliform	NA	NA	2400	70	16000	9000	220	500	16000	9000	16000	3000	9000	3000	800
Fecal Coliforms	NA	NA	200	14	16000	9000	220	500	16000	9000	16000	3000	9000	3000	500

SAMPLE ID	2012 Recreational Water Quality Criteria		New York State Standards		GC-1D	GC-2D	GC-4D	GC-5D	GC-6D	GC-7D	GC-8D	GC-9D	GC-10D	GC-11D	GC-12D
SAMPLE DATE	GM	STV	Water Quality	Shellfish	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015	8/27/2015
ANALYTE (MPN/100 mL)															
Enterococci	35	130	NA	NA	1520	1330	13000	70.0	437	816	554	405	156	20.0	30.0
Total Coliform	NA	NA	2400	70	9000	5000	500	3000	16000	9000	9000	3000	2200	700	2400
Fecal Coliforms	NA	NA	200	14	9000	5000	500	3000	16000	9000	9000	3000	2200	700	2400

1 - USEPA, 2012. Based on estimated Illness rate of 36 per 1,000 primary contact recreators.
2 - 6 CRR NY 703.4.

cfu - Colony forming units
GM - Geometric mean
MPN - Most probable number
STV - Statistical threshold value

TABLE 3-4

BACTERIOLOGICAL RESULTS FOR STORM WATER SURFACE WATER RUN-OFF SAMPLES COLLECTED DURING THE AUGUST 11, 2015 WET SAMPLING EVENT
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

SAMPLE ID	**2012 Recreational Water Quality Criteria (cfu/100 mL)[1]**		**New York State Standards (number/100 mL)[2]**		SW 1	SW 2	SW 3	SW 4	SW 5	SW 6
SAMPLE DATE	**GM**	**STV**	**Water Quality**	**Shellfish**	8/11/2015	8/12/2015	8/13/2015	8/14/2015	8/15/2015	8/16/2015
ANALYTE (MPN/100 mL)										
Enterococci	35	130	NA	NA	275	1250	323	576	801	620
Total Coliform	NA	NA	2400	70	2200	5400	1300	2400	1400	700
Fecal Coliforms	NA	NA	200	14	300	5400	1300	500	700	700

1 - USEPA, 2012. Based on estimated Illness rate of 36 per 1,000 primary contact recreators.
2 - 6 CRR NY 703.4.

cfu - Colony forming units
GM - Geometric mean
MPN - Most probable number
STV - Statistical threshold value

TABLE 3-5

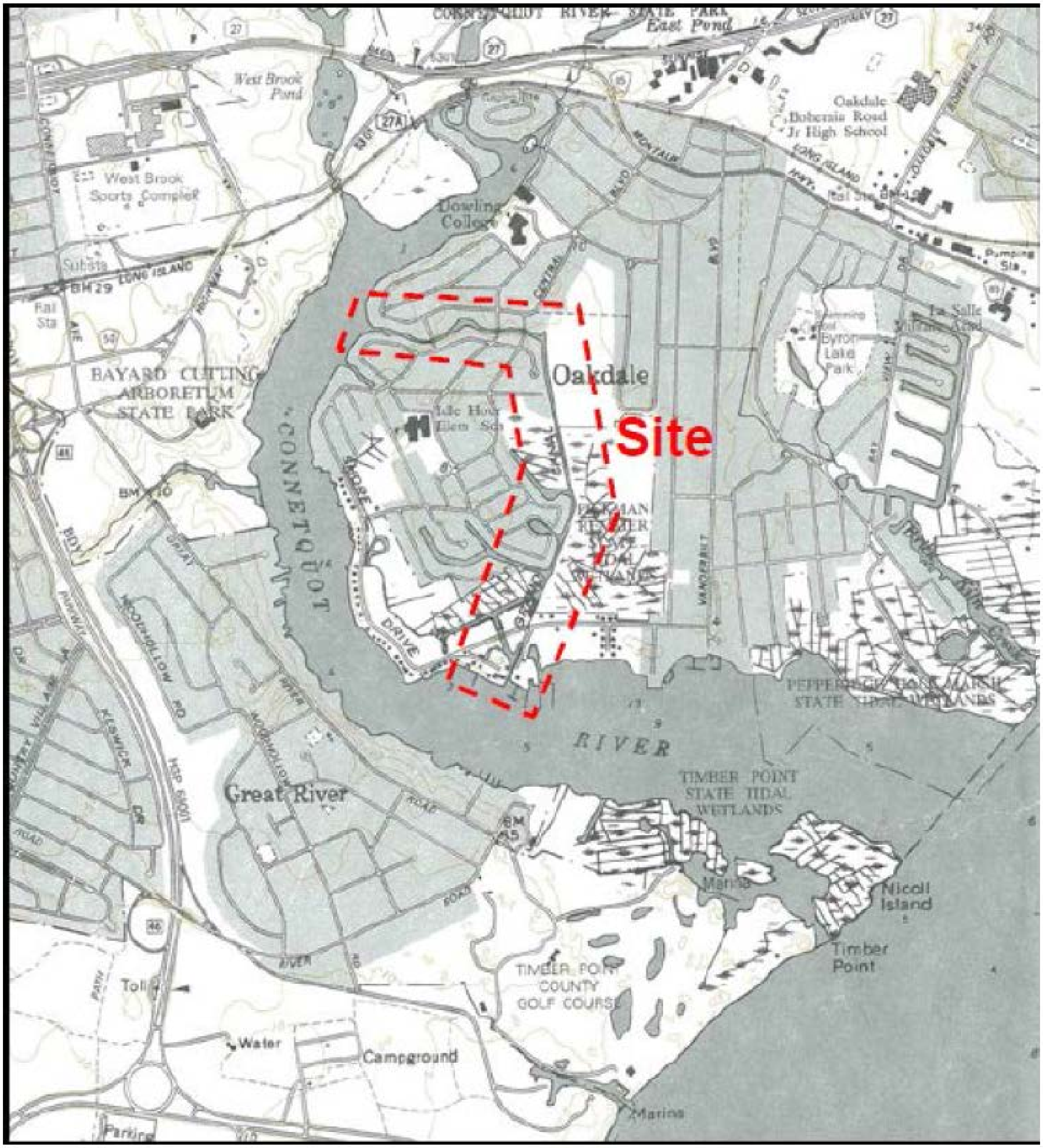
BACTERIOLOGICAL RESULTS FOR STORM WATER SURFACE WATER RUN-OFF SAMPLES COLLECTED DURING THE SEPTEMBER 3, 2015 DRY SAMPLING EVENT
PUBLIC HEALTH EVALUATION
GRAND CANAL, OAKDALE, NEW YORK

SAMPLE ID	**2012 Recreational Water Quality Criteria (cfu/100 mL)(1)**		**New York State Standards (number/100 mL)(2)**		SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	WL 1	WL 2	GC North	GC South	WL Ref 1	WL Ref 2
SAMPLE DATE	**GM**	**STV**	**Water Quality**	**Shellfish**	9/3/2015	9/3/2015	9/3/2015	9/3/2015	9/3/2015	9/3/2015	9/3/2015	9/3/2015	9/3/2015	9/3/2015	9/3/2015	9/3/2015
ANALYTE (MPN/100 mL)																
Enterococci	35	130	NA	NA	1100	355	20	148	703	1250	318	402	20	ND	776	292
Total Coliform	NA	NA	2400	70	3000	500	130	300	3000	3000	800	2400	220	300	2400	300
Fecal Coliforms	NA	NA	200	14	3000	500	130	300	3000	3000	800	2400	220	300	2400	300

1 - USEPA, 2012. Based on estimated Illness rate of 36 per 1,000 primary contact recreators.
2 - 6 CRR NY 703.4.

cfu - Colony forming units
GM - Geometric mean
MPN - Most probable number
STV - Statistical threshold value

FIGURES



Source: Cashin Associates, 2015

Figure 1. Overview of the Grand Canal Study Area.

Suffolk County Dept. of Health Services
Grand Canal Monitoring Locations

3/31/15

Figure 2. Sampling Locations for 2004 SCDHS/SCDPW and 2015 Cashin Associates Sample Events.

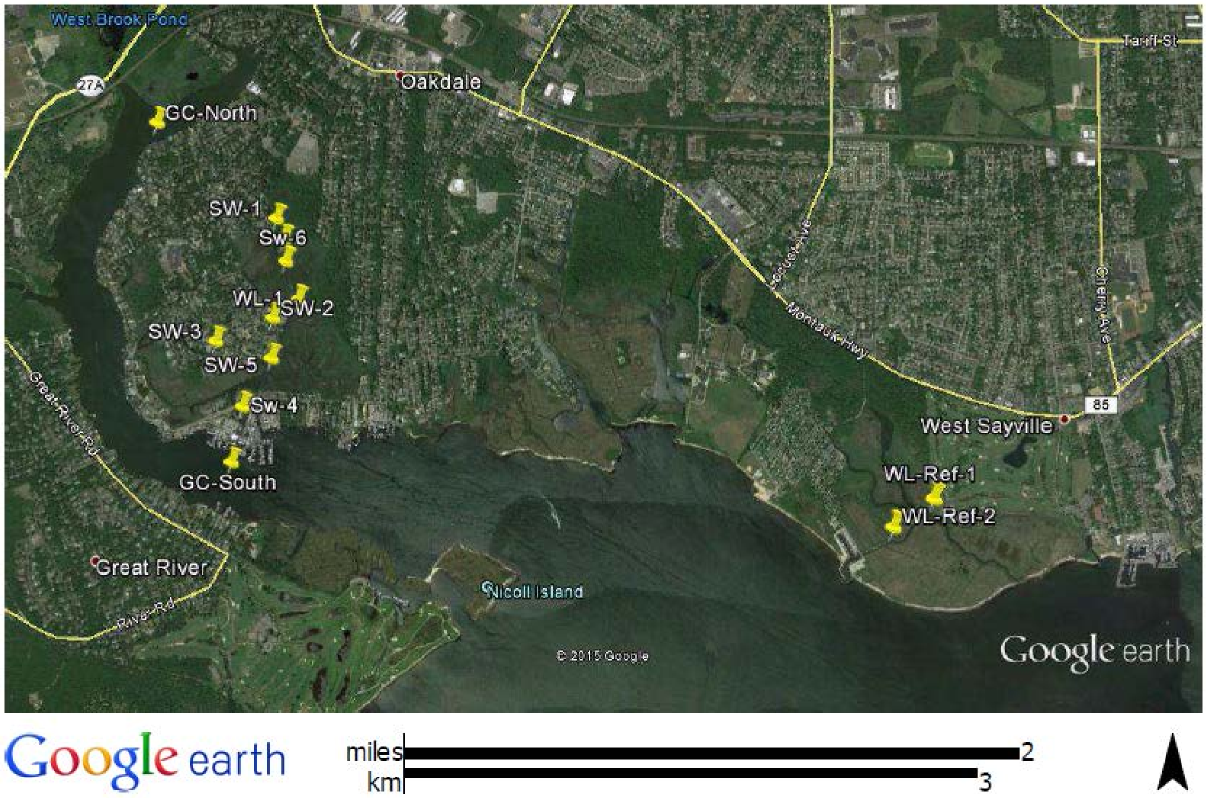


Figure 3. Sampling Locations for 2015 Cashin Associates Sample Events.

Figure 4
Total Nitrogen Concentrations in Surface Water Samples from July 15, 2015 Tidal Surface Water Sampling Event

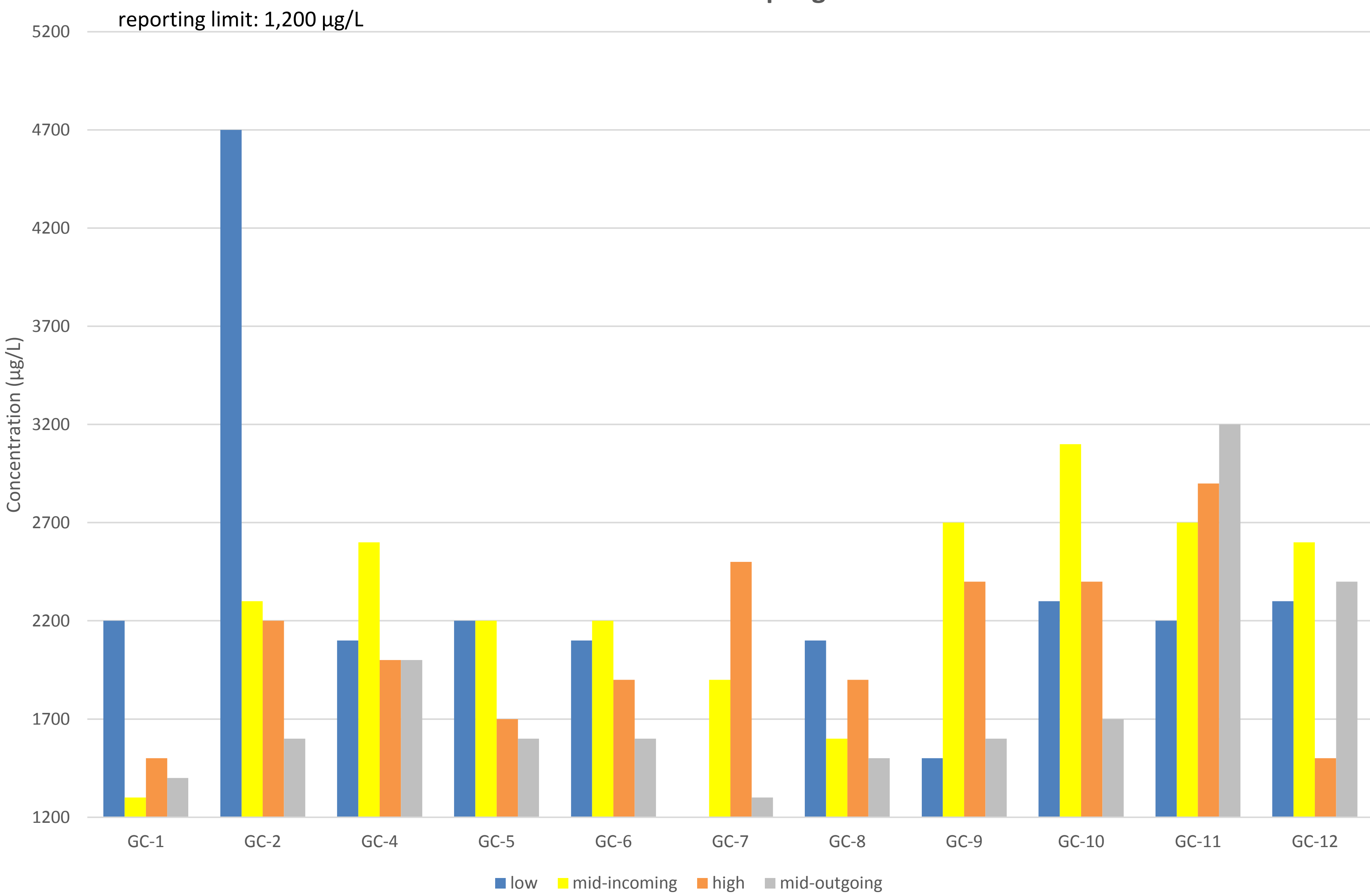
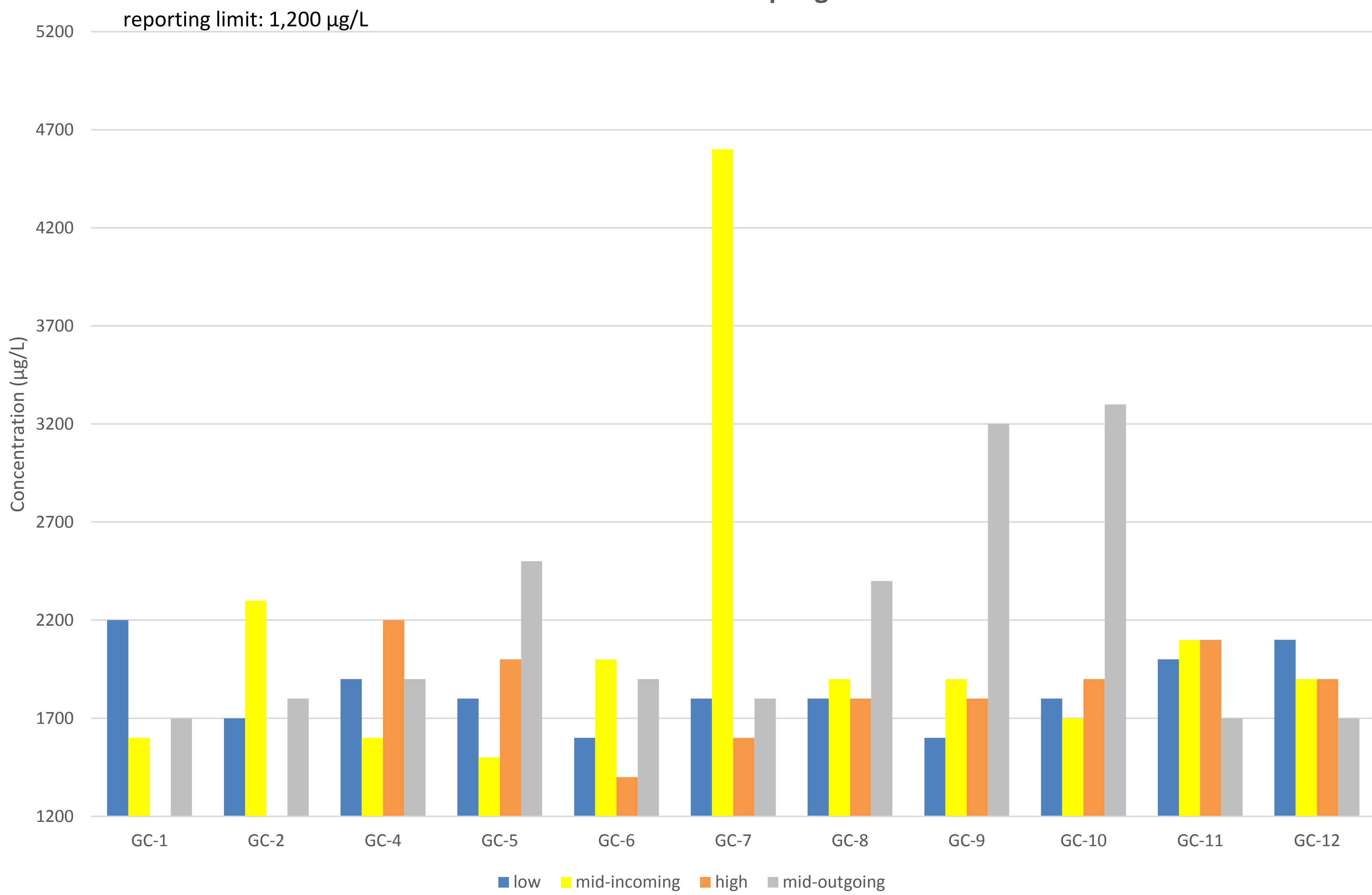


Figure 5
Total Nitrogen Concentrations in Surface Water Samples from August 27, 2015 Tidal Surface Water Sampling Event



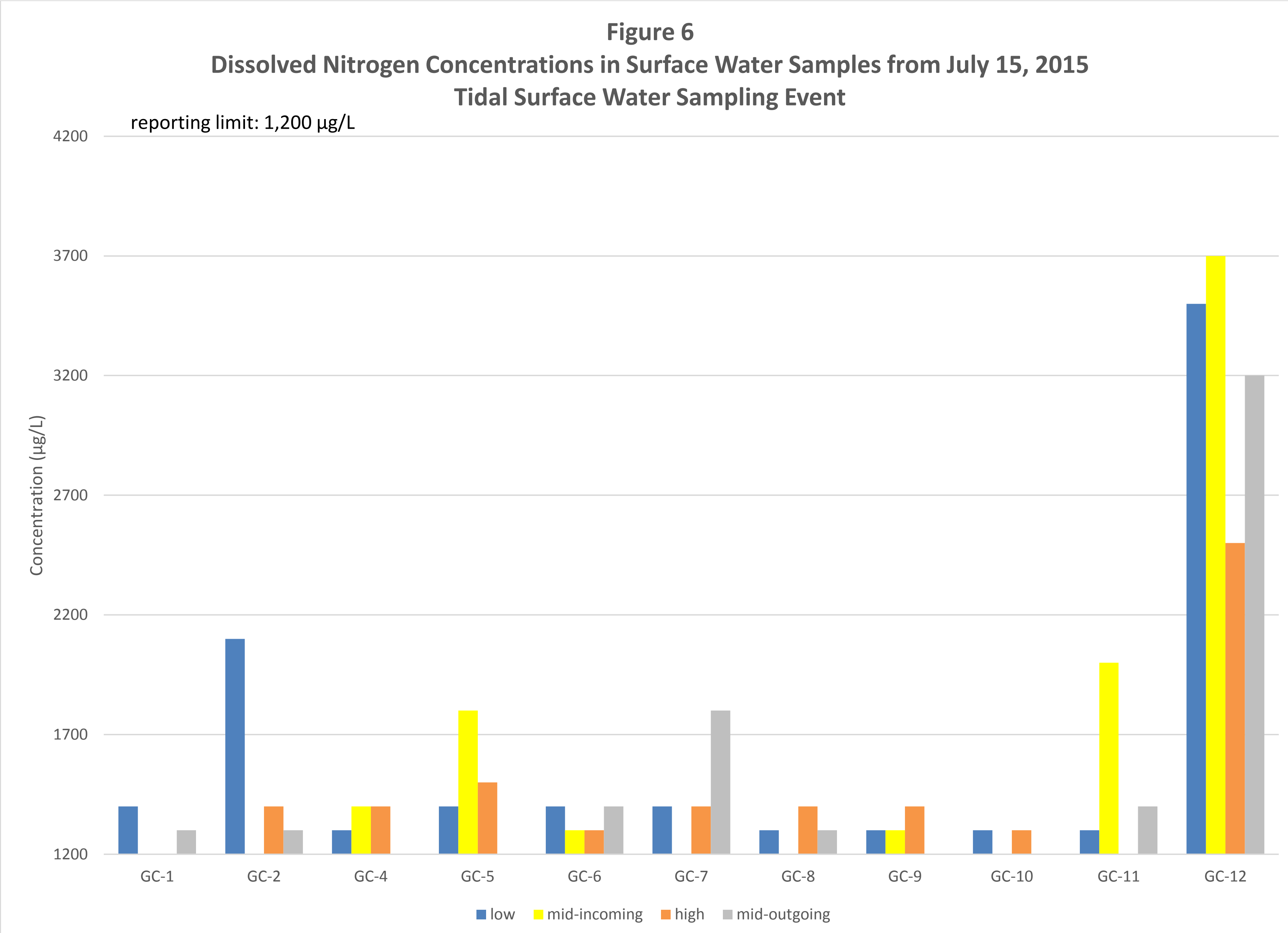


Figure 6
Dissolved Nitrogen Concentrations in Surface Water Samples from July 15, 2015
Tidal Surface Water Sampling Event
reporting limit: 1,200 µg/L
Concentration (µg/L)
4200
3700
3200
2700
2200
1700
1200
GC-1
GC-2
GC-4
GC-5
GC-6
GC-7
GC-8
GC-9
GC-10
GC-11
GC-12
low
mid-incoming
high
mid-outgoing

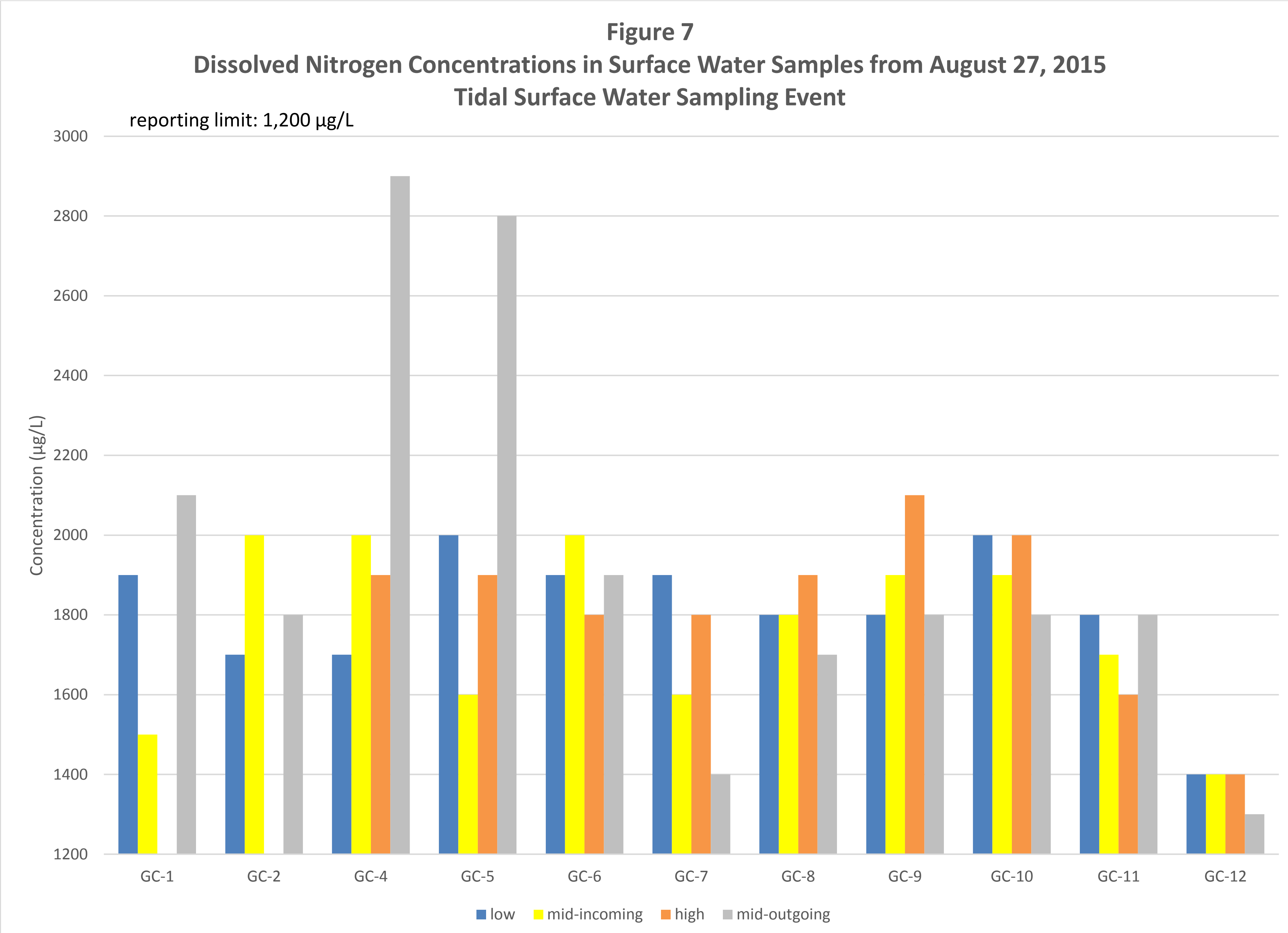


Figure 7
Dissolved Nitrogen Concentrations in Surface Water Samples from August 27, 2015
Tidal Surface Water Sampling Event
reporting limit: 1,200 µg/L
Concentration (µg/L)
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
GC-1
GC-2
GC-4
GC-5
GC-6
GC-7
GC-8
GC-9
GC-10
GC-11
GC-12
low
mid-incoming
high
mid-outgoing

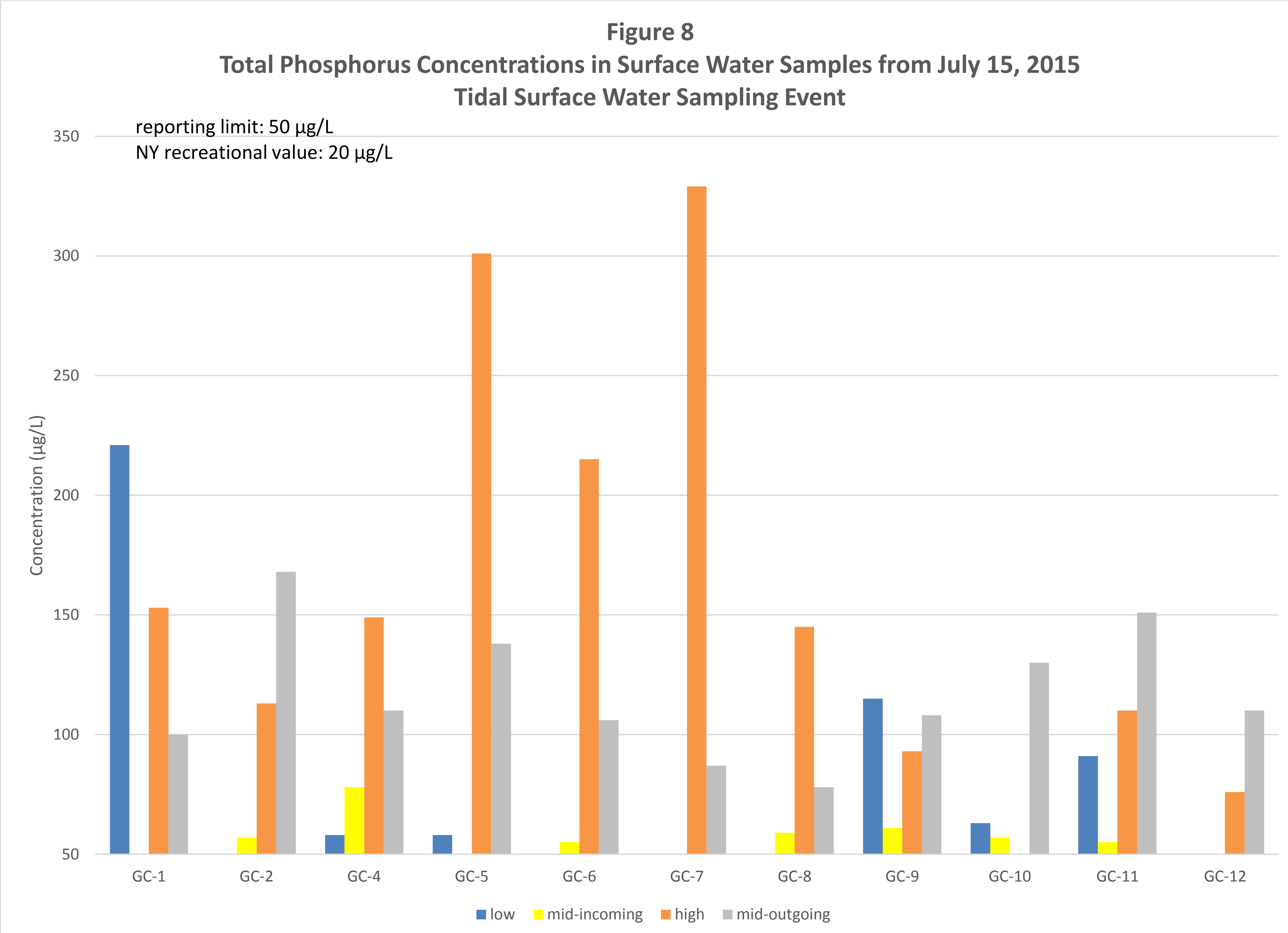


Figure 8
Total Phosphorus Concentrations in Surface Water Samples from July 15, 2015
Tidal Surface Water Sampling Event
reporting limit: 50 µg/L
NY recreational value: 20 µg/L
Concentration (µg/L)
350
300
250
200
150
100
50
GC-1
GC-2
GC-4
GC-5
GC-6
GC-7
GC-8
GC-9
GC-10
GC-11
GC-12
low
mid-incoming
high
mid-outgoing

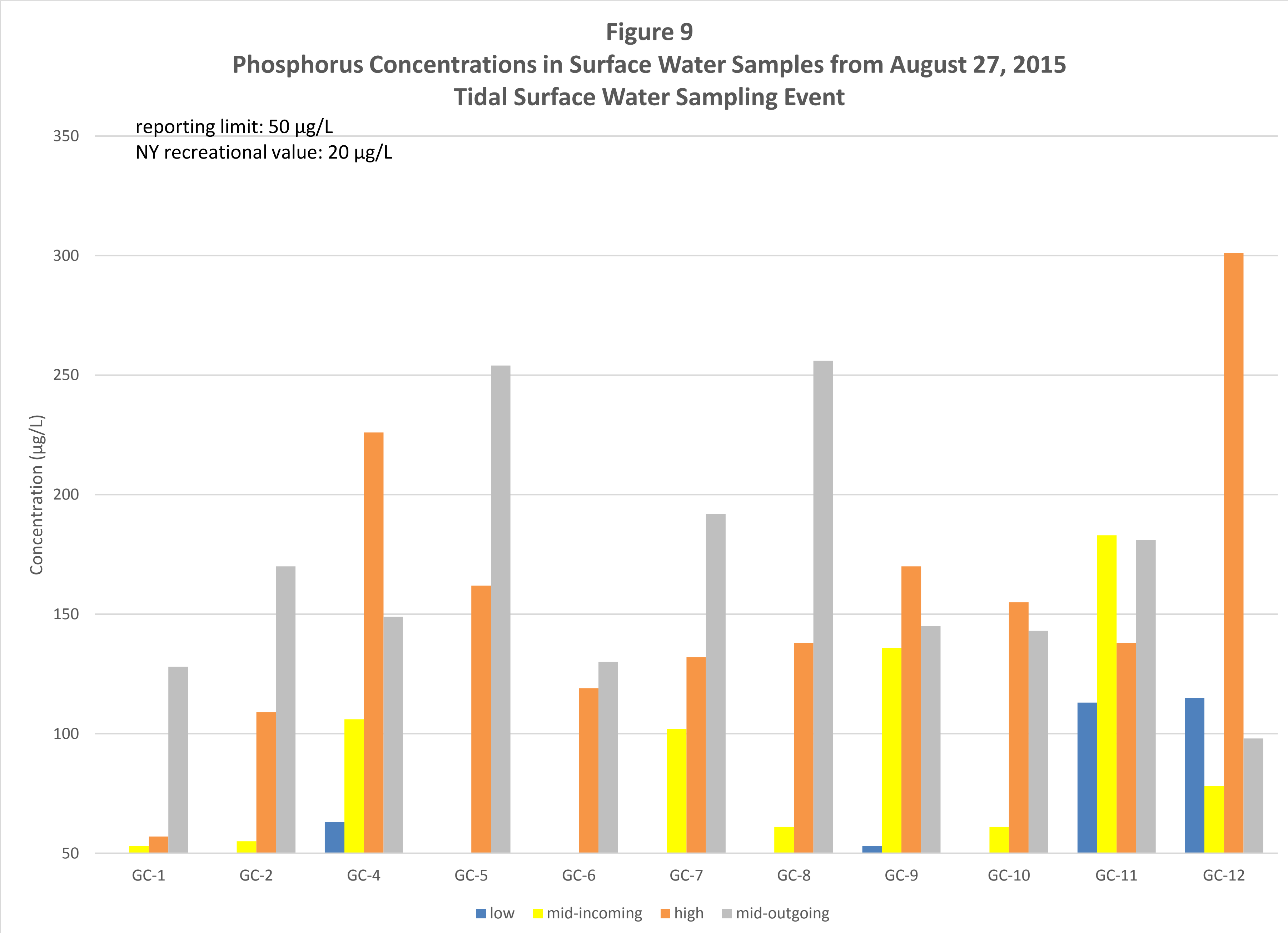


Figure 9
Phosphorus Concentrations in Surface Water Samples from August 27, 2015
Tidal Surface Water Sampling Event
reporting limit: 50 µg/L
NY recreational value: 20 µg/L
Concentration (µg/L)
350
300
250
200
150
100
50
GC-1
GC-2
GC-4
GC-5
GC-6
GC-7
GC-8
GC-9
GC-10
GC-11
GC-12
low
mid-incoming
high
mid-outgoing

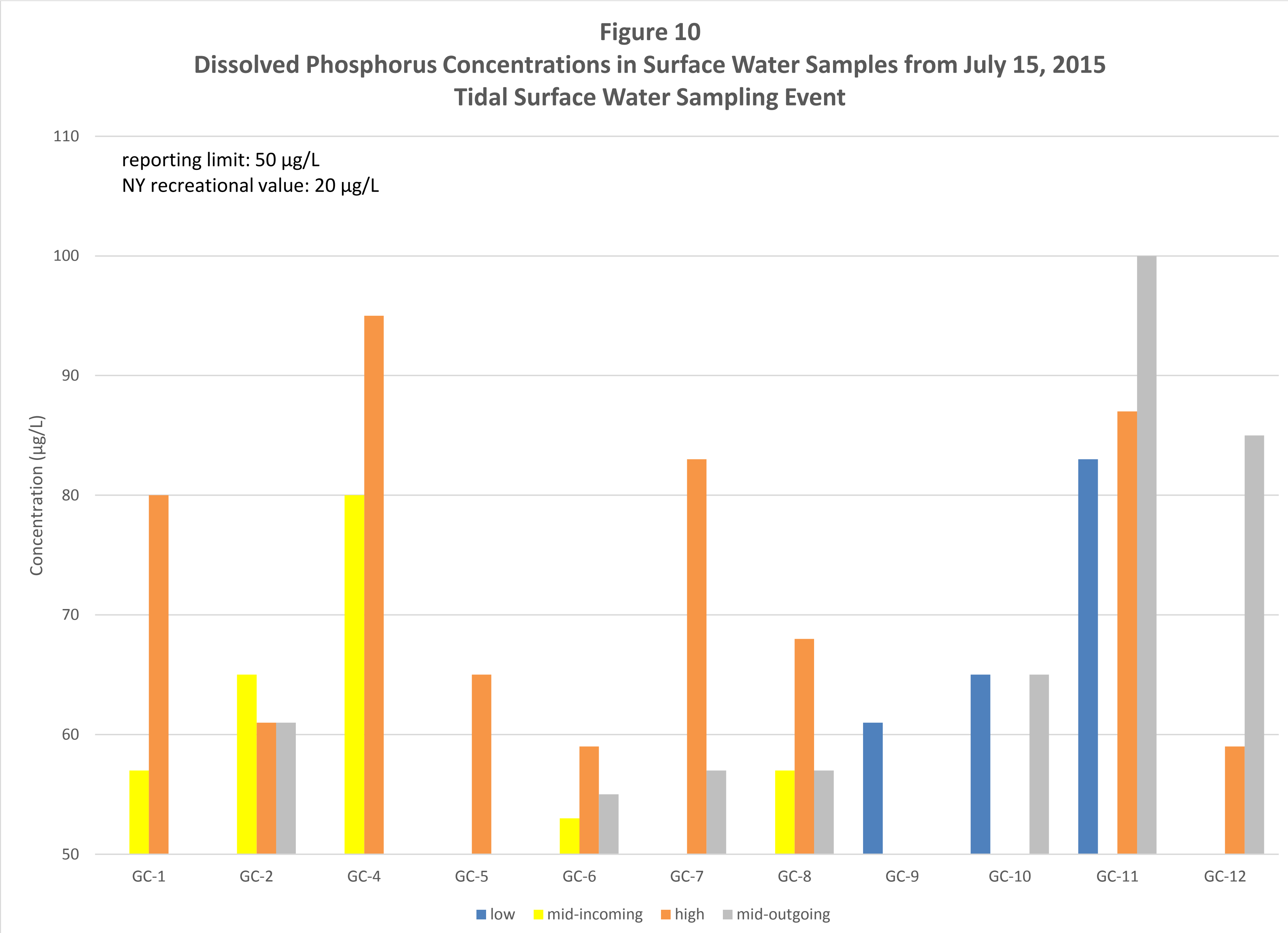


Figure 10
Dissolved Phosphorus Concentrations in Surface Water Samples from July 15, 2015
Tidal Surface Water Sampling Event
reporting limit: 50 µg/L
NY recreational value: 20 µg/L
Concentration (µg/L)
110
100
90
80
70
60
50
GC-1
GC-2
GC-4
GC-5
GC-6
GC-7
GC-8
GC-9
GC-10
GC-11
GC-12
low
mid-incoming
high
mid-outgoing

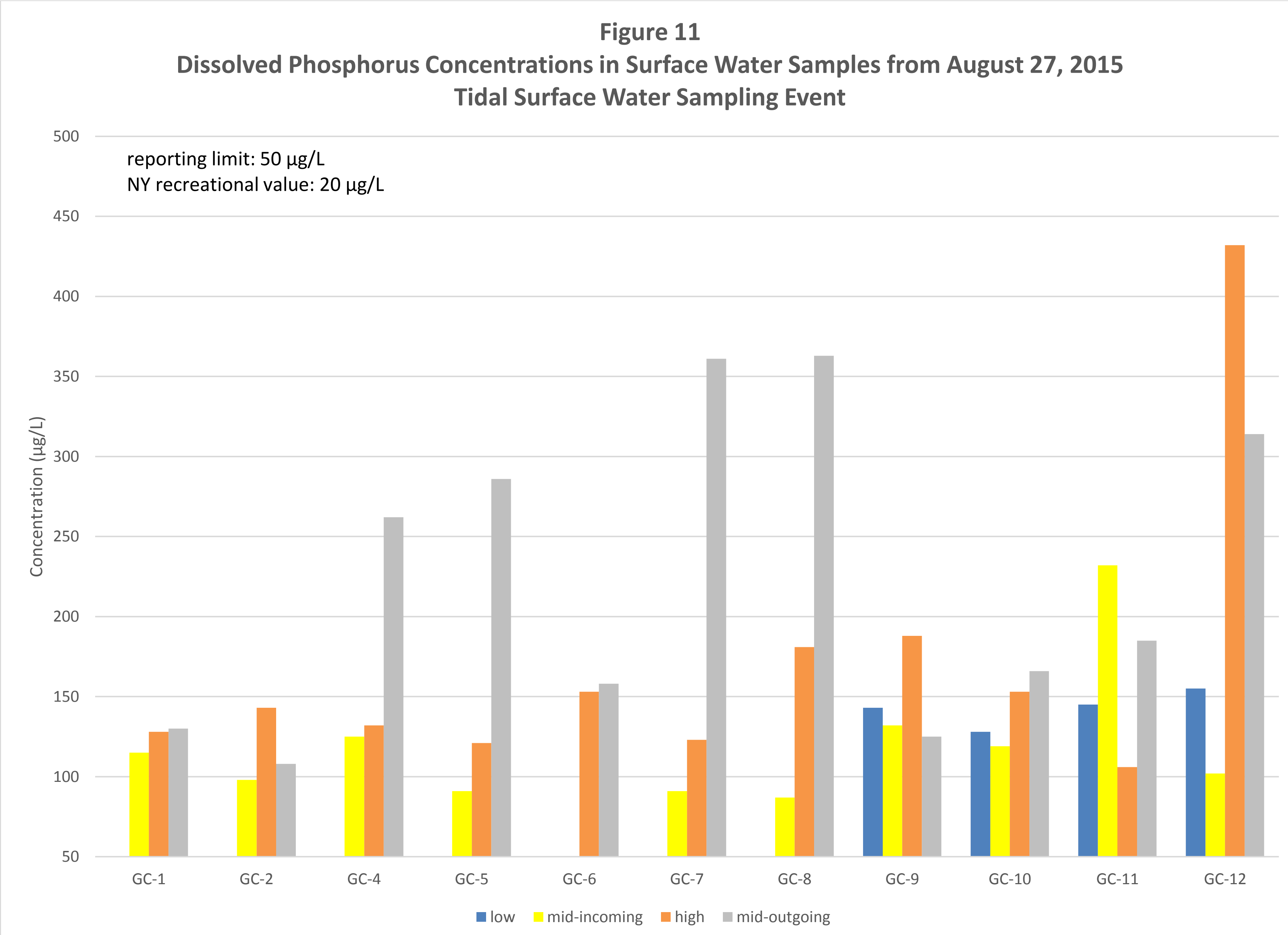


Figure 11
Dissolved Phosphorus Concentrations in Surface Water Samples from August 27, 2015
Tidal Surface Water Sampling Event
reporting limit: 50 µg/L
NY recreational value: 20 µg/L
Concentration (µg/L)
500
450
400
350
300
250
200
150
100
50
GC-1
GC-2
GC-4
GC-5
GC-6
GC-7
GC-8
GC-9
GC-10
GC-11
GC-12
low
mid-incoming
high
mid-outgoing

Figure 12
Water Quality Data for July 15, 2015 Tidal Surface Water Sampling Event - Temperature

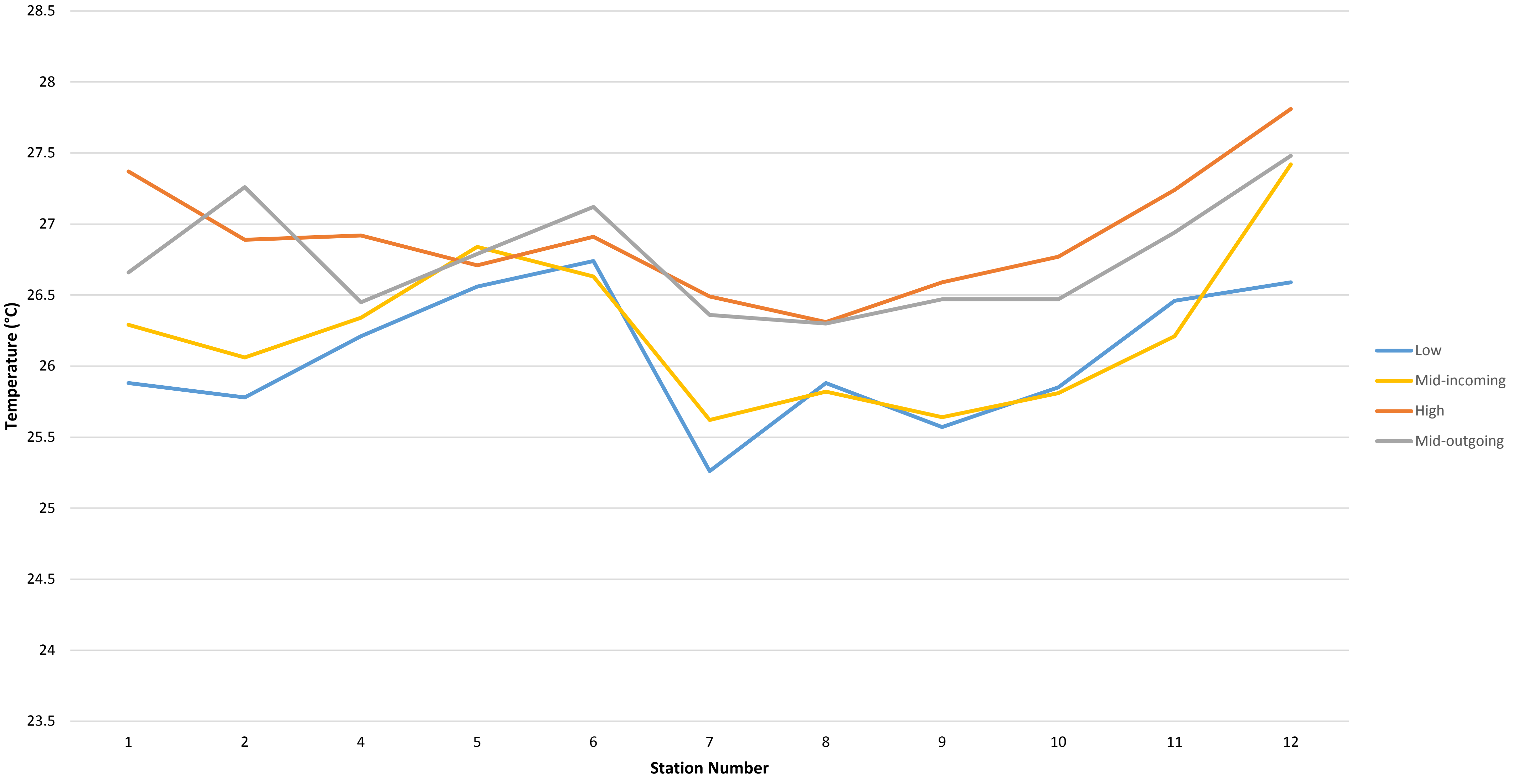


Figure 13
Water Quality Data for July 15, 2015 Tidal Surface Water Sampling Event – Dissolved Oxygen

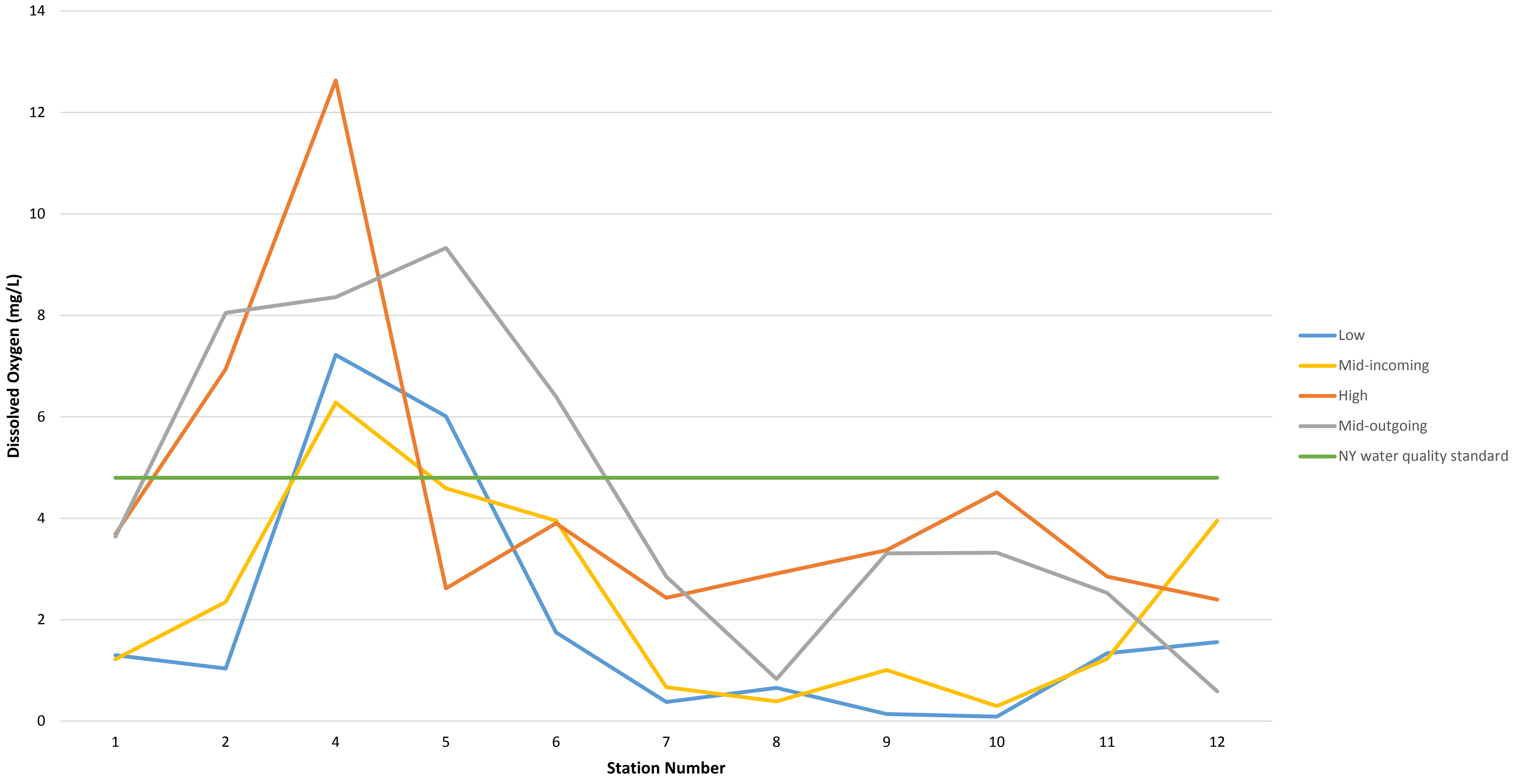


Figure 14
Water Quality Data for July 15, 2015 Tidal Surface Water Sampling Event – Salinity

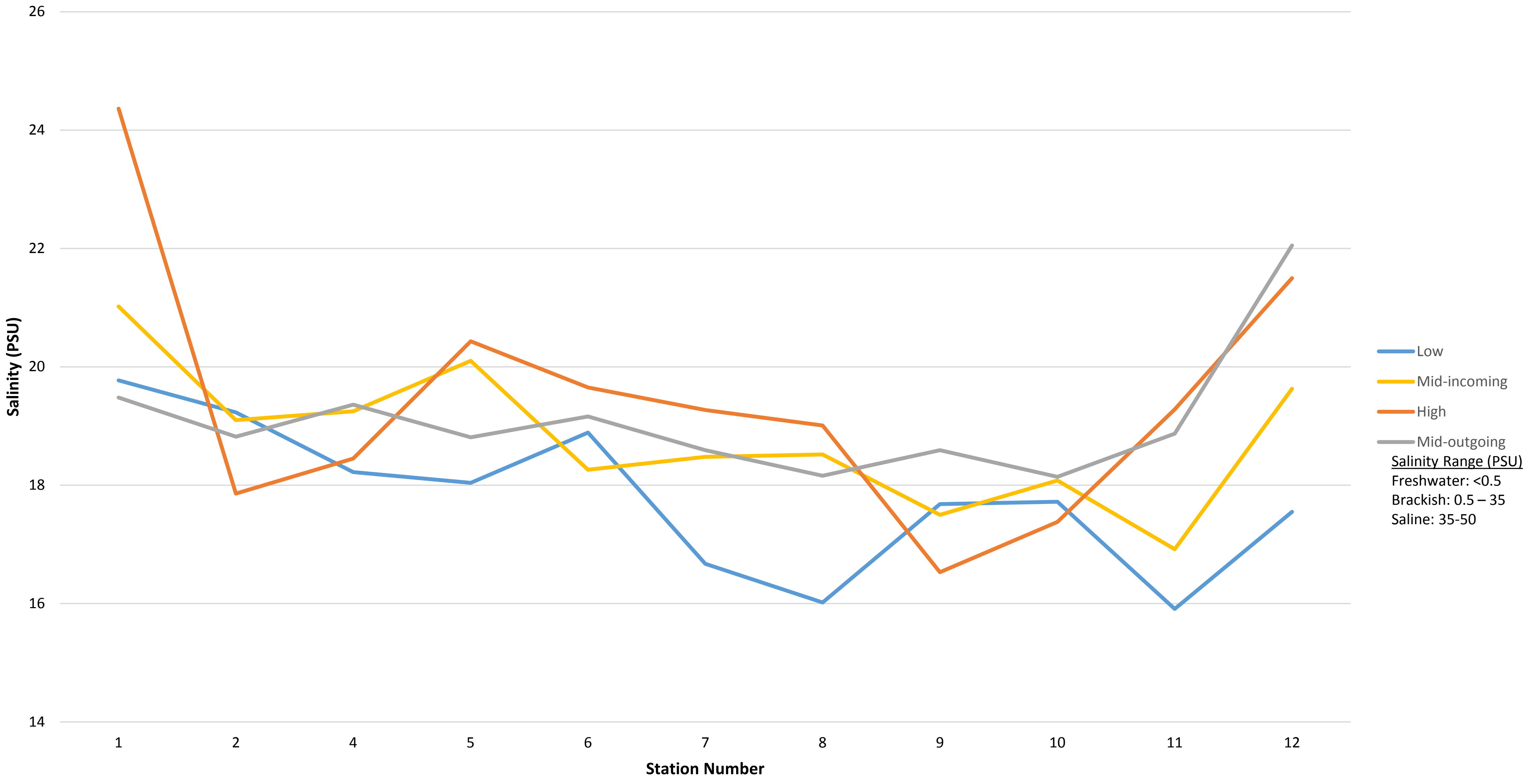


Figure 15
Water Quality Data for July 15, 2015 Tidal Surface Water Sampling Event - Turbidity

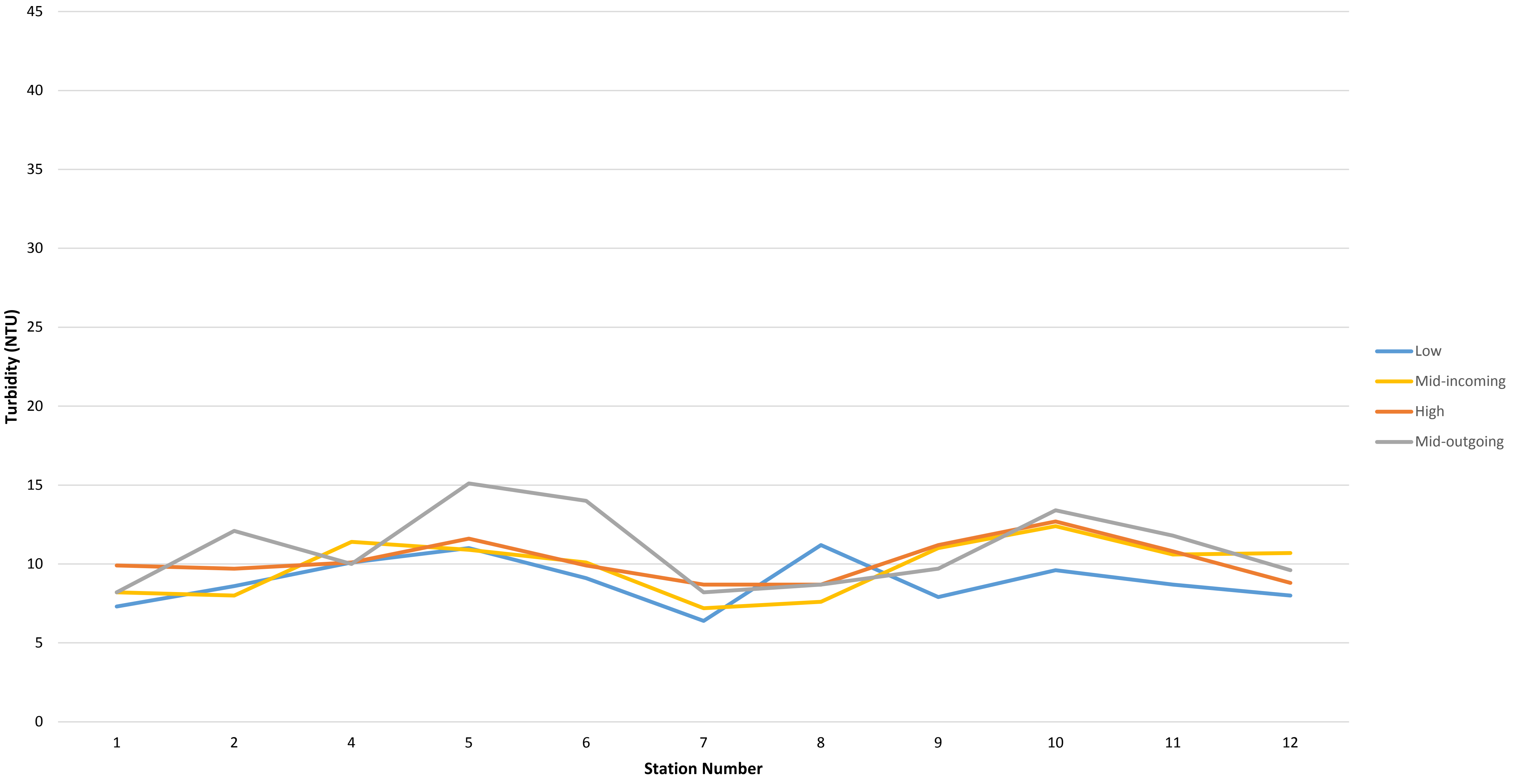


Figure 16
Water Quality Data for August 27, 2015 Tidal Surface Water Sampling Event – Temperature

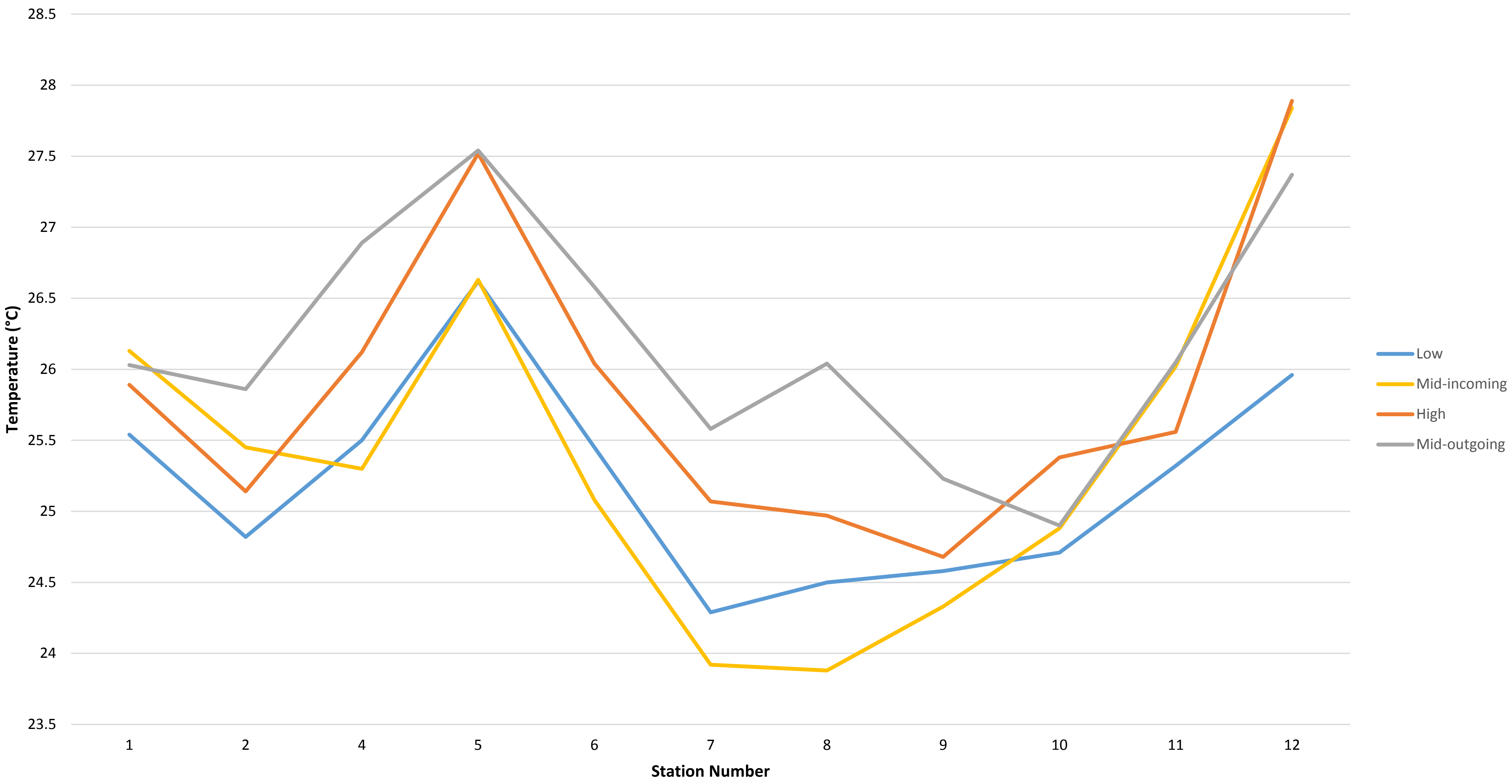


Figure 17
Water Quality Data for August 27, 2015 Tidal Surface Water Sampling Event – Dissolved Oxygen

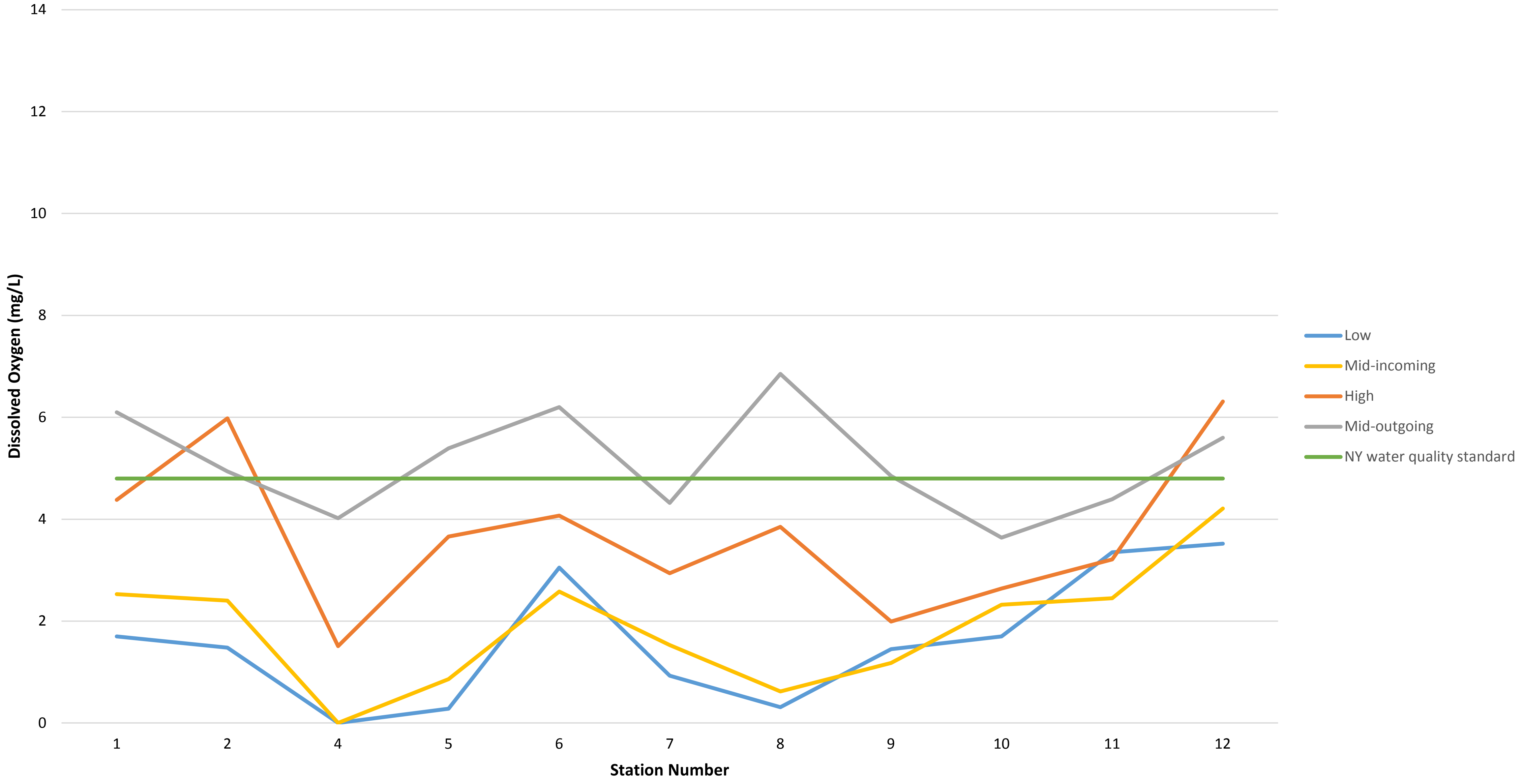


Figure 18
Water Quality Data for August 27, 2015 Tidal Surface Water Sampling Event – Salinity

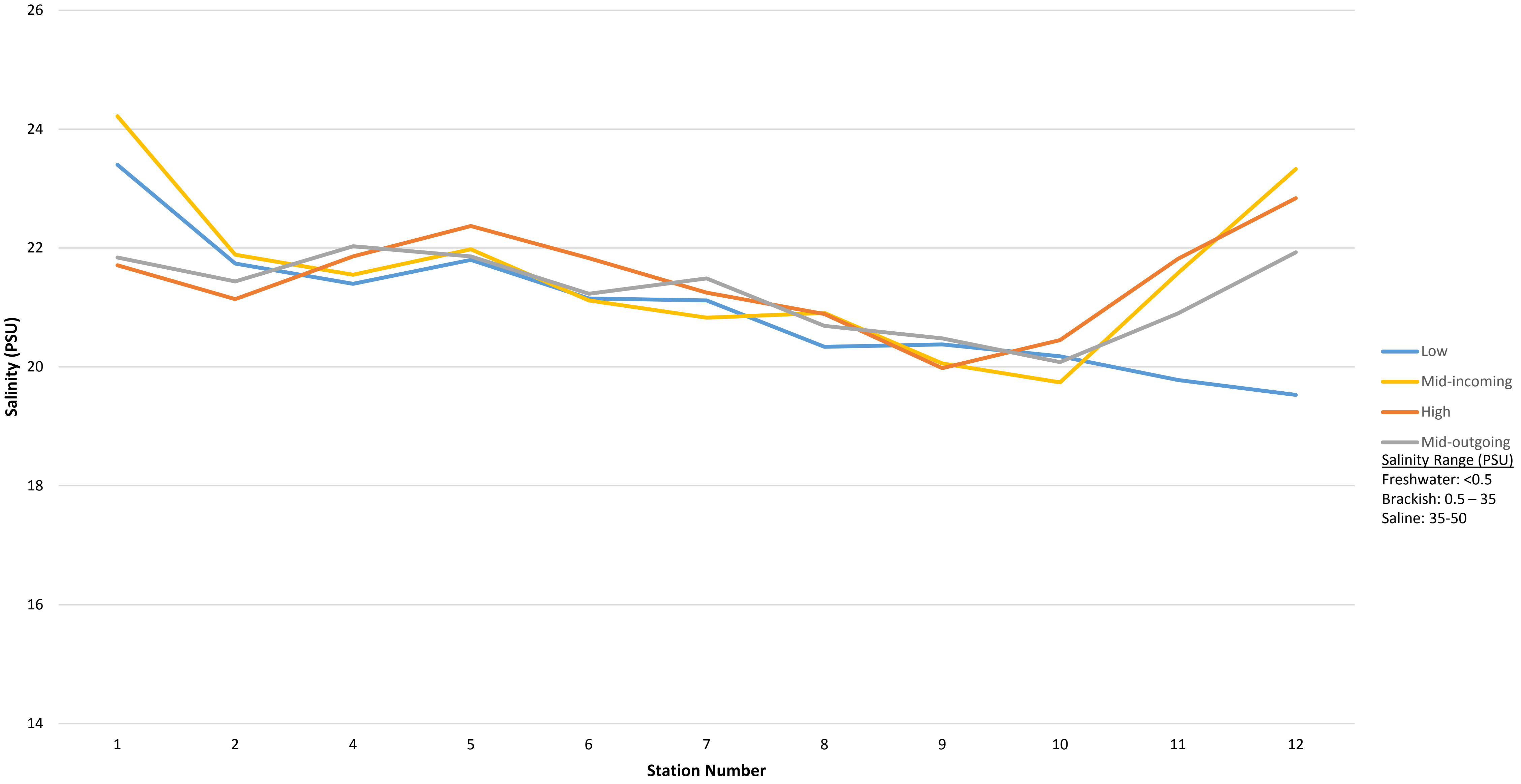
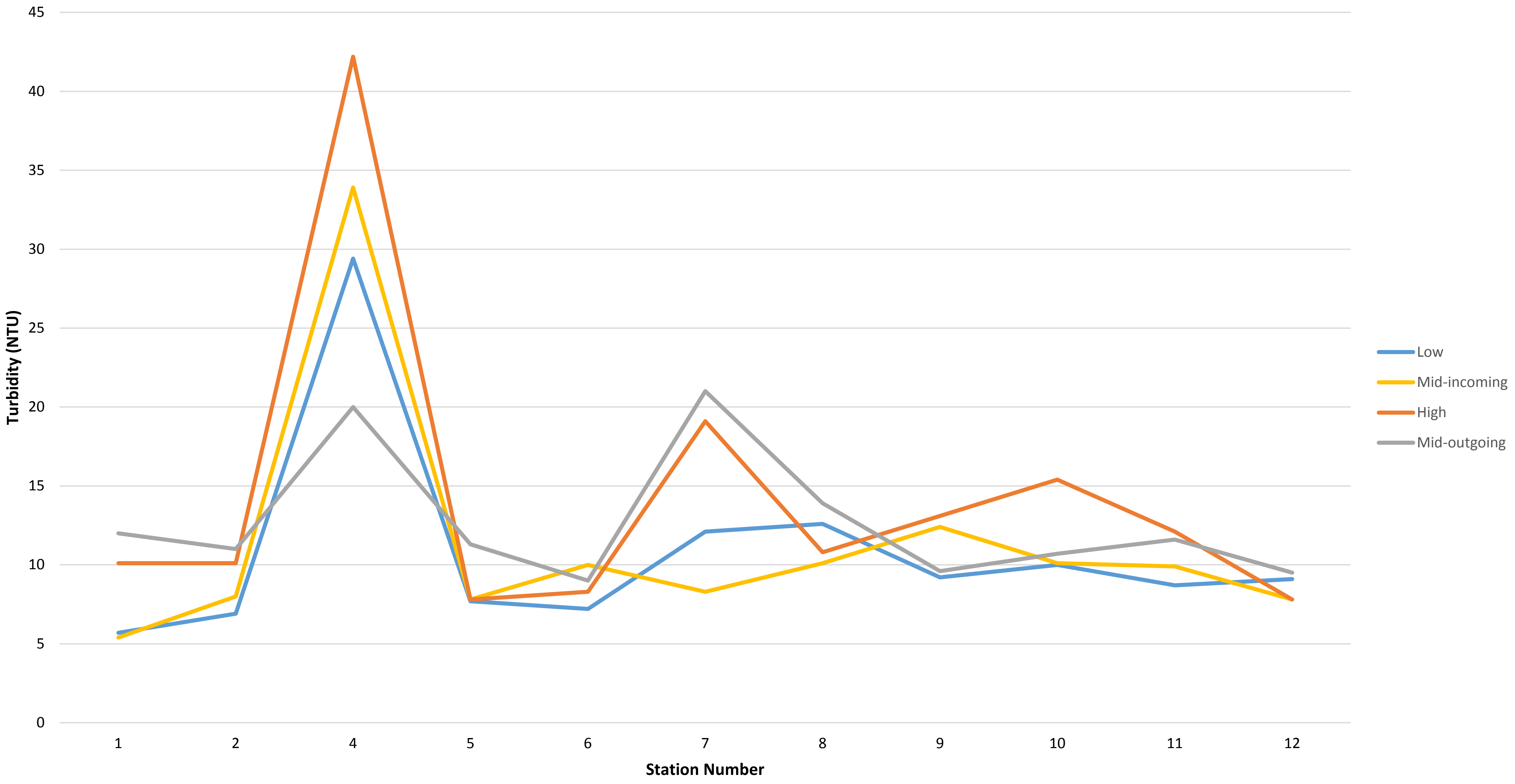


Figure 19
Water Quality Data for August 27, 2015 Tidal Surface Water Sampling Event – Turbidity



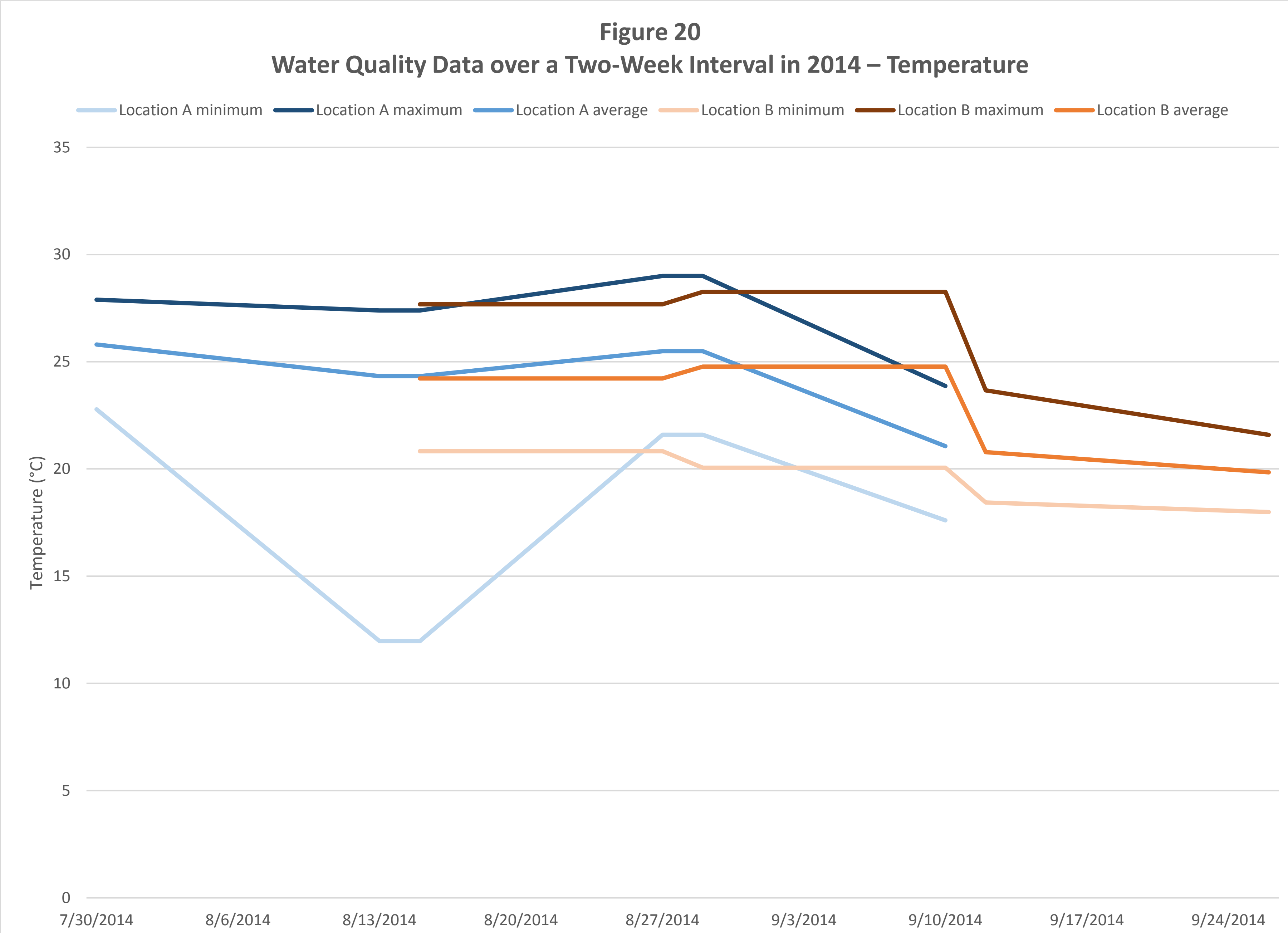
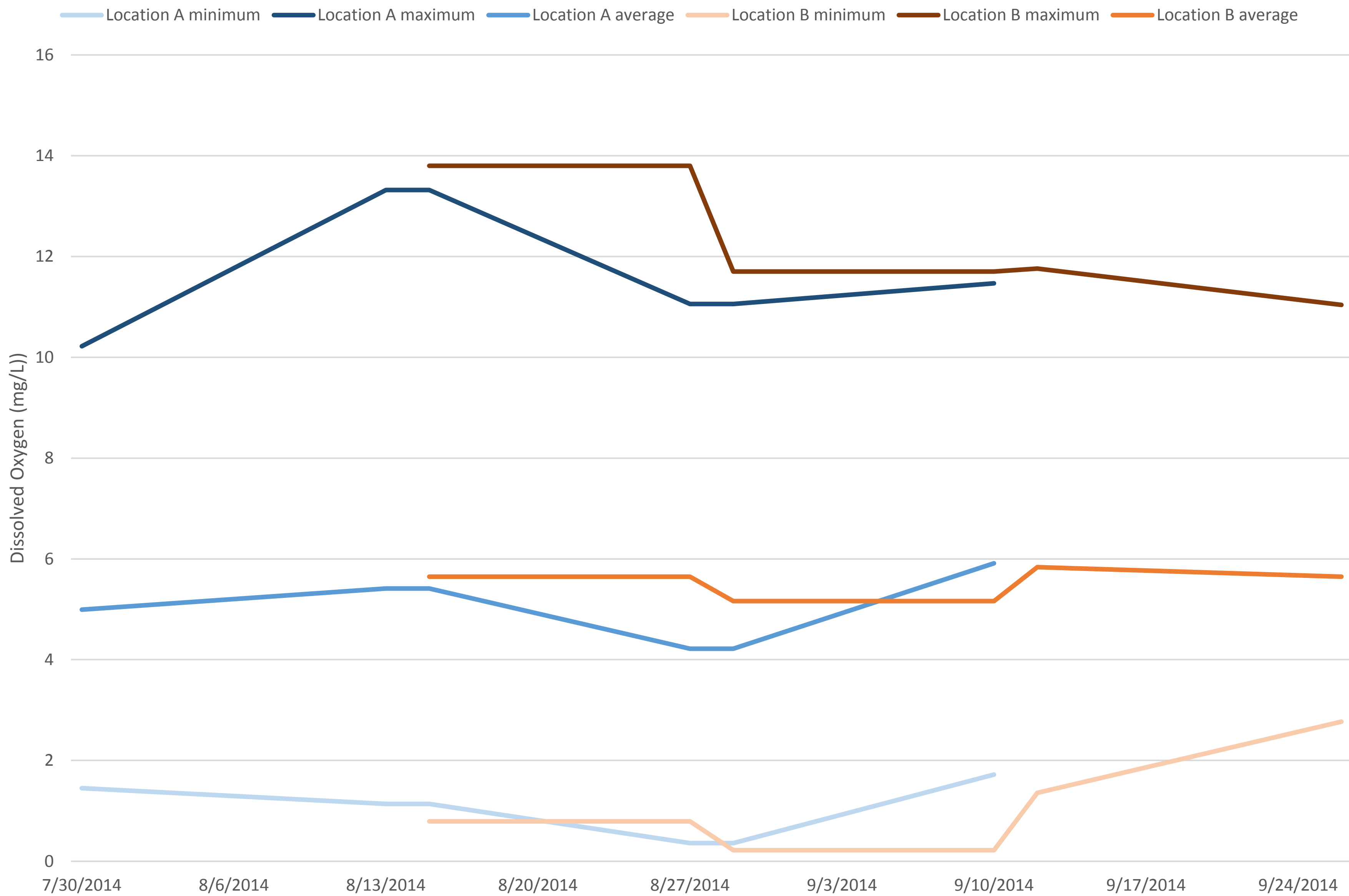


Figure 20
Water Quality Data over a Two-Week Interval in 2014 – Temperature
Location A minimum
Location A maximum
Location A average
Location B minimum
Location B maximum
Location B average
Temperature (°C)
35
30
25
20
15
10
5
0
7/30/2014
8/6/2014
8/13/2014
8/20/2014
8/27/2014
9/3/2014
9/10/2014
9/17/2014
9/24/2014

Figure 21
Water Quality Data over a Two-Week Interval in 2014 – Dissolved Oxygen



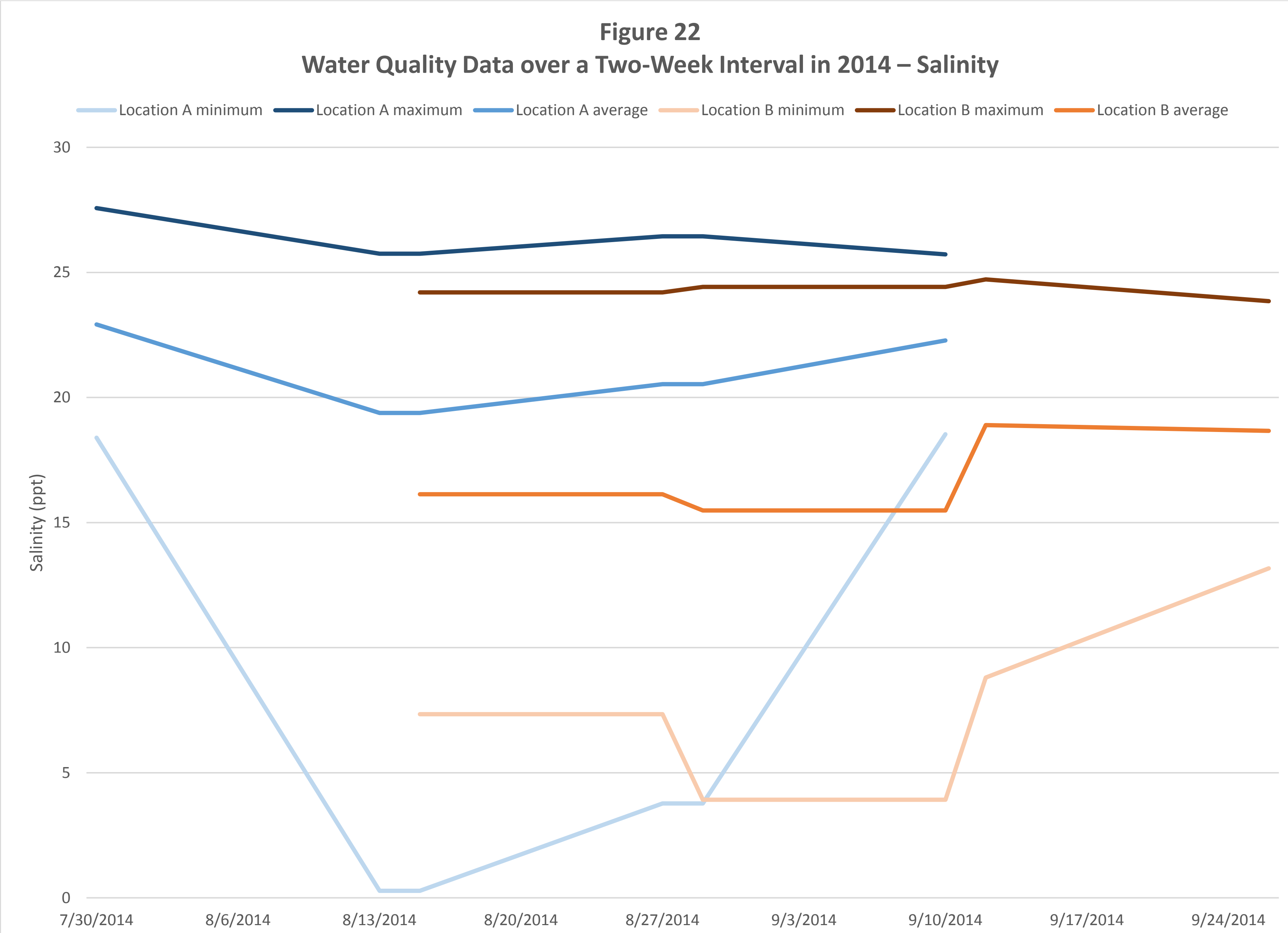


Figure 22
Water Quality Data over a Two-Week Interval in 2014 – Salinity
Location A minimum
Location A maximum
Location A average
Location B minimum
Location B maximum
Location B average
Salinity (ppt)
30
25
20
15
10
5
0
7/30/2014
8/6/2014
8/13/2014
8/20/2014
8/27/2014
9/3/2014
9/10/2014
9/17/2014
9/24/2014

Figure 23
Daily Fluctuation in Salinity for a Five-Day Period in 2014
Tower Mews - A Location

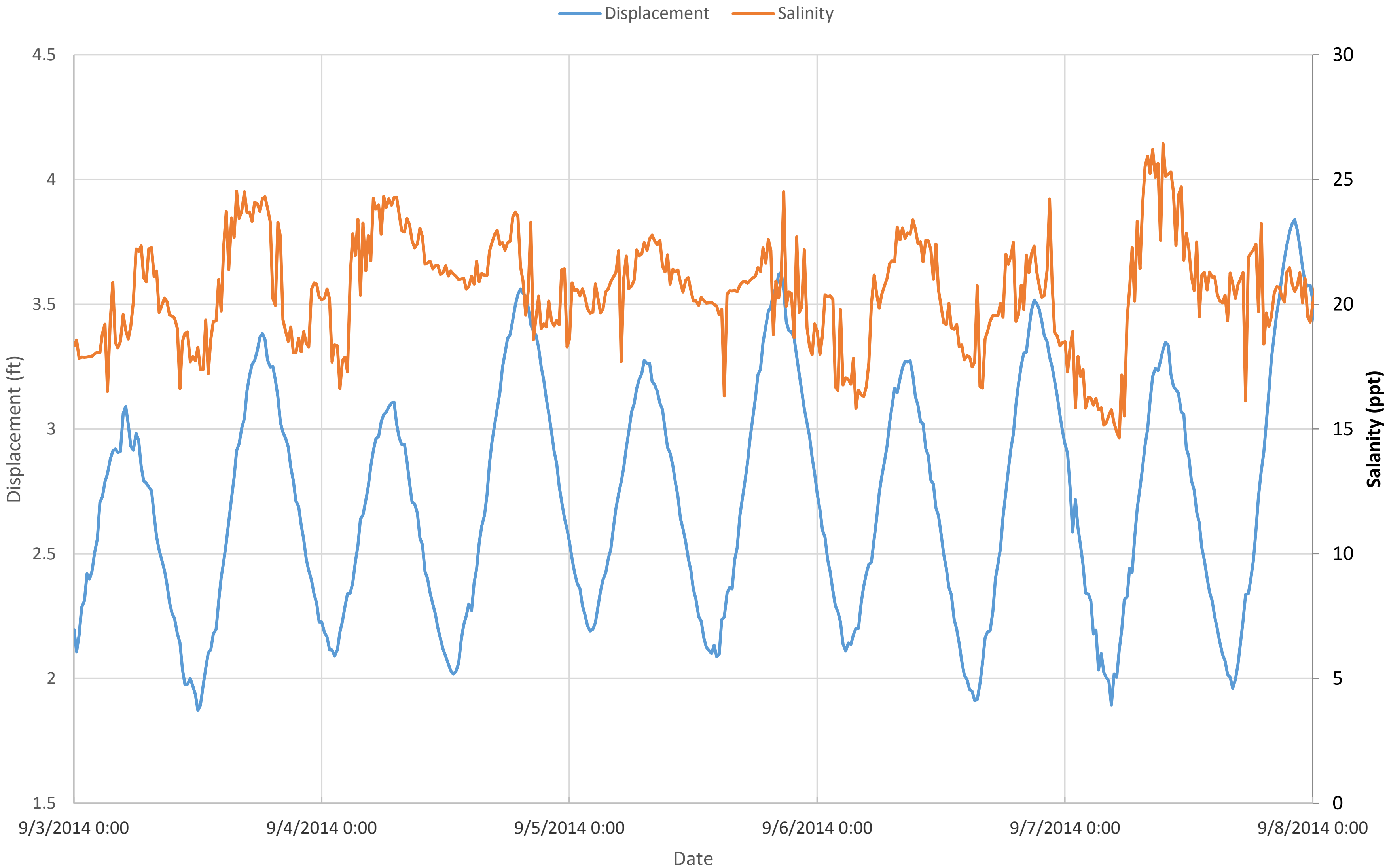


Figure 24
Daily Fluctuation in Temperature for a Five-Day Period in 2014
Tower Mews - A Location

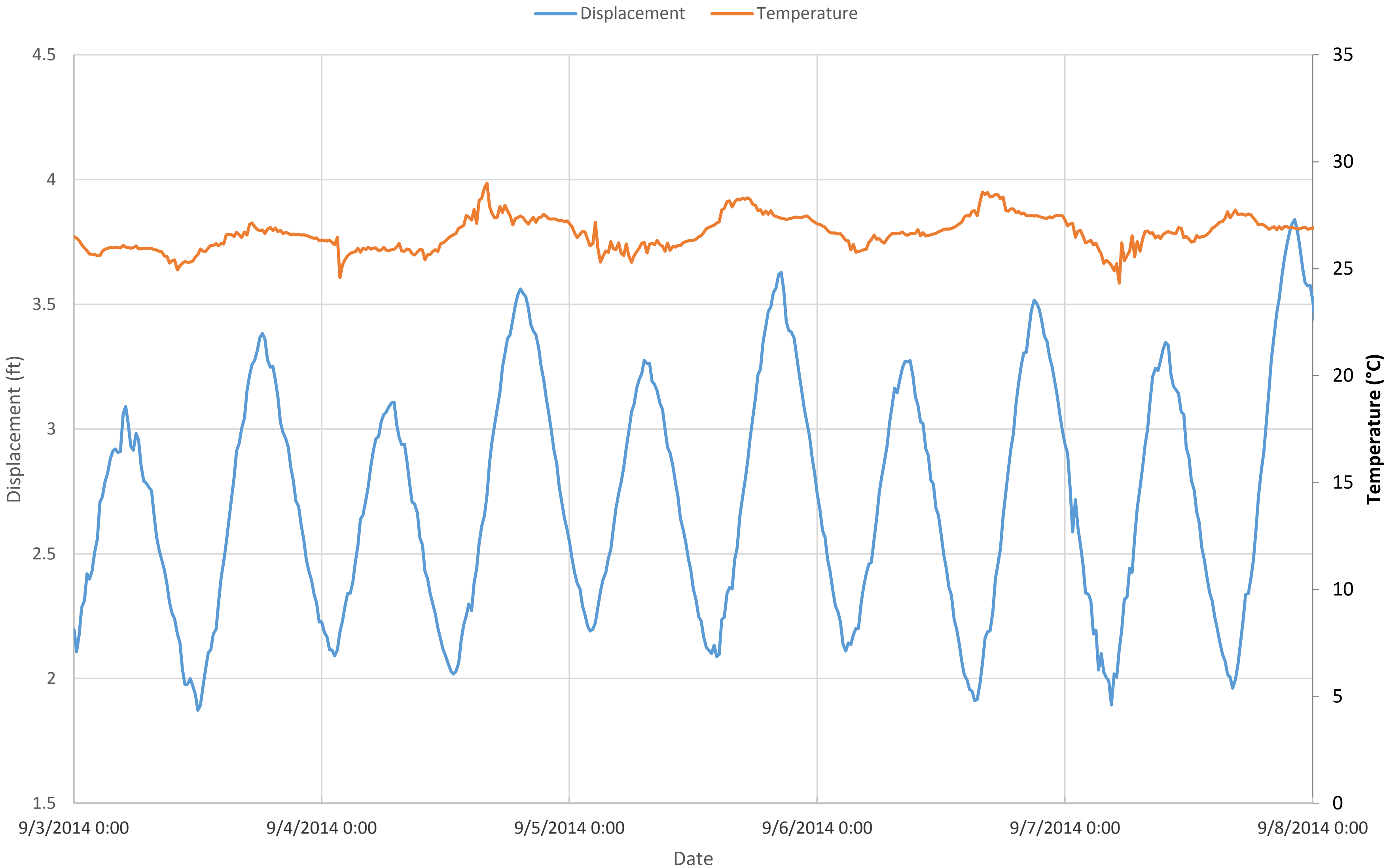
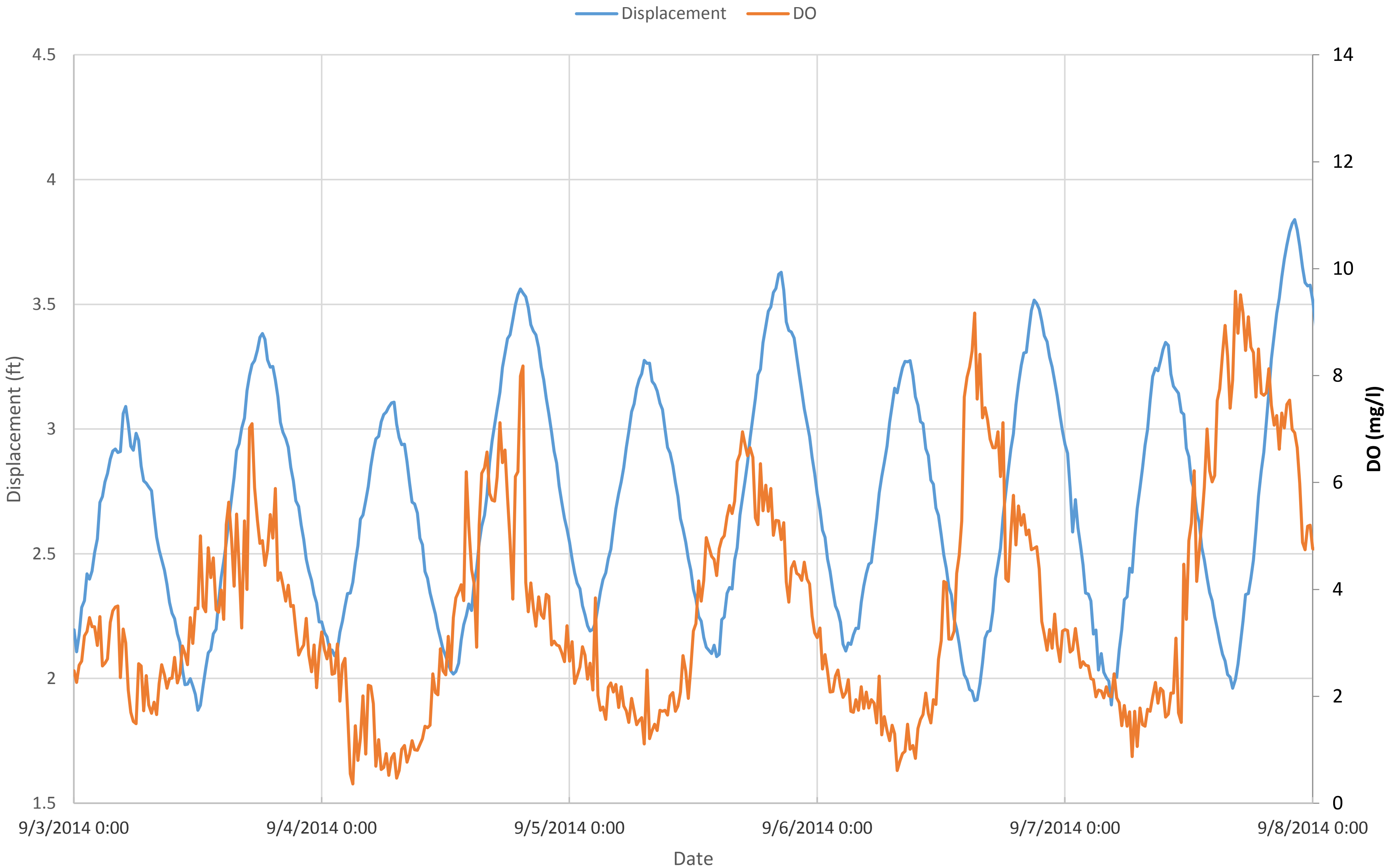


Figure 25
Daily Fluctuation in Dissolved Oxygen for a Five-Day Period in 2014
Tower Mews - A Location



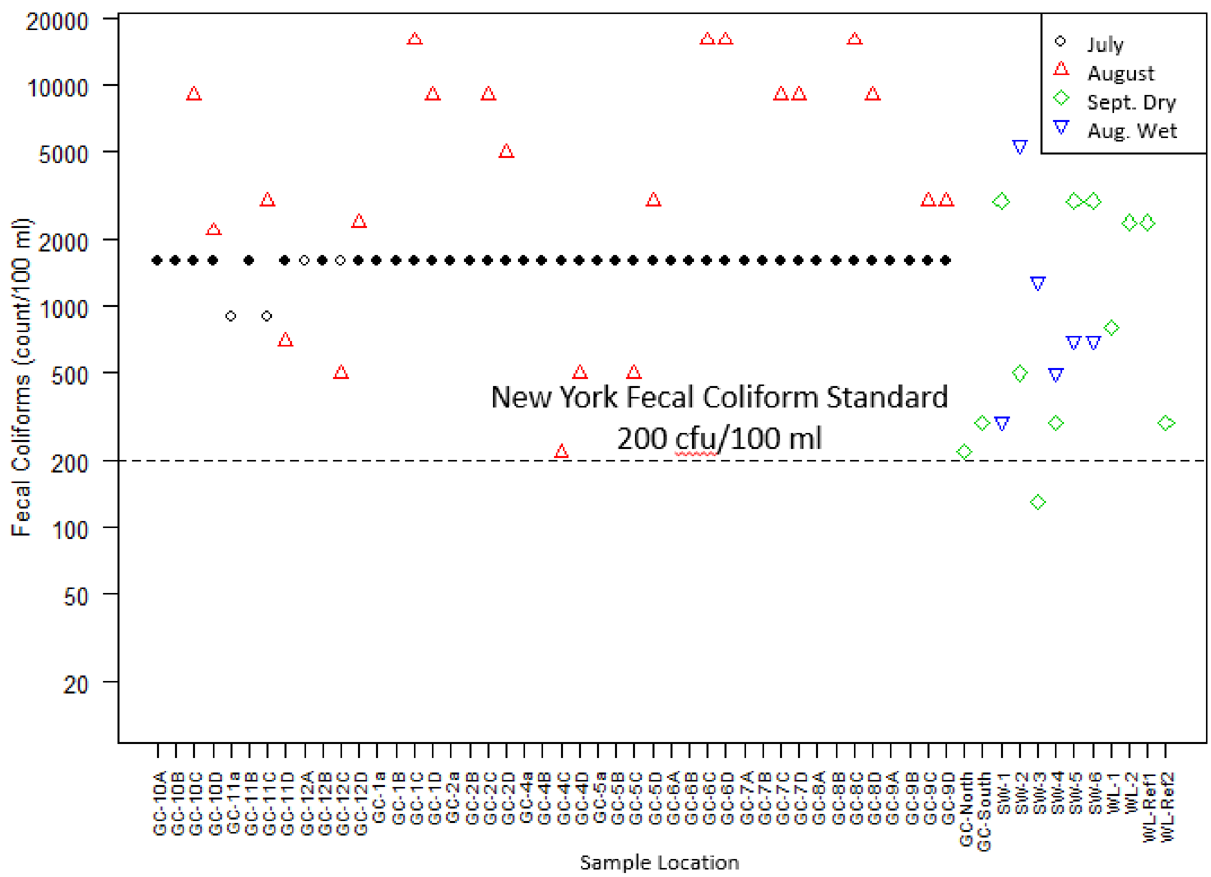


Figure 26. Fecal Coliform for All Sampling Events.

Solid shapes indicate that data value were quantified as " " the reported value'

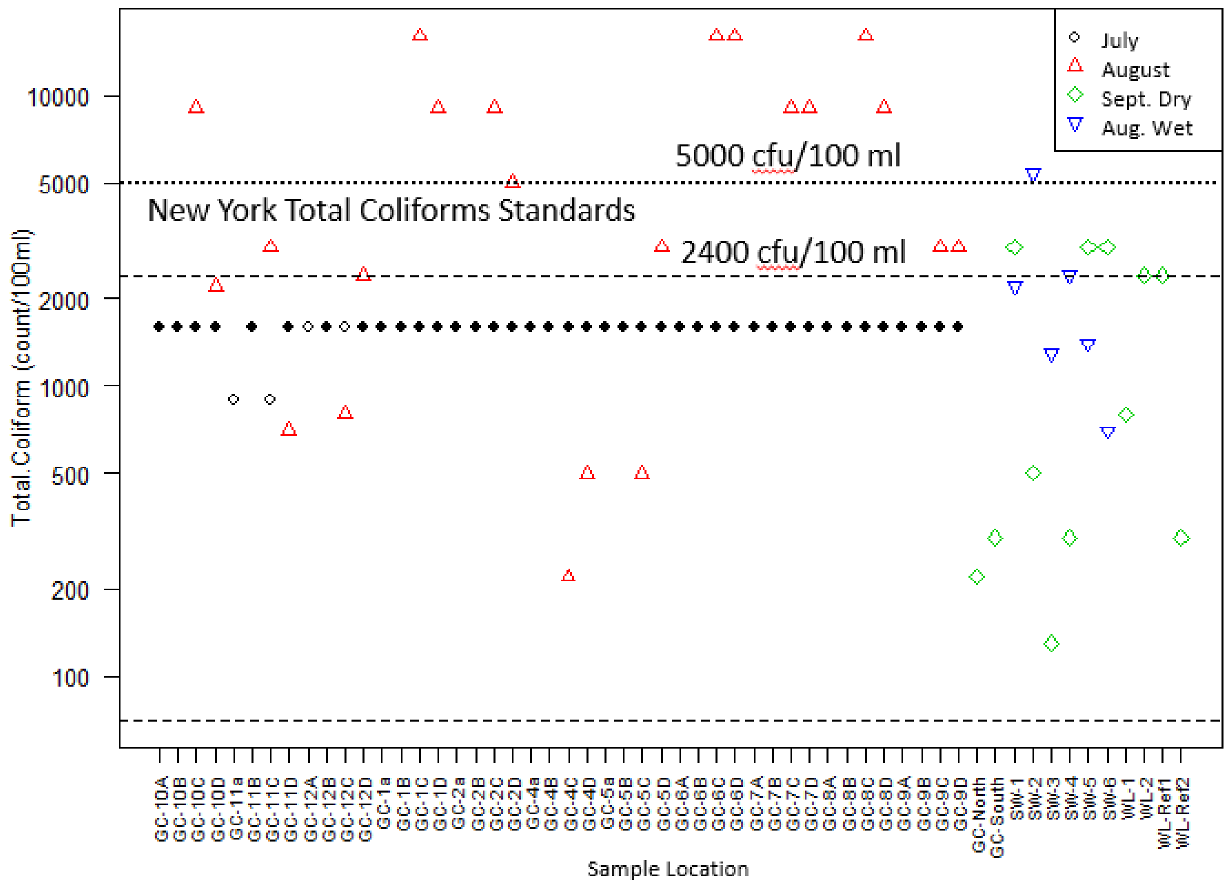


Figure 27. Total Coliform for All Sampling Events.

Solid shapes indicate that data value were quantified as " " the reported value.

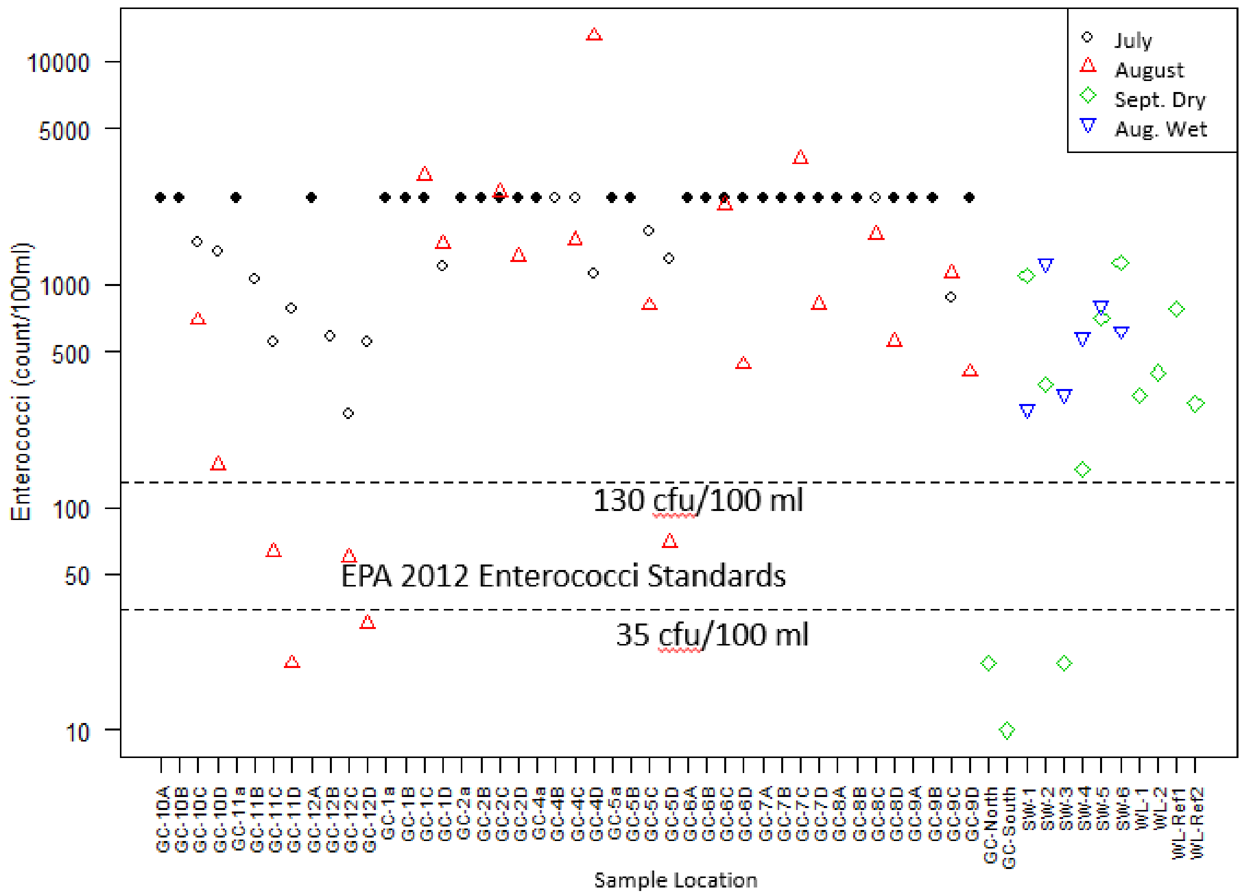


Figure 28. Enterococci for All Sampling Events.

Solid shapes indicate that data value were quantified as " " the reported value.

Figure 29. Mosquito Trap Site Locations.

ATTACHMENT A

ANALYTICAL RESULTS AND DATA QUALITY REVIEW

ATTACHMENT A-1

WATER QUALITY RESULTS AND FIELD NOTES

TABLE A-1
TIDAL CYCLE SAMPLING - JULY 15, 2015
GRAND CANAL

Station	Tidal Cycle	Site Details					Water Quality Results				Notes
		Time	Coordinates		Depth (ft)	Temp (°C)	DO (mg/L)	Sal (PSU)	Turbidity (NTU)	Hydrogen Sulfide (mg/L)	
1	Low	6:12 AM	N 40.72922	W 73.14925	6	25.88	1.3	19.77	7.3	0	--
	Mid-incoming	8:00 AM	N 40.72918	W 73.14931	5	26.29	1.22	21.02	8.2	0	--
	High	10:45 AM	N 40.72922	W 73.14925	6.7	27.37	3.69	24.36	9.9	0	--
	Mid-outgoing	1:53 PM	N 40.72915	W 73.1493	5.7	26.66	3.64	19.48	8.2	0	--
2	Low	6:25 AM	N 40.73052	W 73.1469	4.7	25.78	1.04	19.23	8.6	0	--
	Mid-incoming	8:07 AM	N 40.73048	W 73.1469	5.8	26.06	2.35	19.1	8	0	--
	High	10:55 AM	N 40.75051	W 73.14706	4.8	26.89	6.94	17.86	9.7	0	(1)
	Mid-outgoing	2:00 PM	N 40.73049	W 73.14702	5.6	27.26	8.05	18.82	12.1	0	--
4	Low	6:40 AM	N 40.73194	W 73.1524	11	26.21	7.22	18.22	10.1	0	--
	Mid-incoming	8:16 AM	N 40.73196	W 73.15247	10.5	26.34	6.28	19.25	11.4	0.1	--
	High	11:05 AM	N 40.73199	W 73.15247	11.7	26.92	12.63	18.45	10.1	0.1	--
	Mid-outgoing	2:15 PM	N 40.73196	W 73.15247	9.8	26.45	8.36	19.36	10	0	--
5	Low	6:48 AM	N 40.73191	W 73.15018	8	26.56	6.01	18.04	11	0	--
	Mid-incoming	8:25 AM	N 40.73194	W 73.15024	6.8	26.84	4.59	20.1	10.9	0	--
	High	11:15 AM	N 40.73199	W 73.15024	8.9	26.71	2.62	20.43	11.6	0	--
	Mid-outgoing	2:25 PM	N 40.73198	W 73.1502	6.6	26.79	9.33	18.81	15.1	0	--
6	Low	6:55 AM	N 40.73212	W 73.14722	7.1	26.74	1.75	18.89	9.1	0	--
	Mid-incoming	8:35 AM	N 40.73214	W 73.14733	7.6	26.63	3.95	18.26	10.1	0	--
	High	11:25 AM	N 40.7321	W 73.14722	7.6	26.91	3.9	19.65	9.9	0	--
	Mid-outgoing	2:32 PM	N 40.7321	W 73.14727	6.7	27.12	6.4	19.16	14	0	--
7	Low	7:05 AM	N 40.73328	W 73.14573	4.7	25.26	0.38	16.67	6.4	0	--
	Mid-incoming	8:42 AM	N 40.73327	W 73.14585	5.8	25.62	0.67	18.48	7.2	0	--
	High	11:37 AM	N 40.73322	W 73.14581	5.6	26.49	2.43	19.27	8.7	0	--
	Mid-outgoing	2:38 PM	N 40.73326	W 73.14585	4.1	26.36	2.85	18.59	8.2	0	--
8	Low	7:13 AM	N 40.73436	W 73.1481	3.2	25.88	0.66	16.02	11.2	0	--
	Mid-incoming	8:48 AM	N 40.73429	W 73.14805	4.8	25.82	0.39	18.52	7.6	0	--
	High	11:44 AM	N 40.73429	W 73.14811	4.3	26.31	2.91	19.01	8.7	0	--
	Mid-outgoing	2:43 PM	N 40.73429	W 73.14811	5	26.3	0.83	18.16	8.7	0	--

TABLE A-1
TIDAL CYCLE SAMPLING - JULY 15, 2015
GRAND CANAL

Station	Tidal Cycle	Site Details					Water Quality Results				Notes
		Time	Coordinates		Depth (ft)	Temp (°C)	DO (mg/L)	Sal (PSU)	Turbidity (NTU)	Hydrogen Sulfide (mg/L)	
9	Low	7:25 AM	N 40.73668	W 73.1467	4.5	25.57	0.14	17.68	7.9	0	(1)
	Mid-incoming	8:57 AM	N 40.73652	W 73.14664	4.7	25.64	1.01	17.5	11	0	(1)
	High	11:58 AM	N 40.73655	W 73.14669	4.5	26.59	3.37	16.53	11.2	0	--
	Mid-outgoing	2:55 PM	N 40.73663	W 73.14667	4.1	26.47	3.31	18.59	9.7	0	--
10	Low	7:32 AM	N 40.73849	W 73.14695	3.5	25.85	0.09	17.72	9.6	0	(1)
	Mid-incoming	9:05 AM	N 40.73847	W 73.1469	4.6	25.81	0.3	18.08	12.4	0	--
	High	12:05 PM	N 40.73841	W 73.14695	4.9	26.77	4.51	17.38	12.7	0	--
	Mid-outgoing	3:10 PM	N 40.73846	W 73.1469	4.5	26.47	3.32	18.14	13.4	0	(2)
11	Low	5:23 AM	N 40.73914	W 73.15045	4	26.46	1.34	15.91	8.7	0	--
	Mid-incoming	9:28 AM	N 40.73923	W 73.15049	3.5	26.21	1.23	16.92	10.6	0	--
	High	12:30 PM	N 40.73921	W 73.15055	3.5	27.24	2.85	19.28	10.8	0	--
	Mid-outgoing	1:30 PM	N 40.73921	W 73.15048	3.5	26.94	2.53	18.87	11.8	0.1	--
12	Low	5:22 AM	N 40.73897	W 73.15484	5	26.59	1.56	17.55	8	0	--
	Mid-incoming	9:23 AM	N 40.73899	W 73.15486	5.8	27.42	3.95	19.63	10.7	0	--
	High	12:25 PM	N 40.73901	W 73.15495	5.8	27.81	2.4	21.5	8.8	0	--
	Mid-outgoing	1:38 PM	N 40.73897	W 73.15498	5.5	27.48	0.59	22.05	9.6	0	--

Footnotes:
1 - Oily sheen on water.
2- Replicate sample collected.

Abbreviations:
DO - Dissolved oxygen
Sal - Salinity

Notes:
Weather Conditions: 73°F, overcast, winds north 3 mph

Depth to water from 5-star benchmark

6:00 AM	33.25"	Low
7:57 AM	27.75"	Mid-Incoming
11:20 AM	20.75"	High
1:52 PM	29"	Mid-Outgoing

TABLE A-2
TIDAL CYCLE SAMPLING - AUGUST 27, 2015
GRAND CANAL

Station	Tidal Cycle	Site Details					Water Quality Results				Notes
		Time	Coordinates		Depth (ft)	Temp (°C)	DO (mg/L)	Sal (PSU)	Turbidity (NTU)	Hydrogen Sulfide (mg/L)	
1	Low	6:54 AM	N 40.72915	W 73.14933	6	25.54	1.7	23.4	5.7	0	--
	Mid-incoming	8:57 AM	N 40.72921	W 73.14935	6	26.13	2.53	24.22	5.4	0	--
	High	11:04 AM	N 40.72915	W 73.14935	6.5	25.89	4.38	21.71	10.1	0	--
	Mid-outgoing	1:23 PM	N 40.72905	W 73.14927	6.2	26.03	6.1	21.84	12	0	--
2	Low	6:48 AM	N 40.73047	W 73.14690	4.6	24.82	1.48	21.74	6.9	0	(1)
	Mid-incoming	8:53 AM	N 40.73038	W 73.14702	5	25.45	2.4	21.89	8	0	--
	High	10:58 AM	N 40.73051	W 73.14696	5.1	25.14	5.98	21.14	10.1	0	--
	Mid-outgoing	1:17 PM	N 40.73047	W 73.14690	5.1	25.86	4.94	21.44	11	0	--
4	Low	6:31 AM	N 40.73210	W 73.15247	10.7	25.5	0	21.4	29.4	1	(2)
	Mid-incoming	8:38 AM	N 40.73209	W 73.15251	10.7	25.3	0	21.55	33.9	0	(2)
	High	10:44 AM	N 40.73207	W 73.15253	11	26.12	1.51	21.86	42.2	0	(2)
	Mid-outgoing	1:04 PM	N 40.73207	W 73.15253	10.5	26.89	4.02	22.03	20	0	(2)
5	Low	6:40 AM	N 40.73196	W 73.15016	7.9	26.62	0.28	21.8	7.7	0	--
	Mid-incoming	8:45 AM	N 40.73201	W 73.15024	8	26.63	0.86	21.98	7.8	0	--
	High	10:52 AM	N 40.73201	W 73.15024	8.2	27.52	3.66	22.37	7.8	0	--
	Mid-outgoing	1:11 PM	N 40.73201	W 73.15035	7.9	27.54	5.39	21.86	11.3	0	--
6	Low	6:21 AM	N 40.73210	W 73.14732	6.8	25.45	3.05	21.15	7.2	0	--
	Mid-incoming	8:27 AM	N 40.73207	W 73.14722	7.2	25.08	2.58	21.12	10	0	--
	High	10:32 AM	N 40.73201	W 73.14722	7.5	26.04	4.07	21.83	8.3	0	--
	Mid-outgoing	12:54 PM	N 40.73207	W 73.14718	7.4	26.58	6.2	21.23	9	0	--
7	Low	6:17 AM	N 40.73326	W 73.14575	4.6	24.29	0.93	21.12	12.1	0	--
	Mid-incoming	8:20 AM	N 40.73319	W 73.14571	5	23.92	1.53	20.83	8.3	0	--
	High	10:25 AM	N 40.73329	W 73.14573	5.2	25.07	2.94	21.25	19.1	0	--
	Mid-outgoing	12:44 PM	N 40.73327	W 73.14578	5.2	25.58	4.32	21.49	21	0	--
8	Low	6:10 AM	N 40.73405	W 73.14781	3	24.5	0.31	20.34	12.6	0	--
	Mid-incoming	8:13 AM	N 40.73412	W 73.14787	4.1	23.88	0.62	20.91	10.1	0	--
	High	10:18 AM	N 40.73411	W 73.14777	4.4	24.97	3.85	20.89	10.8	0	--
	Mid-outgoing	12:39 PM	N 40.73414	W 73.14789	4	26.04	6.85	20.69	13.9	0	--

Station	Tidal Cycle	Site Details					Water Quality Results				Notes
		Time	Coordinates		Depth (ft)	Temp (°C)	DO (mg/L)	Sal (PSU)	Turbidity (NTU)	Hydrogen Sulfide (mg/L)	
9	Low	6:00 AM	N 40.73663	W 73.14664	4.3	24.58	1.45	20.38	9.2	0	(1)
	Mid-incoming	8:00 AM	N 40.73668	W 73.14667	4.4	24.33	1.18	20.06	12.4	0	--
	High	10:08 AM	N 40.73664	W 73.14667	4.8	24.68	1.99	19.98	13.1	0	(1)
	Mid-outgoing	12:22 PM	N 40.73649	W 73.14661	4.1	25.23	4.85	20.48	9.6	0	--
10	Low	5:54 AM	N 40.73847	W 73.14691	3.4	24.71	1.7	20.18	10	0	--
	Mid-incoming	7:52 AM	N 40.73847	W 73.14698	3.7	24.88	2.32	19.74	10.1	0	(3)
	High	9:48 AM	N 40.73855	W 73.14696	4	25.38	2.64	20.45	15.4	0	(1)
	Mid-outgoing	12:11 PM	N 40.73844	W 73.14696	3.8	24.9	3.64	20.08	10.7	0	(1)
11	Low	5:41 AM	N 40.73911	W 73.15051	3.9	25.32	3.35	19.78	8.7	0	--
	Mid-incoming	7:50 AM	N 40.73907	W 73.14698	4.3	26.02	2.45	21.58	9.9	0	--
	High	9:41 AM	N 40.73905	W 73.15046	4.7	25.56	3.21	21.82	12.1	0	--
	Mid-outgoing	12:04 PM	N 40.73901	W 73.15067	4	26.05	4.39	20.9	11.6	0	--
12	Low	5:29 AM	N 40.73905	W 73.15498	4.8	25.96	3.52	19.53	9.1	0	--
	Mid-incoming	7:40 AM	N 40.73903	W 73.15493	5	27.84	4.21	23.33	7.8	0	--
	High	9:33 AM	N 40.73899	W 73.15498	5.4	27.89	6.31	22.84	7.8	0	--
	Mid-outgoing	11:54 AM	N 40.73907	W 73.15511	4.9	27.37	5.6	21.93	9.5	0	--

Footnotes:
1 - Oily sheen on water.
2 - Smells like sewage. Water very cloudy (white).
3- Replicate sample collected.

Abbreviations:
DO - Dissolved oxygen
Sal - Salinity

Notes:
Weather Conditions: 75°F, partly cloudy, winds northwest 7 mph

<u>Depth to water from 5-star benchmark</u>

5:10 AM	35.25"	Low
7:01 AM	31.0"	Mid-Incoming
9:04 AM	25.25"	High
11:11 AM	29.5"	Mid-Outgoing

TABLE A-3
DRY WEATHER STORMWATER SAMPLING - SEPTEMBER 3, 2015
GRAND CANAL

Site Number	Site Details					Water Quality Results				Notes
	Time	Coordinates		Depth (ft)	Temp (°C)	DO (mg/L)	Sal (PSU)	Turbidity (NTU)	Hydrogen Sulfide (mg/L)	
Reference										
WL-Ref-1	8:53 AM	N 40.72347	W 73.10586	2	24.13	1.7	22.56	8.4	N/A	Taken from center of canal near southwest corner of golf course. Only bacteria samples were collected.
WL-Ref-2	9:00 AM	N 40.72214	W 73.10837	3	25.02	1.62	22.62	7.9	N/A	Taken from culvert discharging from wetland into canal. Only bacteria samples were collected.
WL-1	9:31 AM	N 40.73286	W 73.14530	0.75	24.75	0	21.28	22	N/A	Taken along N/S running mosquitoe ditch. Only bacteria samples were collected.
WL-2	9:55 AM	N 40.73571	W 73.14620	0.5	23.12	0	18.98	20.1	N/A	Taken at threeway intersection of mosquitoe ditches. Only bacteria samples were collected.
Surface Water										
SW-1	10:00 AM	N 40.73668	W 73.14667	3	25.45	1.43	20.78	6.6	0	Taken from overland runoff into canal from dead end road
SW-2	10:15 AM	N 40.73201	W 73.14690	4.8	25.82	2.15	21.87	6.1	0	Stormwater outfall from road
SW-3	10:27 AM	N 40.73092	W 73.15043	4.6	26.21	2.36	22.21	6.2	0	Stormwater outfall from road
SW-4	10:43 AM	N 40.72785	W 73.14877	5.8	26.96	2	24.07	5.1	0	Outlet from small ditch
SW-5	10:34 AM	N 40.73012	W 73.14698	3	26.34	2.03	22.58	8	0	Taken from stream flowing from wetland into canal
SW-6	10:07 AM	N 40.73468	W 73.14607	2	25.59	1.06	21.33	7.6	0	Taken from culvert discharging from wetland into canal
Grand Canal										
GC-South	10:53 AM	N 40.72524	W 73.14946	20	27.92	5.21	23.97	5.8	N/A	Taken in Connetquot River west of the south entrance of Grand Canal. Only bacteria samples were collected.
GC-North	11:10 AM	N 40.74118	W 73.15408	3.8	28.36	8.56	20.95	8.9	N/A	Taken in Connetquot River north of north entrance of Grand Canal. Only bacteria samples were collected.

Notes:
Weather Conditions: 85°F, mostly cloudy, winds northwest 8 mph
0.00" of rain were observed for 72 hours prior to sampling

Abbreviations:
DO - Dissolved oxygen
Sal - Salinity
N/A - Not available
N/S - North/South

TABLE A-4
WET WEATHER STORMWATER SAMPLING - AUGUST 11, 2015
GRAND CANAL

Site Number	Site Details					Water Quality Results			
	Time	Coordinates		Depth (ft)	Temp (°C)	DO (mg/L)	Sal (PSU)	Turbidity (NTU)	Hydrogen Sulfide (mg/L)
SW-1	10:27 AM	N 40.73668	W 73.14667	3	N/A[1]	4.15	16.24	11	0
SW-2	10:38 AM	N 40.73201	W 73.14690	4.8	N/A[1]	4.21	17.7	9.4	0
SW-3	10:54 AM	N 40.73092	W 73.15043	4.6	N/A[1]	3.87	19.68	16.3	0
SW-4	11:08 AM	N 40.72785	W 73.14877	5.8	N/A[1]	2.77	18.74	20.2	0
SW-5	11:18 AM	N 40.73012	W 73.14698	3	N/A[1]	2.33	19.56	6.9	0
SW-6	11:33 AM	N 40.73468	W 73.14607	2	N/A[1]	2.76	16.83	10.7	0

Footnotes:
1 - Temperature sensor was not functioning correctly.

Abbreviations:
DO - Dissolved oxygen
Sal - Salinity
N/A - Not available

Notes:
Weather Conditions: 85°F, mostly cloudy, winds northwest 8 mph
By 8:34 AM, 0.53" of rain had accumulated. Sampling concluded at 11:33 AM within the 3 hour period following the onset of a "significant rainfall event". By 11:56, 1.86" of rain had accumulated.

TABLE A-5
SEDIMENT SAMPLING - DECEMBER 21-22, 2015
GRAND CANAL

Station	Site Details					Water Quality Results					
						Top				Middle	Bottom
	Date	Time	Depth (ft)	Depth @ MLW (ft)	Core Length (ft)	Temp (°C)	DO (mg/L)	Sal (PSU)	Turbidity (NTU)	Sal (PSU)	Sal (PSU)
1	21-Dec	11:11	4	3.5	2.5	7.66	0.64	17.11	6.7	21.44	24.19
2	21-Dec	12:17	3.5	3.25	2.75	8.07	2.33	17.53	6.7	19	20.4
3	21-Dec	1:30	4	4	2	8.31	3.05	15.31	9.4	20	23.15
4	21-Dec	2:10	4	4	2	8.37	3.45	13.43	8.8	14.05	19.9
5	21-Dec	2:50	4	4	2	8.74	4.11	12.79	15.6	15.04	15.53
6	22-Dec	12:50	3	2.75	3.25	9.82	3.39	1.67	6.9	(1)	(1)
7	22-Dec	12:20	3	2.5	3.5	9.18	3.39	1.83	10.4	3.79	16.87
8	22-Dec	11:55	3.5	3	3	9.66	3.23	0.81	0.2	16.53	20.7
9	22-Dec	11:16	3	2.5	3.5	9.57	3.32	0.86	7.9	1.76	13.03
10	22-Dec	10:45	4	3.75	2.25	9.63	2.66	1.2	1	10.2	23.58

Footnotes:
1 - Only top value available, because it was very shallow.

Notes:
It was raining heavily on 12/22, so the salinity is lower.

Abbreviations:
DO - Dissolved oxygen
MLW - Mean low water
Sal - Salinity

ATTACHMENT A-2

ANALYTICAL RESULTS FOR 2015 SURFACE WATER SAMPLES

Detected Results for Surface Water Samples

Detected Results for Grand Canal – July 2015 Tidal Sampling Event

Sample ID		**GC-1A**		**GC-2A**		**GC-4A**		**GC-5A**		**GC-6A**		**GC-7A**		**GC-8A**		**GC-9A**	
York ID		**15G0557-01**		**15G0557-02**		**15G0557-03**		**15G0557-04**		**15G0557-05**		**15G0557-06**		**15G0557-07**		**15G0557-08**	
Sampling Date		**7/15/2015 6:12:00 AM**		**7/15/2015 6:25:00 AM**		**7/15/2015 6:40:00 AM**		**7/15/2015 6:48:00 AM**		**7/15/2015 6:55:00 AM**		**7/15/2015 7:05:00 AM**		**7/15/2015 7:13:00 AM**		**7/15/2015 7:25:00 AM**	
Client Matrix		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	1		0.20	U	0.20	U	0.20	U
1,3,5-Trimethylbenzene	108-67-8	0.20	U	0.20	U	0.20	U	0.20	U	0.30	J	0.20	U	0.20	U	0.20	U
Acrolein	107-02-8	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.57		0.20	U	0.20	U	0.20	U
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.20	U	0.58		0.20	U	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	1.10		0.20	U	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.50	U	2.20		0.50	U	0.50	U	0.50	U
Toluene	108-88-3	0.20	U	0.20	U	0.20	U	0.20	U	2.90		0.20	U	0.20	U	0.20	U
Trichloroethylene	79-01-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.60	U	3.20		0.60	U	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Bis(2-ethylhexyl)phthalate	117-81-7	0.51	U	0.62		0.50	U	0.51	U	0.51	U	0.59		0.51	U	0.57	U
Fluoranthene	206-44-0	0.051	U	0.051	U	0.050	U	0.051	U	0.051	U	0.056	U	0.051	U	0.057	U
Naphthalene	91-20-3	0.051	U	0.051	U	0.050	U	0.051	U	0.051	U	0.056	U	0.051	U	0.069	
N-nitroso-di-n-propylamine	621-64-7	2.56	U	2.56	U	2.50	U	2.56	U	2.56	U	2.78	U	2.56	U	2.86	U
Phenanthrene	85-01-8	0.051	U	0.051	U	0.050	U	0.051	U	0.051	U	0.078		0.051	U	0.13	
Pyrene	129-00-0	0.051	U	0.051	U	0.050	U	0.051	U	0.051	U	0.056	U	0.051	U	0.057	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		2,200		4,700		2,100		2,200		2,100		1,200	U	2,100		1,500	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		1,400		2,100		1,300		1,400		1,400		1,400		1,300		1,300	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		50	U	50	U	50	U	50	U	50	U	50	U	50	U	61	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		221		50	U	58		58		50	U	50	U	50	U	115	
Total Inorg. Nitrogen, Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Inorganic Nitrogen, Dissolved		1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U

Sample ID		GC-10A		GC-1B		GC-2B		GC-4B		GC-5B		GC-6B		GC-7B		GC-8B	
York ID		15G0557-09		15G0557-10		15G0557-11		15G0557-12		15G0557-13		15G0557-14		15G0557-15		15G0557-16	
Sampling Date		7/15/2015 7:32:00 AM		7/15/2015 8:00:00 AM		7/15/2015 8:07:00 AM		7/15/2015 8:16:00 AM		7/15/2015 8:25:00 AM		7/15/2015 8:35:00 AM		7/15/2015 8:42:00 AM		7/15/2015 8:48:00 AM	
Client Matrix		Water		Water		Water		Water		Water		Water		Water		Water	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.50		0.20	U	0.20	U
1,3,5-Trimethylbenzene	108-67-8	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Acrolein	107-02-8	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.40	J	0.20	U	0.45	J
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.31	J	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.54		0.20	U	0.23	J
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	1.10		0.50	U	0.50	U
Toluene	108-88-3	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	1.50		0.20	U	0.78	
Trichloroethylene	79-01-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	1.60		0.60	U	0.72	J
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		10		1	
Bis(2-ethylhexyl)phthalate	117-81-7	0.51	U	15.10		0.51	U	0.50	U	4.52		7.60		101	D	5.15	
Fluoranthene	206-44-0	0.051	U	0.051	U	0.051	U	0.050	U	0.056	U	0.051	U	0.050	U	0.050	U
Naphthalene	91-20-3	0.051	U	0.051	U	0.051	U	0.050	U	0.056	U	0.051	U	0.050	U	0.050	U
N-nitroso-di-n-propylamine	621-64-7	2.56	U	2.56	U	2.56	U	2.50	U	2.78	U	2.56	U	2.50	U	2.50	U
Phenanthrene	85-01-8	0.051	U	0.051	U	0.051	U	0.050	U	0.056	U	0.051	U	0.050	U	0.050	U
Pyrene	129-00-0	0.051	U	0.051	U	0.051	U	0.050	U	0.056	U	0.051	U	0.050	U	0.050	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		2,300		1,300		2,300		2,600		2,200		2,200		1,900		1,600	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		1,300		1,200	U	1,200	U	1,400		1,800		1,300		1,200	U	1,200	U
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		65		57		65		80		50	U	53		50	U	57	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		63		50		57		78		50	U	55		50		59	
Total Inorg. Nitrogen, Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Inorganic Nitrogen, Dissolved		1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U

Sample ID		**GC-9B**		**GC-10B**		**GC-1C**		**GC-2C**		**GC-4C**		**GC-5C**		**GC-6C**		**GC-7C**	
York ID		**15G0557-17**		**15G0557-18**		**15G0557-19**		**15G0557-20**		**15G0557-21**		**15G0557-22**		**15G0557-23**		**15G0557-24**	
Sampling Date		**7/15/2015 8:57:00 AM**		**7/15/2015 9:05:00 AM**		**7/15/2015 10:45:00 AM**		**7/15/2015 10:55:00 AM**		**7/15/2015 11:05:00 AM**		**7/15/2015 11:15:00 AM**		**7/15/2015 11:25:00 AM**		**7/15/2015 11:37:00 AM**	
Client Matrix		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
1,3,5-Trimethylbenzene	108-67-8	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Acrolein	107-02-8	0.20	U	0.20	U	0.20	U	0.20	U	7.50		0.20	U	0.20	U	0.20	U
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Toluene	108-88-3	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.37	J	0.20	U
Trichloroethylene	79-01-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Bis(2-ethylhexyl)phthalate	117-81-7	4.64		3.08		6.87		4		8.18		9.02		5.33		4.83	
Fluoranthene	206-44-0	0.056	U	0.051	U	0.051	U	0.057	U	0.12		0.051	U	0.056	U	0.050	U
Naphthalene	91-20-3	0.056	U	0.051	U	0.051	U	0.057	U	0.092		0.051	U	0.056	U	0.050	U
N-nitroso-di-n-propylamine	621-64-7	2.78	U	2.56	U	2.56	U	2.86	U	2.56	U	2.56	U	2.78	U	2.50	U
Phenanthrene	85-01-8	0.056	U	0.051	U	0.051	U	0.057	U	0.051	U	0.051	U	0.056	U	0.050	U
Pyrene	129-00-0	0.056	U	0.051	U	0.051	U	0.057	U	0.062		0.051	U	0.056	U	0.050	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		2,700		3,100		1,500		2,200		2,000		1,700		1,900		2,500	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		1,300		1,200	U	1,200	U	1,400		1,400		1,500		1,300		1,400	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		50	U	50	U	80		61		95		65		59		83	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		61		57		153		113		149		301		215		329	
Total Inorg. Nitrogen, Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Inorganic Nitrogen, Dissolved		1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U

Detected Results for Grand Canal – July 2015 Tidal Sampling Event

Sample ID		GC-8C		GC-9C		GC-10C		GC-1D		GC-2D		GC-4D		GC-5D		GC-6D	
York ID		15G0557-25		15G0557-26		15G0557-27		15G0557-28		15G0557-29		15G0557-30		15G0557-31		15G0557-32	
Sampling Date		7/15/2015 11:44:00 AM		7/15/2015 11:58:00 AM		7/15/2015 12:05:00 PM		7/15/2015 1:53:00 PM		7/15/2015 2:00:00 PM		7/15/2015 2:15:00 PM		7/15/2015 2:25:00 PM		7/15/2015 2:32:00 PM	
Client Matrix		Water		Water		Water		Water		Water		Water		Water		Water	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
1,3,5-Trimethylbenzene	108-67-8	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Acrolein	107-02-8	0.20	U	0.20	U	3.50		0.20	U	0.20	U	0.20	U	2	J	2.60	
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Toluene	108-88-3	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Trichloroethylene	79-01-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Bis(2-ethylhexyl)phthalate	117-81-7	4.83		9.61		4.39		3.62		4.41		5.24		28.10		9.76	
Fluoranthene	206-44-0	0.056	U	0.051	U	0.051	U	0.050	U	0.051	U	0.051	U	0.051	U	0.051	U
Naphthalene	91-20-3	0.056	U	0.051	U	0.051	U	0.050	U	0.051	U	0.051	U	0.051	U	0.051	U
N-nitroso-di-n-propylamine	621-64-7	2.78	U	2.56	U	2.56	U	2.50	U	2.56	U	2.56	U	2.56	U	2.56	U
Phenanthrene	85-01-8	0.056	U	0.051	U	0.051	U	0.050	U	0.051	U	0.051	U	0.051	U	0.051	U
Pyrene	129-00-0	0.056	U	0.051	U	0.051	U	0.050	U	0.051	U	0.051	U	0.051	U	0.051	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		1,900		2,400		2,400		1,400		1,600		2,000		1,600		1,600	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		1,400		1,400		1,300		1,300		1,300		1,200	U	1,200	U	1,400	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		68		50	U	50	U	50	U	61		50	U	50	U	55	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		145		93		50	U	100		168		110		138		106	
Total Inorg. Nitrogen, Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Inorganic Nitrogen, Dissolved		1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U

Sample ID		GC-7D		GC-8D		GC-9D		GC-10D		GC-11A		GC-11B		GC-11C		GC-11D	
York ID		15G0557-33		15G0557-34		15G0557-35		15G0557-36		15G0557-37		15G0557-38		15G0557-39		15G0557-40	
Sampling Date		7/15/2015 2:38:00 PM		7/15/2015 2:43:00 PM		7/15/2015 2:55:00 PM		7/15/2015 3:10:00 PM		7/15/2015 5:23:00 AM		7/15/2015 9:28:00 AM		7/15/2015 12:30:00 PM		7/15/2015 1:30:00 PM	
Client Matrix		Water		Water		Water		Water		Water		Water		Water		Water	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
1,3,5-Trimethylbenzene	108-67-8	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Acrolein	107-02-8	0.20	U	0.20	U	0.20	U	2	J	0.20	U	0.20	U	2.70		4.30	
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Toluene	108-88-3	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Trichloroethylene	79-01-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Bis(2-ethylhexyl)phthalate	117-81-7	7.17	U1	6.66	U1	6.66	U1	6.36	U1	7.21	U1	7.03	U1	6.43	U1	3.72	U1
Fluoranthene	206-44-0	0.054	U	0.054	U	0.054	U	0.054	U	0.087		0.054	U	0.054	U	0.054	U
Naphthalene	91-20-3	0.054	U	0.054	U	0.054	U	0.054	U	0.054	U	0.054	U	0.054	U	0.054	U
N-nitroso-di-n-propylamine	621-64-7	2.70	U	2.70	U	2.70	U	2.70	U	2.70	U	2.70	U	2.70	U	4.32	J
Phenanthrene	85-01-8	0.054	U	0.054	U	0.054	U	0.054	U	0.054	U	0.054	U	0.054	U	0.054	U
Pyrene	129-00-0	0.054	U	0.054	U	0.054	U	0.054	U	0.065		0.054	U	0.054	U	0.054	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		1,300		1,500		1,600		1,700		2,200		2,700		2,900		3,200	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		1,800		1,300		1,200	U	1,200	U	1,300		2,000		1,200	U	1,400	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		57		57		50	U	65		83		50	U	87		100	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		87		78		108		130		91		55		110		151	
Total Inorg. Nitrogen, Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Inorganic Nitrogen, Dissolved		1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,200		1,050	U	1,050	U

Sample ID		**GC-12A**		**GC-12B**		**GC-12C**		**GC-12D**		**Replicate**		**Trip Blank**	
York ID		**15G0557-41**		**15G0557-42**		**15G0557-43**		**15G0557-44**		**15G0557-45**		**15G0557-46**	
Sampling Date		**7/15/2015 5:22:00 AM**		**7/15/2015 9:23:00 AM**		**7/15/2015 12:25:00 PM**		**7/15/2015 1:38:00 PM**		**7/15/2015 3:00:00 PM**		**7/15/2015 3:00:00 PM**	
Client Matrix		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L				ug/L	
Dilution Factor		1		1		1		1				1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	NT		0.20	U
1,3,5-Trimethylbenzene	108-67-8	0.20	U	0.20	U	0.20	U	0.20	U	NT		0.20	U
Acrolein	107-02-8	0.20	U	0.20	U	0.20	U	0.20	U	NT		0.20	U
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	NT		0.20	U
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.20	U	NT		0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	NT		0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.50	U	NT		0.50	U
Toluene	108-88-3	0.45	J	0.20	U	0.20	U	0.20	U	NT		0.20	U
Trichloroethylene	79-01-6	0.36	J	0.22	J	0.20	U	0.20	U	NT		0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.60	U	NT		0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Bis(2-ethylhexyl)phthalate	117-81-7	8.28	U1	6.03	U1	6.09	U1	6.50	U1	6.27	U1	NT	
Fluoranthene	206-44-0	0.054	U	0.054	U	0.054	U	0.056	U	0.056	U	NT	
Naphthalene	91-20-3	0.054	U	0.054	U	0.054	U	0.056	U	0.056	U	NT	
N-nitroso-di-n-propylamine	621-64-7	2.70	U	2.70	U	2.70	U	2.78	U	2.78	U	NT	
Phenanthrene	85-01-8	0.054	U	0.054	U	0.054	U	0.056	U	0.056	U	NT	
Pyrene	129-00-0	0.054	U	0.054	U	0.054	U	0.056	U	0.056	U	NT	
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Total Nitrogen		2,300		2,600		1,500		2,400		1,700		NT	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Nitrogen, Total-Dissolved		3,500		3,700		2,500		3,200		3,900		NT	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Phosphorous, Dissolved as P		50	U	50	U	59		85		76		NT	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Phosphorous, Total as P		50	U	50	U	76		110		65		NT	
Total Inorg. Nitrogen, Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Total Inorganic Nitrogen, Dissolved		1,400		1,600		1,050	U	1,050	U	1,050	U	NT	

Q is the Qualifier Column with definitions as follows:
D=result is from an analysis that required a dilution
J=analyte detected at or above the MDL (method detection limit) but below the RL (Reporting Limit) - data is estimated
U=analyte not detected at or above the level indicated
NT=this indicates the analyte was not a target for this sample

Validation Qualifiers:
1 - Qualified as nondetect due to method blank contamination

Detected Results for Grand Canal – August 2015 Tidal Sampling Event

Sample ID		GC-1A		GC-2A		GC-4A		GC-5A		GC-6A		GC-7A		GC-8A		GC-9A	
York ID		15H0938-01		15H0938-02		15H0938-03		15H0938-04		15H0938-05		15H0938-06		15H0938-07		15H0938-08	
Sampling Date		8/27/2015 6:54:00 AM		8/27/2015 6:48:00 AM		8/27/2015 6:31:00 AM		8/27/2015 6:40:00 AM		8/27/2015 6:21:00 AM		8/27/2015 6:17:00 AM		8/27/2015 6:10:00 AM		8/27/2015 6:00:00 AM	
Client Matrix		Water		Water		Water		Water		Water		Water		Water		Water	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
2-Butanone	78-93-3	0.20	UJ2	0.20	UJ2	0.20	UJ2	0.20	UJ2	0.20	UJ2	0.20	UJ2	0.20	UJ2	0.20	UJ2
Acrolein	107-02-8	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.80	U	0.20	U	0.20	U
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
cis-1,2-Dichloroethylene	156-59-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Toluene	108-88-3	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
2,6-Dinitrotoluene	606-20-2	2.50	U	2.50	U	2.56	U	2.56	U	2.78	U	2.56	U	2.50	U	2.50	U
Acenaphthene	83-32-9	0.050	U	0.050	U	0.062		0.051	U	0.056	U	0.051	U	0.050	U	0.050	U
Bis(2-ethylhexyl)phthalate	117-81-7	0.50	U	1.07		2.41		0.93		0.56	UJ2	0.51	U	0.89		0.50	U
Fluoranthene	206-44-0	0.050	U	0.050	U	0.072		0.051	U	0.056	U	0.051	U	0.050	U	0.050	U
Fluorene	86-73-7	0.050	U	0.050	U	0.051	U	0.051	U	0.056	U	0.051	U	0.050	U	0.050	U
Pyrene	129-00-0	0.050	U	0.050	U	0.051	U	0.051	U	0.056	U	0.051	U	0.050	U	0.050	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		2,200		1,700		1,900		1,800		1,600		1,800		1,800		1,600	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		1,900		1,700		1,700		2,000		1,900		1,900		1,800		1,800	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		50	U	50	U	50	U	50	U	50	U	50	U	50	U	143	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		50	U	50	U	63		50	U	50	U	50	U	50	U	53	

Sample ID		**GC-10A**		**GC-1B**		**GC-2B**		**GC-4B**		**GC-5B**		**GC-6B**		**GC-7B**		**GC-8B**	
York ID		**15H0938-09**		**15H0938-10**		**15H0938-11**		**15H0938-12**		**15H0938-13**		**15H0938-14**		**15H0938-15**		**15H0938-17**	
Sampling Date		**8/27/2015 5:54:00 AM**		**8/27/2015 8:57:00 AM**		**8/27/2015 8:53:00 AM**		**8/27/2015 8:38:00 AM**		**8/27/2015 8:45:00 AM**		**8/27/2015 8:27:00 AM**		**8/27/2015 8:20:00 AM**		**8/27/2015 8:13:00 AM**	
Client Matrix		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.31	J	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
2-Butanone	78-93-3	0.20	UJ2	0.20	UJ2	0.20	UJ2	0.20	UJ2	0.20	U	0.20	U	0.20	U	0.20	U
Acrolein	107-02-8	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	3.50		2.10	
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
cis-1,2-Dichloroethylene	156-59-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Ethyl Benzene	100-41-4	0.25	J	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
o-Xylene	95-47-6	0.24	J	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.75	J	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Toluene	108-88-3	0.82		0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.99	J	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
2,6-Dinitrotoluene	606-20-2	2.50	U	2.56	U	2.50	U	2.56	U	2.50	U	2.50	U	2.50	U	2.56	U
Acenaphthene	83-32-9	0.050	U	0.051	U	0.050	U	0.051	U	0.050	U	0.050	U	0.050	U	0.051	U
Bis(2-ethylhexyl)phthalate	117-81-7	4.18		0.51	UJ2	0.50	UJ2	0.62	J2	0.69	J2	0.50	U	0.50	UJ2	1.06	
Fluoranthene	206-44-0	0.10		0.051	U	0.050	U	0.082		0.050	U	0.050	U	0.050	U	0.051	U
Fluorene	86-73-7	0.050	U	0.051	U	0.050	U	0.072		0.050	U	0.050	U	0.050	U	0.051	U
Pyrene	129-00-0	0.050	U	0.051	U	0.050	U	0.051	U	0.050	U	0.050	U	0.10		0.051	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		1,800		1,600		2,300		1,600		1,500		2,000		4,600		1,900	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		2,000		1,500		2,000		2,000		1,600		2,000		1,600		1,800	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		128		115		98		125		91		50	U	91		87	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		50	U	53		55		106		50	U	50	U	102		61	

Detected Results for Grand Canal – August 2015 Tidal Sampling Event

Sample ID		**GC-9B**		**GC-10B**		**GC-1C**		**GC-2C**		**GC-4C**		**GC-5C**		**GC-6C**		**GC-7C**	
York ID		**15H0938-18**		**15H0938-19**		**15H0938-20**		**15H0938-21**		**15H0938-22**		**15H0938-23**		**15H0938-24**		**15H0938-25**	
Sampling Date		**8/27/2015 8:00:00 AM**		**8/27/2015 7:52:00 AM**		**8/27/2015 11:04:00 AM**		**8/27/2015 10:58:00 AM**		**8/27/2015 10:44:00 AM**		**8/27/2015 10:52:00 AM**		**8/27/2015 10:32:00 AM**		**8/27/2015 10:25:00 AM**	
Client Matrix		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
2-Butanone	78-93-3	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Acrolein	107-02-8	4.50		3.40		3.50		4.10		0.20	U	0.20	U	6		2.60	
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
cis-1,2-Dichloroethylene	156-59-2	0.20	U	0.91		0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Toluene	108-88-3	0.20	U	0.88		0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
2,6-Dinitrotoluene	606-20-2	2.78	U	2.56	U	2.50	U	2.78	U	2.56	U	2.56	U	2.56	U	2.56	U
Acenaphthene	83-32-9	0.056	U	0.051	U	0.050	U	0.056	U	0.051	U	0.051	U	0.051	U	0.051	U
Bis(2-ethylhexyl)phthalate	117-81-7	0.56	U	0.65	J2	0.54	J2	0.56	U	1.58	J2	0.51	U	0.75	J2	4.41	J2
Fluoranthene	206-44-0	0.056	U	0.051	U	0.050	U	0.056	U	0.051	U	0.051	U	0.051	U	0.051	U
Fluorene	86-73-7	0.056	U	0.051	U	0.050	U	0.056	U	0.051	U	0.051	U	0.051	U	0.051	U
Pyrene	129-00-0	0.056	U	0.051	U	0.050	U	0.14		0.051	U	0.051	U	0.051	U	0.051	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		1,900		1,700		1,200	U	1,200	U	2,200		2,000		1,400		1,600	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		1,900		1,900		1,200	U	1,200	U	1,900		1,900		1,800		1,800	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		132		119		128		143		132		121		153		123	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		136		61		57		109		226		162		119		132	

Sample ID York ID Sampling Date Client Matrix		GC-8C 15H0938-26 8/27/2015 10:18:00 AM Water		GC-9C 15H0938-27 8/27/2015 10:08:00 AM Water		GC-10C 15H0938-28 8/27/2015 9:48:00 AM Water		GC-1D 15H0938-29 8/27/2015 1:23:00 PM Water		GC-2D 15H0938-30 8/27/2015 1:17:00 PM Water		GC-4D 15H0938-31 8/27/2015 1:04:00 PM Water		GC-5D 15H0938-32 8/27/2015 1:11:00 PM Water		GC-6D 15H0938-33 8/27/2015 12:54:00 PM Water	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
2-Butanone	78-93-3	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Acrolein	107-02-8	0.20	U	4.30		0.20	U	2.50		3.20		0.20	U	5.70		4.90	
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
cis-1,2-Dichloroethylene	156-59-2	0.20	U	0.65		0.47	J	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Toluene	108-88-3	0.20	U	0.92		0.94		0.21	J	0.22	J	0.25	J	0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
2,6-Dinitrotoluene	606-20-2	2.56	U	2.56	U	2.56	U	2.56	U	2.56	U	2.50	U	2.56	U	2.78	U
Acenaphthene	83-32-9	0.051	U	0.051	U	0.051	U	0.051	U	0.051	U	0.050	U	0.051	U	0.056	U
Bis(2-ethylhexyl)phthalate	117-81-7	0.51	UJ2	6.12		0.51	UJ2	0.51	UJ2	0.56		0.54		0.51	U	0.62	
Fluoranthene	206-44-0	0.051	U	0.051	U	0.051	U	0.051	U	0.051	U	0.080		0.051	U	0.056	U
Fluorene	86-73-7	0.051	U	0.051	U	0.051	U	0.051	U	0.051	U	0.050	U	0.051	U	0.056	U
Pyrene	129-00-0	0.051	U	0.051	U	0.051	U	0.051	U	0.051	U	0.050	U	0.051	U	0.056	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		1,800		1,800		1,900		1,700		1,800		1,900		2,500		1,900	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		1,900		2,100		2,000		2,100		1,800		2,900		2,800		1,900	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		181		188		153		130		108		262		286		158	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		138		170		155		128		170		149		254		130	

Sample ID		**GC-7D**		**GC-8D**		**GC-9D**		**GC-10D**		**GC-11A**		**GC-11B**		**GC-11C**		**GC-11D**	
York ID		**15H0938-34**		**15H0938-35**		**15H0938-36**		**15H0938-37**		**15H0938-38**		**15H0938-39**		**15H0938-40**		**15H0938-41**	
Sampling Date		**8/27/2015 12:44:00 PM**		**8/27/2015 12:39:00 PM**		**8/27/2015 12:22:00 PM**		**8/27/2015 12:11:00 PM**		**8/27/2015 5:41:00 AM**		**8/27/2015 7:50:00 AM**		**8/27/2015 9:41:00 AM**		**8/27/2015 12:04:00 PM**	
Client Matrix		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.37	J	0.20	U	0.20	U	0.46	J	0.20	U
2-Butanone	78-93-3	0.33	J	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
Acrolein	107-02-8	7.80		5.70		5.30		6.10		2.20		2.80		2.60		6.20	
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.43	J	0.20	U	0.20	U	0.47	J	0.32	J
cis-1,2-Dichloroethylene	156-59-2	0.20	U	0.20	U	0.40	J	0.41	J	0.43	J	0.32	J	0.20	U	0.27	J
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.33	J	0.20	U	0.20	U	0.46	J	0.31	J
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.42	J	0.20	U	0.20	U	0.49	J	0.33	J
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.95	J	0.50	U	0.50	U	1.20		0.71	J
Toluene	108-88-3	0.20	U	0.20	U	0.33	J	2.20		0.20	U	0.26	J	2.70		1.40	
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	1.40	J	0.60	U	0.60	U	1.70		1	J
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
2,6-Dinitrotoluene	606-20-2	2.78	UJ2	2.56	U	2.56	U	2.56	U	2.50	U	2.50	UJ2	2.56	U	2.56	UJ2
Acenaphthene	83-32-9	0.056	UJ2	0.051	U	0.051	U	0.051	U	0.050	U	0.050	UJ2	0.051	U	0.051	UJ2
Bis(2-ethylhexyl)phthalate	117-81-7	11.90	J2	0.71		0.61		0.51	U	1.28		11.60	J2	0.80		2.75	J2
Fluoranthene	206-44-0	0.056	UJ2	0.051	U	0.051	U	0.051	U	0.050	U	0.050	UJ2	0.051	U	0.051	UJ2
Fluorene	86-73-7	0.056	UJ2	0.051	U	0.051	U	0.051	U	0.050	U	0.050	UJ2	0.051	U	0.051	UJ2
Pyrene	129-00-0	0.056	UJ2	0.051	U	0.051	U	0.051	U	0.050	U	0.050	UJ2	0.051	U	0.051	UJ2
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Total Nitrogen		1,800		2,400		3,200		3,300		2,000		2,100		2,100		1,700	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		1,400		1,700		1,800		1,800		1,800		1,700		1,600		1,800	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Dissolved as P		361		363		125		166		145		232		106		185	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1		1		1	
Phosphorous, Total as P		192		256		145		143		113		183		138		181	

Detected Results for Grand Canal – August 2015 Tidal Sampling Event

Sample ID		GC-12A		GC-12B		GC-12C		GC-12D		Replicate		Trip Blank	
York ID		15H0938-42		15H0938-43		15H0938-44		15H0938-45		15H0938-46		15H0938-47	
Sampling Date		8/27/2015 5:29:00 AM		8/27/2015 7:40:00 AM		8/27/2015 9:33:00 AM		8/27/2015 11:54:00 AM		8/27/2015 12:00:00 AM		8/27/2015 12:00:00 AM	
Client Matrix		Water		Water		Water		Water		Water		Water	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
2-Butanone	78-93-3	0.20	U	0.20	U	0.20	UJ2	0.20	UJ2	0.20	UJ2	0.20	UJ2
Acrolein	107-02-8	4.60		3.50		0.20	U	0.20	U	0.20	U	0.20	U
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
cis-1,2-Dichloroethylene	156-59-2	0.20	U	0.20	U	0.20	U	0.20	U	0.84		0.20	U
Ethyl Benzene	100-41-4	0.20	U	0.20	U	0.20	U	0.28	J	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.69	J	0.50	U	0.50	U
Toluene	108-88-3	0.33	J	0.29	J	0.20	U	1.50		0.85		0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.69	J	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
2,6-Dinitrotoluene	606-20-2	2.50	U	2.50	U	2.50	U	16		2.86	U	NT	
Acenaphthene	83-32-9	0.050	U	0.050	U	0.050	U	0.050	U	0.057	U	NT	
Bis(2-ethylhexyl)phthalate	117-81-7	1.87		2.39		0.50	U	1.04		0.77		NT	
Fluoranthene	206-44-0	0.050	U	0.050	U	0.050	U	0.050	U	0.057	U	NT	
Fluorene	86-73-7	0.050	U	0.050	U	0.050	U	0.050	U	0.057	U	NT	
Pyrene	129-00-0	0.050	U	0.050	U	0.050	U	0.050	U	0.057	U	NT	
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Total Nitrogen		2,100		1,900		1,900		1,700		1,800		NT	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Nitrogen, Total-Dissolved		1,400		1,400		1,400		1,300		1,700		NT	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Phosphorous, Dissolved as P		155		102		432		314		164		NT	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L			
Dilution Factor		1		1		1		1		1			
Phosphorous, Total as P		115		78		301		98		153		NT	

Q is the Qualifier Column with definitions as follows:
D=result is from an analysis that required a dilution
J=analyte detected at or above the MDL (method detection limit) but below the RL (Reporting Limit) - data is estimated
U=analyte not detected at or above the level indicated
NT=this indicates the analyte was not a target for this sample

Validation Qualifiers:
1 - Qualified as nondetect due to trip blank contamination
2 - Qualified as estimated due to LCS noncompliance

Sample ID		**SW-1**		**SW-2**		**SW-3**		**SW-4**		**SW-5**		**SW-6**	
York ID		**15H0318-01**		**15H0318-02**		**15H0318-03**		**15H0318-04**		**15H0318-05**		**15H0318-06**	
Sampling Date		**8/11/2015 10:27:00 AM**		**8/11/2015 10:38:00 AM**		**8/11/2015 10:54:00 AM**		**8/11/2015 11:08:00 AM**		**8/11/2015 11:18:00 AM**		**8/11/2015 11:33:00 AM**	
Client Matrix		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
2-Butanone	78-93-3	0.20	U	0.20	U	0.21	J	0.20	U	0.20	U	0.20	U
Acetone	67-64-1	2.10		1.90	J	1.80	J	3.10		1	U	1	U
Acrolein	107-02-8	0.80	U	1.10	J	1.60	J	0.80	U	0.80	U	0.80	U
Benzene	71-43-2	0.20	U	0.46	J	0.20	U	0.20	U	0.20	U	0.20	U
Carbon disulfide	75-15-0	0.24	J	0.20	U	0.21	J	0.20	U	0.20	U	0.20	U
Chloromethane	74-87-3	0.32	J	0.27	J	0.37	J	0.36	J	0.28	J	0.35	J
Toluene	108-88-3	0.20	U	0.93		0.20	U	0.20	U	0.20	U	0.20	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Bis(2-ethylhexyl)phthalate	117-81-7	1.33		5.89		0.75		5.37		0.51	U	0.53	
Fluoranthene	206-44-0	0.092		0.051	U	0.082		0.051	U	0.051	U	0.051	U
Fluorene	86-73-7	0.051	U	0.051	U	0.051	U	0.051	U	0.051	U	0.051	U
Phenanthrene	85-01-8	0.13		0.051	U	0.051	U	0.051	U	0.051	U	0.051	U
Pyrene	129-00-0	0.082		0.051	U	0.051	U	0.051	U	0.051	U	0.051	U
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Total Nitrogen		3,500		2,000	U	2,000	U	2,000	U	2,000	U	2,400	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Phosphorous, Dissolved as P		80		87		85		132		80		72	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Phosphorous, Total as P		85		282		115		597		140		100	

Q is the Qualifier Column with definitions as follows:
J=analyte detected at or above the MDL (method detection limit) but below the RL (Reporting Limit) - data is estimated
U=analyte not detected at or above the level indicated

Detected Results for Grand Canal – September 2015 Sampling Event

Sample ID		**SW 1**		**SW 2**		**SW 3**		**SW 4**		**SW 5**		**SW 6**	
York ID		**15I0122-01**		**15I0122-02**		**15I0122-03**		**15I0122-04**		**15I0122-05**		**15I0122-06**	
Sampling Date		**9/3/2015 10:00:00 AM**		**9/3/2015 10:15:00 AM**		**9/3/2015 10:27:00 AM**		**9/3/2015 10:43:00 AM**		**9/3/2015 10:34:00 AM**		**9/3/2015 10:07:00 AM**	
Client Matrix		**Water**		**Water**		**Water**		**Water**		**Water**		**Water**	
Compound	**CAS Number**	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Volatile Organics, 8260 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
1,2,4-Trimethylbenzene	95-63-6	0.20	U	0.20	U	0.20	U	0.26	J	0.20	U	0.20	U
Acetone	67-64-1	1	U	1.80	J	1	U	1	U	2		1.80	J
Acrolein	107-02-8	7.20		0.20	U	2.40		2.70		2.20		0.20	U
Benzene	71-43-2	0.20	U	0.20	U	0.20	U	0.25	J	0.20	U	0.20	U
o-Xylene	95-47-6	0.20	U	0.20	U	0.20	U	0.26	J	0.20	U	0.20	U
p- & m- Xylenes	179601-23-1	0.50	U	0.50	U	0.50	U	0.66	J	0.50	U	0.50	U
tert-Butyl alcohol (TBA)	75-65-0	0.81	J	0.87	J	0.71	J	0.50	U	0.50	U	0.50	U
Toluene	108-88-3	1		0.20	U	0.20	U	1.20		0.20	U	0.20	U
Xylenes, Total	1330-20-7	0.60	U	0.60	U	0.60	U	0.92	J	0.60	U	0.60	U
Semi-Volatiles, 8270 - Comprehensive		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Bis(2-ethylhexyl)phthalate	117-81-7	2.53		4.15		90.30		2.75		4.97		5.71	
Naphthalene	91-20-3	0.053	U	0.051	U	0.053	U	0.86		0.60		0.87	
Nitrogen, Total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Total Nitrogen		3,100		2,300		2,900		2,200		2,000		2,100	
Nitrogen, Total-Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Nitrogen, Total-Dissolved		3,000		2,400		2,000		2,400		2,300		2,300	
Phosphorous, Dissolved as P		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Phosphorous, Dissolved as P		224		138		149		164		155		128	
Phosphorous, total		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Phosphorous, Total as P		175		87		320		115		106		87	
Total Inorg. Nitrogen, Dissolved		ug/L		ug/L		ug/L		ug/L		ug/L		ug/L	
Dilution Factor		1		1		1		1		1		1	
Total Inorganic Nitrogen, Dissolved		1,050	U	1,050	U	1,050	U	1,050	U	1,050	U	1,050	U

Q is the Qualifier Column with definitions as follows:

J=analyte detected at or above the MDL (method detection limit) but below the RL (Reporting Limit) - data is estimated

U=analyte not detected at or above the level indicated

All Analytical Results for Surface Water Samples

See Appendix G for Laboratory Results

Appendix D

Essential Fish Habitat Assessment

and

Supplemental Fish Sampling Report

Analysis and Assessment Of Grand Canal Project

ESSENTIAL FISH HABITAT ASSESSMENT

Prepared for:
Suffolk County Department of Health Services
Office of Ecology
360 Yaphank Avenue
Suite 2B
Yaphank, NY 11980

June 2015
Revision 1

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Section **Page**

1.0 Introduction

This assessment to Essential Fish Habitat (EFH) for the Grand Canal Dredging Project is being provided in conformance with the 1996 amendments to the Magnuson-Stevens Fishery Management and Conservation Act (see FR 62, 244, December 19, 1997). The 1996 amendments to the Magnuson-Stevens Act set forth a number of new mandates for the National Marine Fisheries Service (NMFS), eight regional fishery management councils (Councils), and other federal agencies to identity and protect important marine and anadromous fish habitat. The Councils, with assistance from NOAA Fisheries, are required to delineate EFH for all managed species. Federal action agencies which fund, permit or carry out activities that may adversely impact EFH are required to consult with NOAA Fisheries regarding the potential effects of their actions on EFH, and respond in writing to the NOAA Fisheries' recommendations. The proposed dredging project is located within an area designated as EFH for the Northeast Council's Coastal Pelagics and Northeast Groundfish Management Plans.

2.0 Project Purpose

For a number of years, Grand Canal has been the subject of complaints by area residents, reportedly concerned with progressive shoaling and reduction in tidal flushing. Issues surrounding the reduction of tidal flushing include but are not limited to: possible increases of mosquito breeding with links to West Nile Virus, general water quality degradation, the ecological health of the adjacent wetlands, residential area flooding, and shoaling within the navigation channel. The purpose of the Grand Canal Dredge Project is to improve the ecological condition of the canal by mitigating the build-up of sediment within the canal in areas that are shallow and restricting tidal flow.

3.0 Description of the Proposed Action

The objective of the dredging project is to create a 5 foot below MLW channel (where applicable) throughout the canal to enhance water movement during tidal cycles. The dredge material (approximately 15,000 cubic yards) will be disposed of in an existing upland containment area.

4.0 Location and Site Description

The Grand Canal is a man-made waterway and is a tributary or branch of the Connetquot River, located in Oakdale, NY, Town of Islip. The main channel of the canal is approximately 8,000 feet in length and 20 feet wide (variable). The canal system also includes a number of branch channels that extend into residential areas, providing access to the main channel. There are two interfaces that lead into the Connetquot River, one is at midsection (northern interface) of the tidal portion of the river and the other interface is in the southern section of the tidal portion. The northern interface is surrounded by residential properties and the southern interface is bordered on either side by commercial properties, including a marina and restaurant. The land area surrounding the northern section of the main canal, that runs east-west, consists of residential properties. For the north to south section of the main channel, the land to the west is a mixture of residential properties and tidal wetlands. The adjacent land area to the east is dominated by an extensive tidal and freshwater wetland complex known as the Pickman-Remmer Wetlands owned by the State of New York. (Figure 1)

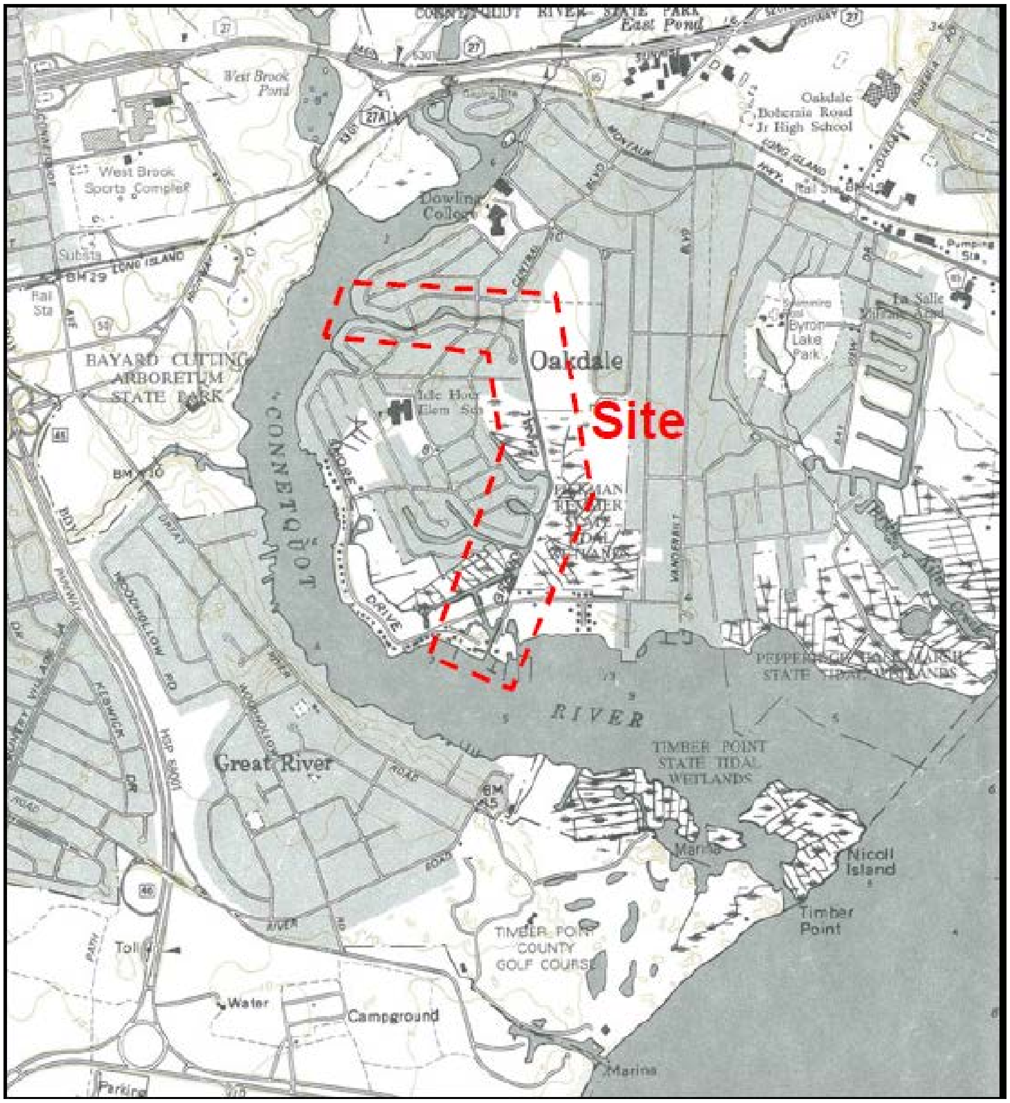
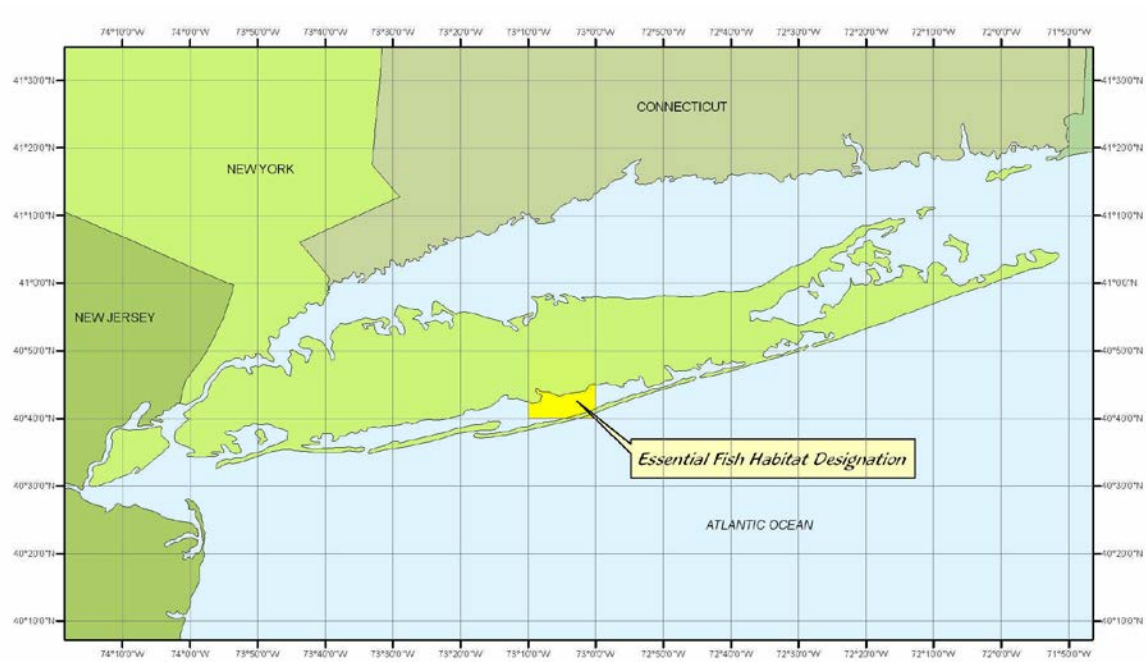


Figure 1. Site map depicting approximate location of project area.

5.0 Summary of Essential Fish Habitat (EFH) Designation

According to the NYS Department of State, the project area is located in the Significant Coastal Fish and Wildlife Habitat (SCFWH)-Connetquot River. The SCFWH is approximately 4,500 acres in area and is the largest contiguous area of undeveloped land in Suffolk County that encompasses an entire watershed. The river itself is also significant due to its designation as a Wild, Scenic and Recreational River under Article 15, Title 27 of the New York State Conservation Law. This EFH provides suitable habitat for a tremendous diversity of fish and wildlife species. The Connetquot River is fed by many natural coldwater springs and supports a significant sea-run fishery for non-native trout. The estuary is a nursery for yearling striped bass and bluefish that concentrate to feed in the tidewater areas before commencing coastal migration. The EFH associated with this project encompasses the area shown in Figure 2.

Figure 2. Shows the 10-minute x 10-minute square of latitude and longitude where Grand Canal is located.



<u>10� x 10� Square Coordinates:</u>

Boundary	North	East	South	West
Coordinate	40° 50.0� N	73° 00.0� W	40° 40.0� N	73° 10.0� W

<u>Square Description (i.e. habitat, landmarks, coastline markers):</u> Atlantic Ocean waters within the square and within Great South Bay, north of Ocean Beach, and south of Sayville, NY. and Boheamia, NY., from Patchogue, NY. and western Patchogue Bay to just west of Nicoll Pt. on Nicoll Bay, southeast of Great River, NY., and the Connetquot River.

-

Species	Eggs	Larvae	Juveniles	Adults
Atlantic salmon *(Salmo salar)*				X

Atlantic cod *(Gadus morhua)*				
haddock *(Melanogrammus aeglefinus)*				
pollock *(Pollachius virens)*			X	
whiting *(Merluccius bilinearis)*				
offshore hake *(Merluccius albidus)*				
red hake *(Urophycis chuss)*				
white hake *(Urophycis tenuis)*				
redfish *(Sebastes fasciatus)*	n/a			
witch flounder *(Glyptocephalus cynoglossus)*				
winter flounder *(Pseudopleuronectes americanus)*	X	X	X	X
yellowtail flounder *(Limanda ferruginea)*				
windowpane flounder *(Scophthalmus aquosus)*	X	X	X	X
American plaice *(Hippoglossoides platessoides)*				
ocean pout *(Macrozoarces americanus)*				
Atlantic halibut *(Hippoglossus hippoglossus)*				
Atlantic sea scallop *(Placopecten magellanicus)*				
Atlantic sea herring *(Clupea harengus)*			X	X
monkfish *(Lophius americanus)*				
bluefish *(Pomatomus saltatrix)*			X	X
long finned squid *(Loligo pealeii)*	n/a	n/a		
short finned squid *(Illex illecebrosus)*	n/a	n/a		
Atlantic butterfish *(Peprilus triacanthus)*	X	X	X	X
Atlantic mackerel *(Scomber scombrus)*	X	X	X	X
summer flounder *(Paralichthys dentatus)*			X	X

scup *(Stenotomus chrysops)*	n/a	n/a	X	X
black sea bass *(Centropristis striata)*	n/a			X
surf clam *(Spisula solidissima)*	n/a	n/a		
ocean quahog *(Artica islandica)*	n/a	n/a		
spiny dogfish *(Squalus acanthias)*	n/a	n/a		
tilefish *(Lopholatilus chamaeleonticeps)*				
king mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
cobia *(Rachycentron canadum)*	X	X	X	X
sand tiger shark *(Carcharias taurus)*		X		
blue shark (*Prionace glauca)*				X
dusky shark *(Carcharhinus obscurus)*		X		
sandbar shark *(Carcharhinus plumbeus)*		X	X	X
skipjack tuna *(Katsuwonus pelamis)*				X

-

The following is an evaluation of the effects on the EFH associated with this project:

- Atlantic salmon (*Salmo salar*) – No adverse effect is expected because adults are not found in project area.
- Pollock (*Pollachius virens*) – Juveniles have been reported over a wide variety of substrates, including sand, mud, or rocky bottoms and vegetation. They are found at temperatures ranging from 0 to 16^{o} C and prefer salinities of around 31.5 ppt . No adverse effect is expected because juveniles are normally not found in the project area and the impacts associated with a project of this size can be easily avoided by mobile juveniles.
- Winter flounder (*Pleuronectes americanus*) – Although this species is known to migrate inshore to spawning grounds in early fall to late winter, spawning most

likely does not occur in the project area due to substrate characteristics and poor water quality. In addition, the area of dredging is small in comparison to the essential habitat of the surrounding area. Adult fish migrating into the area to spawn will be able to avoid proposed dredge location. No adverse effect on all life stages of this species is expected from proposed action.

- Windowpane flounder (*Scopthalmus aquosus*) - No adverse effect is expected on all life stages of this fish because of a very limited project size and because dredging will be done during the winter months when this species is not inhabiting the project area.
- Atlantic sea herring (*Clupea harengus*) - No adverse effect is expected because adults and juveniles are not known to inhabit the in project area. Adults and juveniles are known to prefer higher salinities than found in project area.
- Bluefish (*Pomatomus saltatrix*) – Both juvenile and adults are found in the project area; however, both life stages are mobile and can avoid the proposed action. No adverse effect is expected on juveniles or adults of this species are expected because dredging will be done during the winter months when this species does not inhabit the project area.
- Atlantic butterfish (*Perpilus triacanthus*) –All life stages of this species are not normally found in project area. Larvae, juveniles and adults are normally found offshore in the pelagic waters over the Continental Shelf. No impact to this species is expected from the proposed project.
- Atlantic mackerel (*Scomber scombrus*) - All life stages of this species occur offshore in pelagic waters found over the Continental Shelf. No impact to this species is expected from the proposed project.
- Summer Flounder (*Paralicthys dentatus*) – This species is listed as occurring in this EFH area; however both juvenile and adults are mobile and can easily avoid the dredge activities. No adverse impact to this species is expected to occur as a result of the proposed action because dredging will be done during the winter months when this species does not inhabit the project area.
- Scup (*Stenotomus chrysops*) - This species is listed as occurring in this EFH area; however, both juvenile and adults are mobile and can easily avoid the dredge

area. In addition, this species is not commonly found in the project area during the proposed dredge window. No adverse impact to this species is expected to occur as a result of the proposed action.

- Black sea bass (*Centropristus striata*) - This species is listed as occurring in the EFH; however adults are usually found in association with rough bottom and are mobile and can easily avoid the dredge activity area. No adverse impact to this species is expected to occur as a result of the proposed action because dredging will be done during the winter months when this species does not inhabit the project area.
- King mackerel (*Scomberomorus cavalla*) – No adverse effect on all life stages of this species is expected because they are pelagic off the coast on the Continental Shelf.
- Spanish mackerel (*Scomberomorus maculates*) - No adverse effect on all life stages of this species is expected because they are pelagic off the coast on the Continental Shelf.
- Cobia (*Rachycentron canadum*) - No adverse effect is expected on all life stages of this species because they are pelagic off the coast on the Continental Shelf.
- Sand tiger (*Odontaspis Taurus*), common thresher (*Alopias vulpinus*), blue (*Prionace glauca*), white (*Charcharadon carcharias*), tiger (*Galeocerdo cuvieri*), dusky (*Charcarinus obscurus*), sandbar (*Charcharinus plumbeus*), and shortfin mako (*Isurus oxyrhyncus*) sharks - No adverse effect on any life stages of these species is expected because they are pelagic off the coast on the Continental Shelf.
- Skipjack tuna (*Katsuwonus pelamis*)- No adverse effect on the juvenile or adult life stages of these species is expected because they are pelagic off the coast on the continental shelf.

In addition, the New England Fishery Management Council and the Skate Plan Development Team prepared a 2000 Skate Stock Assessment and Fishery Evaluation Report regarding essential fish habitat for skates. The document determined that seven species in the Northeast skate complex are of concern. Two of those species, winter skate (*Leucoraja ocellata*) and little skate (*Leucoraja erinacea*), may inhabitat waters surrounding the project area during their juvenile and adult life stages. However, due to the relatively small project area compared to the overall EFH and the fact that both juveniles and adults are mobile and can avoid the proposed action, no significant adverse impact of either of these species is expected.

6.0 Impact Assessment of Proposed Project

This section of the report discusses the potential impacts that may result from the proposed project. The impacts are evaluated as direct, indirect and cumulative as they relate to habitat and to species of concern that may be using the habitat.

6.1 Direct Adverse Impact

Direct impacts that may result from this proposed project include: direct impacts from dredging; direct impacts from placement of beach re-nourishment material. The activities associated with this project may cause temporary substrate disturbance, temporary water quality degradation (turbidity), and possibly temporary disturbance and displacement of some benthic fauna species. However, due to the limited project size, location and proposed construction window, all of these activities will have little or no impact on any of the important marine and anadromous species located in the area designated with an Essential Fish Habitat for the Northeast Council's Coastal Pelagics and Northeast Groundfish Management Plans.

Estuary faunal composition, abundance, and biomass are strongly seasonal in the Northeastern Region of the EFH, with peak abundance and biomass occurring in late spring (May) and late summer (August). The only species listed in this destination that may be slightly effected by the action would be the winter flounder which tends to start their inshore migration to spawning grounds in late fall to early winter. The adults and juveniles are mobile, it is expected that they will avoid the area during disturbance. Also, dredging will be done during the winter months when this species does not inhabit the project area, therefore no adverse impact is expected.

The suspended sediments that may be introduced into the water column during the dredging operation would be very localized and short-term. The visual inspection and grain size analysis of the sediment being dredged indicates that it is mostly fine sediment. However, any suspended sediment resulting from the action is expected to be short termed and very localized.

6.2 Indirect Adverse Impacts

No indirect adverse impacts to the EFH species are expected from the proposed project.

6.3 Cumulative Adverse Impacts

No cumulative adverse impacts to the EFH species are expected from the proposed project.

Draft Supplement Fish Survey Report

For

Grand Canal, Oakdale, New York

Prepared for:

Suffolk County Department of Health Services

335 Yaphank Avenue

Yaphank, NY 11980

Prepared by:

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1200 Veterans Memorial Highway

Hauppauge, NY 11788

October 2015

Supplemental Fisheries Survey

In addition to conducting an Essential Fish Habitat Assessment, supplemental fisheries data was collected utilizing various sampling methodologies. The result of this survey was to provide an absence/presence qualitative analysis of the fish assemblage in Grand Canal.

Fish sampling was conducted on 10/14/2014, and 7/7, 9/1, 9/2, 9/3, 9/17 and 10/22/2015. The following sampling methods were utilized: throw nets, seine nets, gill nets of various size, minnow traps, eel traps, and crab traps. Table 1 lists all of the finfish species captured or observed during the survey. Table 2 lists all incidental by-catch (non-finfish species) captured or observed during the finfish survey.

In addition, a photo of each species is shown in Appendix 1. Note: All photographs were taken by CA staff during Grand Canal finfish survey with the exception of the Atlantic Needlefish which was only observed swimming (i.e. never captured during survey).

Table 1. List of finfish species captured or observed during finfish survey.

Common Name	**Scientific Name**
Atlantic Silverside	*Menidia menidia*
Bay Anchovy	*Anchoa mitchili*
Bluefish	*Pomatomus saltaatrix*
Mummichug	*Fundulus heteroclitus*
American Eel	*Anguilla rostrate*
Atlantic Menhaden	*Brevoortia tyannus*
Oyster Toadfish	*Opsanus tau*
Sheepshead Minnow	*Cyprinodont variegates*
Banded Killifish	*Fundulus diaphanus*
Naked Goby	*Gobiosoma bosc*
Winter Flounder	*Psuedopleuronectes americanus*
Atlantic Needlefish	*Strongylura marina*
Black Drum	*Pogonias cromis*

<u>Atlantic Silverside (*Menidia menidia*)</u> – The Atlantic silverside is an important forage fish, reaching high abundance in the shore-zone of salt marches, estuaries, and tidal creeks (Bigelow and Schroeder, 1953). This species is often the most abundant fish encountered in these areas. The importance of Atlantic silversides as forage for such piscivores as striped bass, Atlantic mackerel, and bluefish has been well documented (Bayliff, 1950). Silversides tend to congregate in schools, frequently along sandy or gravely shorelines. They are omnivorous, feeding chiefly on copepods, mysids, shrimp, small decapods shrimp, amphipods, Cladocera, fish eggs (including their own), young squid, annelid worms, insect larvae and mollusca larvae. They mature at age 1 and spawn in the intertidal zone of estuaries from March to June in the mid- Atlantic region. Few 2-year-old fish are ever encountered, so the Atlantic silverside is basically a short-lived species. Most spawning occurs at high tide during new or full moon phases. Eggs are adhesive and are found attached to submerged vegetation. Larvae, juveniles, and adults generally inhabit similar areas. Sex is determined in larval development 32 to 46 days after hatching, and is a function of parental genotype and water temperature regime during the critical period. Fisheries for this species are not documented. Eggs can tolerate water temperatures between 15" and 30°C, and larvae need temperature above 15°C for survival. Larvae tolerate relatively acute temperature

increases. Upper lethal temperatures for juveniles and adults range from 30.5" to 33.8"C, depending on acclimation temperature. Salinities of 20 ppt or lower significantly delay hatching and affect larval survival. Juveniles and adults tolerate the full range of naturally occurring salinities (i.e., freshwater to at least 37.8 ppt) (US Fish and Wildlife Services, 1983).

Bay anchovy (*Anchoa mitchili*) – Ecologically, the bay anchovy is one of the most important species in the Mid-Atlantic region. It is of enormous trophic importance as a primary forage item for many economically important predators and is an important link in the estuarine food web. Bay Anchovies are ubiquitous inhabitants of the Mid-Atlantic Region. Adults inhabit shallow and moderately deep offshore water, nearshore waters off sand beaches, open bays, muddy coves, grassy areas along beaches, and waters around the mouths of rivers. Substrate and vegetation appear to be of little significance in their distribution. In the Mid-Atlantic Region spawning apparently occurs in estuarine waters when water temperature are at least 12^{o}C and salinities are over 10 ppt. Zooplankton constitutes the major portion of the diet of bay anchovies. They have been collected at water temperatures ranging from 2.2 to 27.1^{o}C and from water salinities ranging from 0.0 to 80ppt (Morton, 1989).

Bluefish (*Pomatomus saltaatrix*) – Bluefish are considered an important recreational fishery in the Mid-Atlantic Region, but not commercially. One population spawns offshore during spring from northern Florida to North Carolina, and these young migrate into Mid Atlantic coastal waters to spend their summer and fall. A second population spawns offshore during summer from North Carolina to Massachusetts, but most of these young remain offshore for the remainder of the season. In late fall, young and adults of both populations migrate south until the following spring. Bluefish are migratory, opportunistic, pelagic predators throughout life, and their seasonal abundance may have profound community structuring effects. Schools of juvenile bluefish may be important forage for many pelagic predators, including adults of their own species. Photoperiod apparently triggers long-range migration, and temperature serves as a proximal cue to short-range migrations. Bluefish are sensitive to bacterial infection in polluted water and have little tolerance for low oxygen conditions (Potter, 1989).

Mummichug (*Fundulus heteroclitus*) – Although not valued as a commercial or sport fishes, the mummichug is important in the marsh food chain and may be instrumental in movement of organic material within and out of salt marsh ecosystems. Mummichugs are considered to be one of the primary predators in marsh management mosquito control programs as well as being used in research in experimental studies of embryology, genetics, physiology endocrinology, cytology, bioassay for water pollution and behavior. Mummichugs have a semilunar spawning periodicity during the spawning season; eggs incubate in air and are not submerged until the next spring tide after they are laid. Young mummichogs remain on the marsh for 6-8 weeks, then begin to move off with the tides, with the adults. Mummichogs are euryphagous predators, and are tolerant of temperature and salinity fluctuations (Abraham, 1985).

American eel (*Anguilla rostrate*) – The American eel is an ecologically and economically important catadromous species that occupies freshwater streams, river, brackish estuaries, and the open ocean during various phases of its lifecycle. Adults apparently spawn in the Sargasso Sea, and ocean currents transport the developing larva northward until the young metamorphose into juveniles capable of swimming shoreward and moving upstream into brackish areas for 10-12 years before migrating to spawn. They pray on a variety of other animals including commercially important crabs and clams. Eels contribute to the loss of nutrients from freshwater rivers and lakes becaus3ee of their high organic intake, large number, and lengthy stay in freshwater, and subsequent migration to sea. Eels occupy areas having wide ranges of temperature, salinity, and other environmental factors (Facey, 1987).

Atlantic Menhaden (*Brevoortia tyannus*) – Atlantic menhaden occupy estuaries and coastal waters from northern Florida to Nova Scotia and are believed to consist of a single population. Adult and juvenile menhaden form large, near-surface schools, primarily in estuaries and nearshore ocean waters from early spring through early winter. By summer, menhaden schools stratify by size and age along the coast, with older and larger menhaden found farther north. During fall-early winter, menhaden of all sizes and ages migrate south around the North Carolina capes to spawn. Menhaden are very efficient filter feeders. Water is pushed through specialized gill rakers that are formed into a basket that allows them to capture plankton. Menhaden are an important component of the food chain, providing a link between primary production and higher organisms by consuming plankton and providing forage for species such as striped bass, bluefish, and weakfish, to name just a few (Atlantic States Marine Fisheries Commission website, 2015).

Oyster Toadfish (*Opsanus tau*) – The toadfish is a year round resident of the Great South Bay. This species is a bottom-dweller found primarily within and around oyster reefs, wrecks, debris, rocks, vegetation and other dark, secluded spots in the shallows during the winter months and moving into deeper channels during the winter. They feed mostly on small crabs and other crustaceans but will also eat mollusks and small fish. This species is hardy, tolerating litter and polluted water and can survive out of water for a lengthy period of time (Chesapeake Bay Program website, 2015).

Sheepshead Minnow (*Cyprinodont variegates*) - The sheepshead minnow is native to the eastern coast of the United States. Its range extends from Cape Cod southwards to the Yucatan peninsula in Mexico, also the West Indies. It is found in brackish water in bays, inlets, lagoons, saltmarshes and similar locations with little wave action and sandy or muddy bottoms. It is tolerant of wide variations in salinity and is also found in hypersaline conditions. The sheepshead minnow is an omnivore, eating both animal and vegetable matter. Its diet mainly consists of detritus, microalgae, crustacean larvae and other small invertebrates (including mosquito larva). It is aggressive and will attack fish larger than itself, slashing its prey with its sharp teeth and devouring it when it is subdued. Breeding takes place in shallow water between April and September, the males competing fiercely for the females. A few eggs are spawned at a time, and these are fertilized by the males which grasp the females with their fins. The eggs clump together and sink to the seabed, connected by sticky threads. They hatch after five or six days. During the winter, this fish burrows into the soft substrate and remains dormant (Wikipedia, 2015).

Banded Killifish (*Fundulus diaphanus*) – The banded killifish is a North American species of temperate freshwater killifish with a natural geographic range extending from Newfoundland to South Carolina, and west to Minnesota. The banded killifish is the only freshwater killifish found in the northeastern United States. While it is primarily a freshwater species, it can occasionally be found in brackish water. Banded killifish are schooling fish, usually traveling in groups of 3–6 individuals, while the juveniles travel in groups of 8–12. The fish are most often found in the shallow and quiet areas of clear lakes, ponds, rivers, and estuaries with sandy gravel or muddy bottoms and with abundant aquatic vegetation. The sand and gravel provides hatchlings and juveniles with places to hide when threatened by predatory fish. Because the banded killifish is small, it generally does not venture into deeper waters, where it would be vulnerable to predation as well as unable to swim in the fast currents. However, adult banded killifish have been observed to travel into deep bodies of water to feed. Banded killifish often congregate near aquatic vegetation, as it provides protection as well as breeding habitat. Banded killifish are euryhaline, but they usually inhabit freshwater streams and lakes. They are important to aquatic ecosystems because they are a food source for larger fish such as largemouth bass, northern pike, and trout. They are also a food source for birds such as belted kingfisher (*Megaceryle alcyon*), common merganser (*Mergus merganser*), and herons (Wikipedia, 2015).

Naked Goby (*Gobiosoma bosc*) - The naked goby occurs in a variety of generally shallow estuarine habitats like patches of oysters, oyster reef, saltmarsh and bare sand/mud substrate, but it is most abundant in tide pools and subtidal areas with oyster shell. The naked goby occurs along the Atlantic coast from Massachusetts to Florida, except for extreme south Florida. Naked goby population size is very likely linked to the quantity and quality of their preferred habitat. This fish utilizes these areas for its entire life cycle and requires specific physical structure within to ensure successful reproduction. Reducing the quantity and quality of habitat for structure-associated invertebrates and fishes will result in reduced populations (Roumillat. 2004).

Winter Flounder (*Psuedopleuronectes americanus*) – Winter flounder are found primarily in estuarine and coastal waters along the Atlantic coast of North America from Newfoundland to Georgia, except for off-shore populations on Georges Bank and Nantucket Shoal. Larvae begin to feed 2 to 3 weeks after they hatch. They first feed on copepods and phytoplankton, but as they reach metamorphosis, their diet is composed of copepod nauplii, small polychaetes, nemerteans, and ostracods. Adult winter flounder fed largely on organisms of three phyla: Annelida, Cnidaria, and Mollusca. Adult winter flounder are the prey of many of the l a r g e r estuarine and coastal predators such as striped bass,, bluefish, goosefish, spiny dogfish, oyster toadfish, and sea raven (Buckley, 1989).

Atlantic Needlefish (*Strongylura marina)* – The Atlantic needlefish ranges along the Atlantic coast from Maine to the northern Gulf of Mexico and south to Brazil. This species inhabits shallow waters near the shoreline and is often seen at the water's surface near docks, marshes, beaches and bay grass beds. The needlefish forages for shrimp and small fish such as killifishes and silversides. It patiently stalks its prey then catches it sideways in its scissor-like jaws. Spawning occurs in May to June. Females have only one ovary. Her round eggs sink to the bottom, where they attach by adhesive fibers to underwater grass blades and other surfaces (Chesapeake Bay Program website, 2015).

Black Drum (*Pogonias cromis*) – Black drums can be found in nearshore waters along the Atlantic coast from the Gulf of Maine to Florida and as far south as Argentina. Atlantic coast black drum migrate inshore to the north in the spring, and to the south in the fall. Fish can reach over 46", 120 pounds and 60 years of age. They grow rapidly until the age of 15, at which time growth slows. Black drum are primarily bottom feeders. Young black drum feed on small fish and invertebrates, such as copepods, annelids, and amphipods. The eggs and larvae of this species were shown to be subject to high predation. As juveniles, they are prey to a wide range of estuarine fish species, such as spotted seatrout and crevalle jack (Atlantic States Marine Fisheries Commission website, 2015).

Table 2. Incidental invertebrate by-catch captured or observed during the finfish survey.

Common Name	Scientific Name
Blue Crab	*Callinectes sapidus*
Mud Crab	*Panopues spp.*
Sand Shrimp	*Crangon septemspinosa*
Grass Shrimp	*Hippolyte spp.*

Blue Crab (*Callinectes sapidus*) – Blue crabs are found in brackish coastal lagoons and estuaries from Nova Scotia, through the Gulf of Mexico, and as far south as Uruguay. Close relatives of the shrimp and lobster, these bottom-dwelling omnivores have a prickly disposition and are quick to use their sharp front pincers. Large males can reach 9 inches (23 centimeters) in shell width. They feed on almost anything they can get hold of, including mussels, snails, fish, plants, and even carrion and smaller blue crabs. They are also excellent swimmers, with specially adapted hind appendages shaped like paddles. Blue crabs are extremely sensitive to environmental and habitat changes, and many populations in the eastern United States, have experienced severe declines. Blue crabs also play a key role in managing the populations of the animals they prey on, and constant overharvesting has had wide-ranging negative effects on the ecosystems they inhabit. For this reason, comprehensive management schemes are in place in several parts of the blue crab's range (National Geographic website, 2015).

Mud Crab (*Panopues spp)* – The mud crabs belong to the family Xanthidae. Crabs included in *Panopeus* and related genera have five teeth lining the outside of the carapace on each side, the first two mostly fused. The range of the mud crab extends from Massachusetts to Brazil. Most populations inhabit muddy bottoms, mainly in mangrove swamps and oyster beds. However, both adults and juveniles can also be found on jetty rocks, shell or cobble bottoms, and marsh edges. In oyster beds and under rocks, individuals may excavate shallow burrows to a depth of 4-10 cm. The diet of the mud crab is primarily carnivorous. Individuals prey on a variety of organisms, including: oysters and clams; crustaceans; annelid worms; fishes; and the marsh periwinkle. The mud crab is likely preyed upon by a variety of birds, fishes and larger crustaceans, including: juvenile blue crabs, common killifish, and grass shrimp (Smithsonian Marine Station at Fort Pierce website, 2015).

Sand Shrimp (*Crangon septemspinosa*) – The sand shrimp is a small species of shrimp common to estuaries along the Atlantic coast. It has a stout, heavy body that tapers to a narrow tail. These shrimp can be observed in the nearshore salt marsh communities living in similar habitat to that of the grass shrimp. In the summer they are found in shallow waters, while in the winter they move into deeper waters. In the spring they migrate back into the shallow, warm estuarine waters. This shrimp is inactive during the day, burrowing in the sediment with only antennae exposed. They remain burrowed throughout daylight hours but will emerge if the sediment is disturbed. At night they are active in the benthic community, foraging for food. Sand shrimp feed on benthic invertebrates, organic detritus, and even larval and juvenile fish. They are preyed upon by bottom-dwelling fish, comb jellies, and skates, and are subject to cannibalism by their own species (Chesapeake Bay Program website, 2015).

Grass Shrimp (*Hippolyte spp*) – The common grass shrimp is common to estuaries along the Atlantic coast. It has a segmented, nearly transparent body that is compressed on either side and a pointed, serrated "horn" that extends over its eyes. Its first two pairs of walking legs have claws. The shrimp grows to 1.5 inches in length. It is found in shallow waters, often among bay grass beds. In May the grass shrimp moves to shallow, warmer water and in winter to deeper waters. Grass shrimp forage for worms, algae and tiny crustaceans. Grass shrimp are considered to be an important ecological indicator of human impacts on estuaries and other water bodies.

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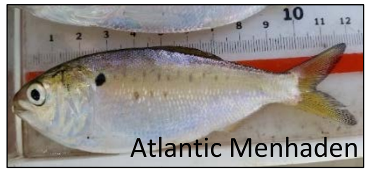
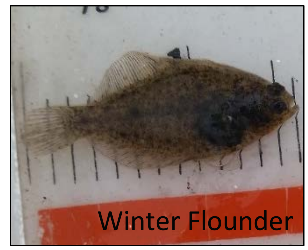
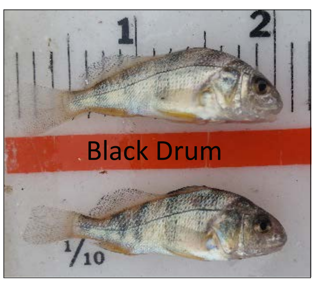
Appendix 1

Selected Pictures from Grand Canal Fisheries Sampling







Banded Killifish

Appendix E

Sediment Sampling Plan

Grand Canal Environmental Assessment Project

Draft Report for Sub-Task 3b-iii

Oakdale, NY

Prepared for: **Suffolk County Department of Health Services**
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Prepared by: **Cashin Associates**
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March 2016

3.1 Sediment Sampling Plan and Analysis

3.1.1 Development of Sediment Sampling Plan

A Sediment Sampling Plan was prepared which incorporated the information needs and sampling requirements of the NYSDEC's Division of Marine Habitat Protection and Division of Solid and Hazardous Material. The plan was developed based on the NYSDEC TOGS 5.1.9 (*In-Water and Riparian Management of Sediment and Dredge Material)* and NYSDEC Remedial Program Soil Cleanup Objectives. The Sediment Sampling Plan was also based on findings from bathymetric data collection performed by CA as part of Task 3 of this project. The Sediment Sampling Plan can be found in Appendix 1.

3.1.2 Submittal and Approval from the NYSDEC

The County-approved Sediment Sampling Plan was submitted to the NYSDEC. It was approved on December 22, 2015.

3.1.3 Coring, Sampling, and Examination of Sediment

A total of 30 sediment samples for subsequent laboratory analysis were collected from the Grand Canal on December 21 and 22, 2015 by CA environmental personnel in accordance with the approved Sediment Sampling Plan. Samples were collected with an AMS Core Sampler. This instrument collects samples by obtaining a core of the sediment bottom. Sediment is contained in a clear cylinder to allow for visual inspection of sediment stratification which occurs with depth.

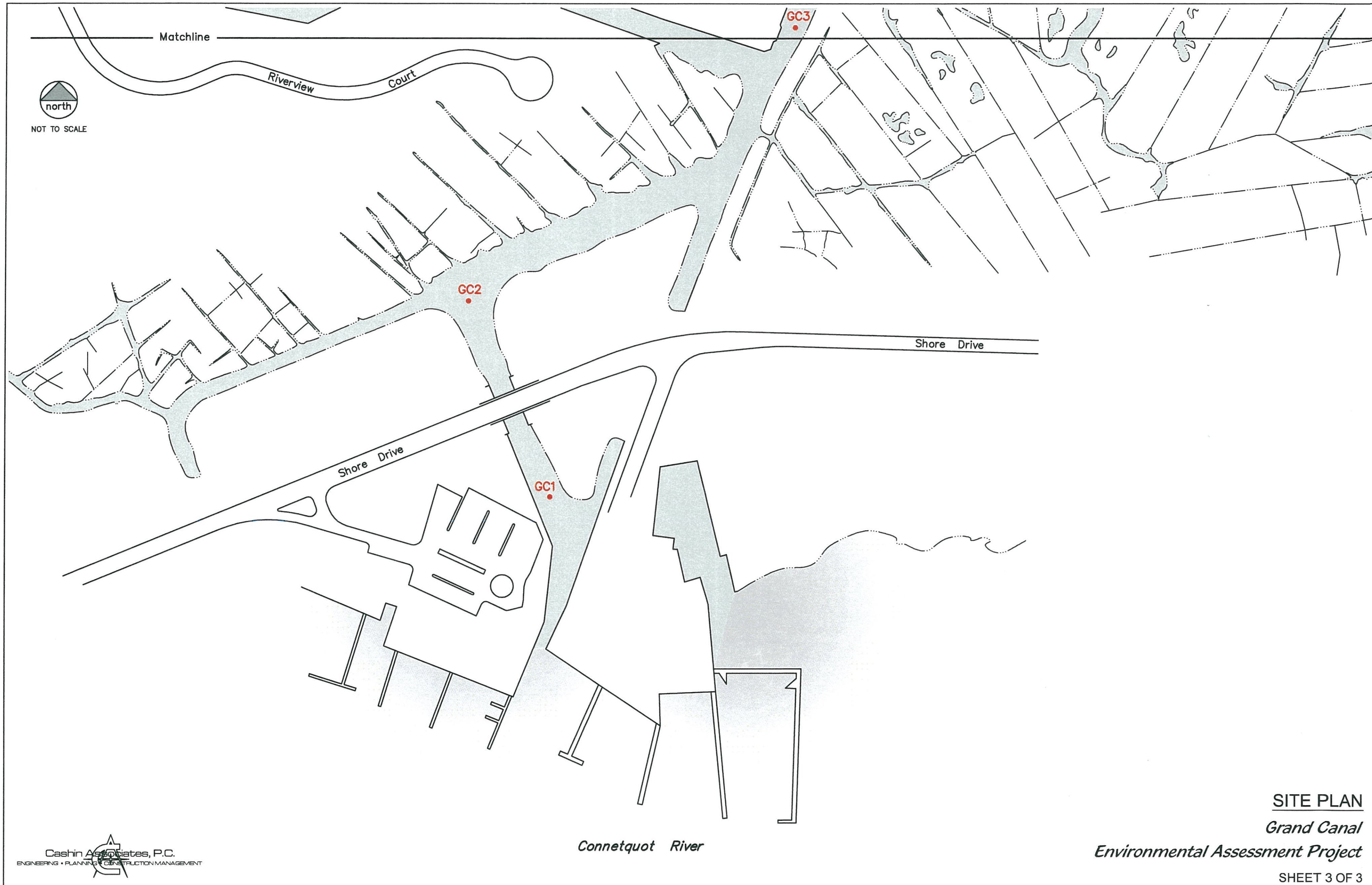
A total of ten sample sites were selected throughout the canal for sediment core sampling; GPS coordinates for each sample location were recorded (Figure 1). At each of the ten sites, three different segment samples were collected using the coring instrument. The three segment samples from each location were as follows: one sample of the material to be dredged (top layer of sediment); one sample of zero to six inches below the dredge depth; and one sample from six to 12 inches below the dredge depth. The sampling methodology used was based on that described in the protocol of the NYSDEC TOGS 5.1.9 *In Water and Riparian Management of Sediment and Dredge Material* document.

The sediment samples were immediately labeled and preserved on ice; the first two sub-samples were analyzed (20 samples) and the third (10 samples) was archived for possible further analysis, depending on initial testing results. Samples were analyzed for grain size distribution analysis and Total Organic Carbon (TOC) content.

In the event that the grain size and TOC analysis determined that the composition of any of the sediment sample was at least 90 percent sand or larger, and less than one-half percent TOC, no further testing was required. All samples falling below the threshold were tested for priority pollutant parameters, as identified by NYSDEC. If the priority pollutant analysis from the dredge material and the first six inches below dredge depth revealed priority pollutant constituents above NYSDEC recommended limits, the archived samples were to be analyzed. Laboratory analyses for TOC and pollutants were performed by York Laboratories, a New York Certified Laboratory. Chain-of-custody procedures were followed for all samples. Laboratory results for the sediment cores have been included in Appendix 2.

3.1.3.1 Grain Size Distribution

Grain size distribution analysis was performed by Long Island Analytical Laboratories, Inc., a certified New York laboratory. Grain size distribution is represented in the form as percent retained in relationship to certain sieve parameters: gravel (Sieve Size 2 inch – ¼ inch); sand (Sieve Size #10 – #200); and silt/clay (Sieve Size <200). According to Long Island Analytical



SITE PLAN

Grand Canal

Environmental Assessment Project

SHEET 3 OF 3

SITE PLAN

Grand Canal

Environmental Assessment Project

SHEET 2 OF 3

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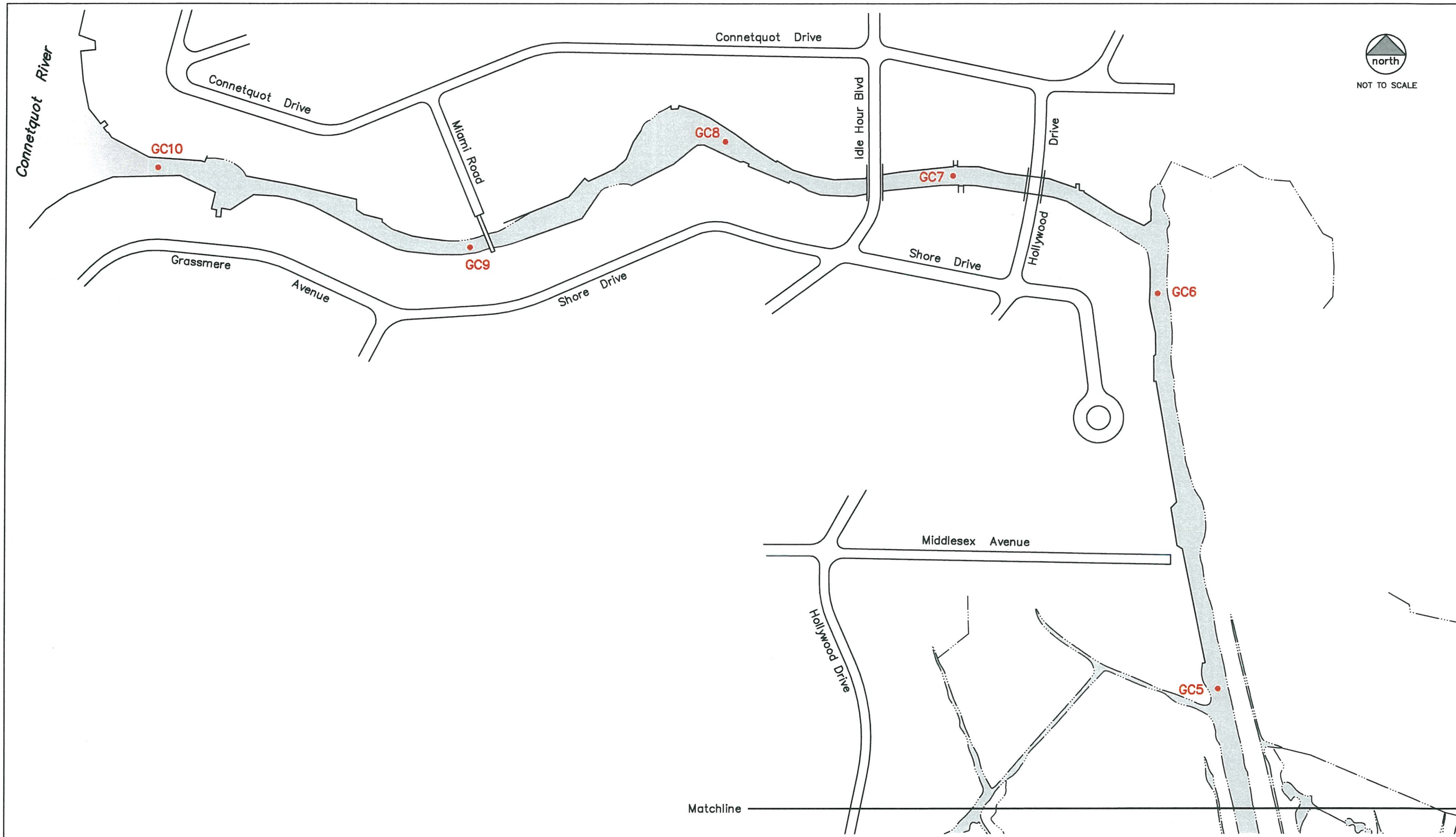

SITE PLAN

Grand Canal

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SHEET 1 OF 3

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Laboratories, a certain percentage of materials is lost during the dry sieving process which is why the total percent retained may be less than 100 percent (the dry sieve standard allows for that loss as long as it is less than 10%). Sample ID “A” represents the material to be dredged and “B” represents 0-6 inches below the dredge depth. Grain sized distribution results are shown in Table 1.

According to the NYSDEC protocol, all of the samples analyzed for grain size met the required composition of at least 90% sand or larger material (less than 10% of the material passes through the No. 200 sieve). Based on these grain size results, none of the samples needed to be tested for contaminant parameters identified and in accordance with the testing methods provided in the NYSDEC *Technical & Operational Guidance Series (TOGS) 5.1.9 In-Water and Riparian Management of Sediment and Dredge Material*.

Table 1. Grain size distribution analysis results for sediment cores

Sample ID	Gravel	Sand	Silt/Clay	Total % Retained	Sample ID	Gravel	Sand	Silt/Clay	Total % Retained
GC 1A	15.80	82.23	0.79	98.10	**GC 6A**	2.78	91.14	3.30	97.22
GC 1B	1.07	97.75	2.38	98.20	**GC 6B**	10.27	84.17	2.85	97.29
GC 2A	1.46	87.47	9.12	98.05	**GC 7A**	3.28	90.41	3.38	97.07
GC 2B	0.00	93.49	4.26	97.75	**GC 7B**	0.00	93.68	4.27	97.95
GC 3A	0.00	91.13	5.69	96.82	**GC 8A**	0.64	89.58	7.22	97.44
GC 3B	9.38	88.43	1.89	99.70	**GC 8B**	12.48	83.76	2.60	98.84
GC 4A	5.53	90.72	2.87	98.43	**GC 9A**	0.00	94.30	2.60	96.90
GC 4B	3.67	93.64	2.39	100	**GC 9B**	12.06	86.23	1.31	99.60
GC 5A	9.79	86.40	2.53	98.72	**GC 10A**	0.00	96.53	2.67	99.20
GC 5B	18.99	75.86	3.83	98.68	**GC 10B**	0.00	91.58	5.94	97.52

3.1.3.2 Total Organic Carbon (TOC)

According to the NYSDEC protocol, three of the sediment samples met the required less than 0.5% of TOC requirement. Based on these results, 17 samples did not meet the minimum TOC requirement and therefore needed to be tested for contaminant parameters identified and in accordance with the testing methods provided in the NYSDEC *Technical & Operational Guidance Series (TOGS) 5.1.9 In-Water and Riparian Management of Sediment and Dredge Material*. TOC analysis results are shown in Table 2 The three samples meeting the TOC requirement are underlined in Table 8.

Table 2. TOC results for the "A" and "B" segments for each of the ten sample sites

Sample ID	Percent	Sample ID	Percent	Sample ID	Percent	Sample ID	Percent
GC 1A	0.1390	**GC 3B**	0.0441	**GC 6A**	0.1910	**GC 8B**	0.1120
GC 1B	0.0713	**GC 4A**	0.0944	**GC 6B**	0.0799	**GC 9A**	0.1250
GC 2A	0.0702	**GC 4B**	0.0606	**GC 7A**	0.0625	**GC 9B**	0.0733
GC 2B	0.0749	**GC 5A**	0.0754	**GC 7B**	0.0772	**GC 10A**	0.0642
GC 3A	0.0258	**GC 5B**	0.0555	**GC 8A**	0.0917	**GC 10B**	0.0502

3.1.3.3 Sediment Cores Primary Pollutants Analysis Results

The results of the sediment chemistry were compared to the NYSDEC's *Sediment Quality Thresholds for In-Water/Riparian Placement* guidelines and the following classifications:

- Class A – No Appreciable Contamination (No Toxicity Aquatic Life);
- Class B – Moderate Contamination (Chronic Toxicity to Aquatic Life); and
- Class C – High Contamination (Acute Toxicity to Aquatic Life).

The sum of DDT and its constituents (DDE and DDD) were detected in the dredge material for Sites GC 1 through GC 8. The dredge sediment in Site GC 1 meets Class B criteria and Sites GC 2 through GC 8 meet or exceeded Class C criteria. The highest concentrations were detected in Sites GC 4 through GC 6. These three sites are located directly adjacent to the Pickman-

Remmer wetlands and these higher concentrations may be associated with sediment transport from these wetlands. The concentrations of this constituent in the sediment below the dredge material are lower than the dredge material but still in Class B and Class C criteria. No DDT, DDE or DDE were detected in Sites GC 9 or GC 10.

Several metals were also detected in the dredge material and sediment below the dredge material. The metals met Class A and Class B criteria. Specific metals detected were: copper, arsenic, chromium, lead, nickel, zinc, and mercury. Copper, arsenic and chromium were most likely introduced into the sediment by the chromated copper arsenate (CCA) wood material used to construct bulk heading. Lead, zinc and mercury were most likely introduced into the sediment from boating activities.

The results of the laboratory analysis for the sediment core samples collected by CA are provided and discussed in greater detail, especially with regards to their potential impacts of human health, in the Public Health Evaluation and Report.

Appendix 1

Sediment Sampling Plan

Grand Canal Environmental Assessment Project

Sediment Sampling Plan

For Grand Canal
Oakdale, NY

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Stony Brook, NY 11790-3409

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1200 Veterans Memorial Highway
Hauppauge, NY 11788

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I **Project Background**

For a number of years, Grand Canal has been the subject of complaints by area residents, reportedly concerned with progressive shoaling and reduction in tidal flushing. Issues surrounding the reduction of tidal flushing include but are not limited to: possible increases of mosquito breeding with links to West Nile Virus, general water quality degradation, deterioration of the ecological health of the adjacent wetlands, residential flooding; and shoaling within the navigation channel. In response to concerns and the possibility that the declining health of the canal may present a public health risk, the Suffolk County Department of Public Health Services (SCDHS) and the Suffolk County Department of Public Works (SCDPW) collaborated in preparing and executing a study to investigate the canal. A preliminary assessment of the canal conducted in 2004, and final report released in January 2005 suggested that a marsh management approach in conjunction with a dredging project designed to increase flushing in the canal may have a beneficial impact on restoring the overall health and environment of the Grand Canal. The intent of this study is to provide a more detailed analysis of the potential ecological issues and to precisely define potential public health problems associated with the Grand Canal and adjacent wetlands, as well as to evaluate the ecological health of the canal and adjacent wetlands. This information will be used to identify possible measures to mitigate adverse conditions indentified in the study.

II **Site Description and History**

The Grand Canal is a man-made waterway and is a tributary or branch of the Connetquot River, located in Oakdale, New York in the Town of Islip. According to the 2005 report the canal was built sometime prior to 1920 to serve the former “Idle Hour” estate of William K. Vanderbilt. The main channel of the canal is approximately 8,000 feet in length and 20 feet wide and variable. The canal system also includes a number of branch channels that extend into residential areas, providing access to the main channel. The Grand Canal is unique in that it has two (2) interfaces that open into the Connetquot River. One opening is in the midsection of the tidal portion of the river and the second opening is in the southern section of the tidal portion of the river. This creates a situation where the river flow may have an influence on the currents and tidal flow in the canal. The Grand Canal is also integral to an extensive wetland system. The canal’s northern opening is surrounded by residential properties and the southern opening is bordered on either side by commercial properties, including a marina and restaurant. The land area surrounding the northern section of the main canal, that runs east-west, is residential. For the north-south section of the main channel, the land to the west is a mixture of residential properties and tidal wetlands. The adjacent land area to the east is dominated by and extensive tidal and freshwater wetland complex known as the Pickman-Remmer Wetlands owned by the State of New York and managed by the New York State Department of Environmental Conservation (NYSDEC).

III. **Sampling Methodology**

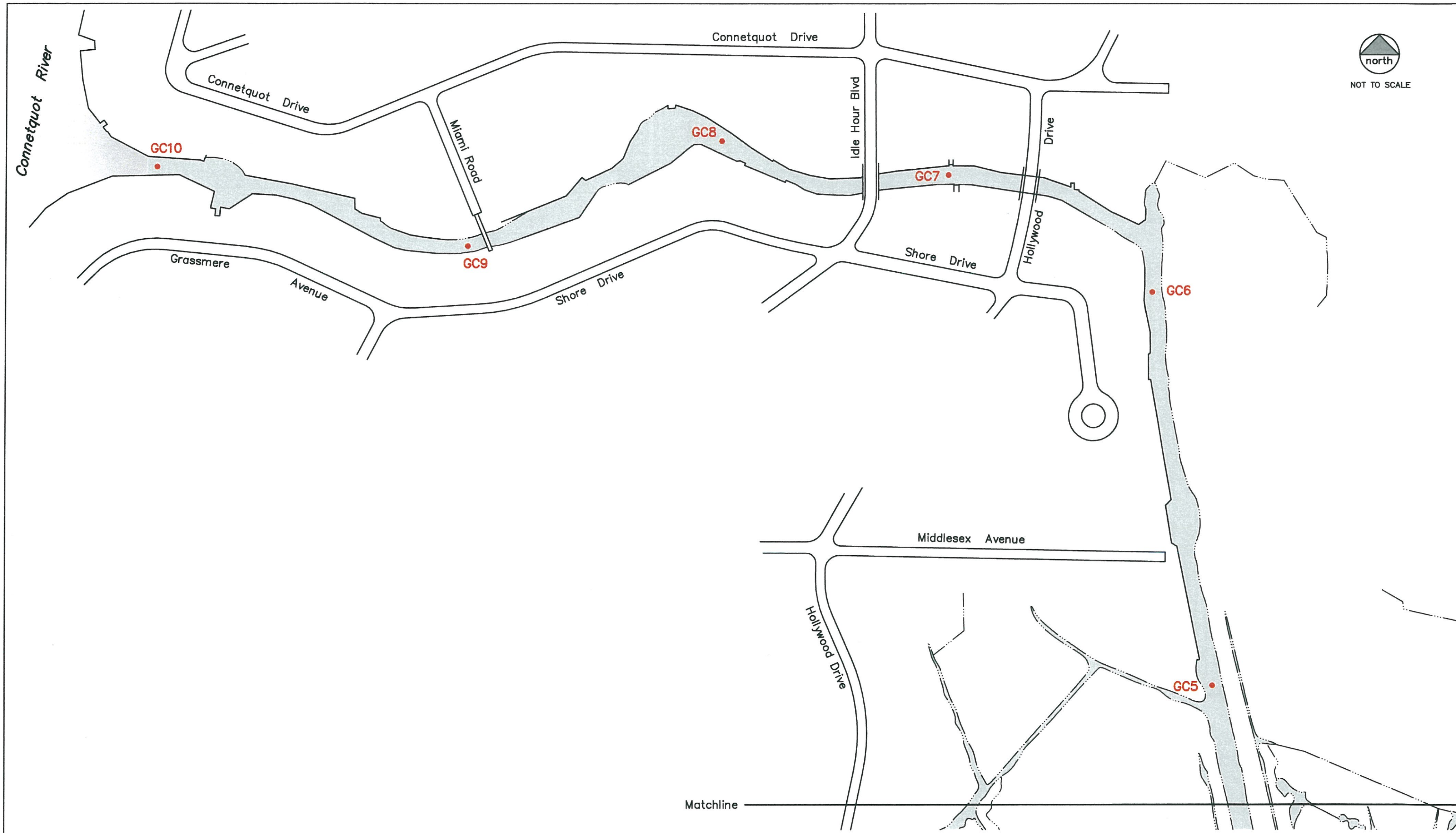
Sediment samples will be collected by Cashin Associates (CA) field personnel. CA is located at 1200 Veterans Memorial Highway, Hauppauge, NY 11788 and the contact person for this project is Keith W. Brewer, Senior Environmental Scientist at (631) 348-7600-ext. 30 or (631) 348-76012 fax. The analytical laboratory used for the chemical analysis will be Essential Environmental Technology, Inc. (EET), located at 208 Route 109, Suite 110, Farmingdale, NY 11735 (631) 249-1456 or (631) 249-8344 fax or equivalent NYS approved and certified if applicable. EET is approved and certified by the New York State Department of Health and Environmental Lab Approval Program (ELAP).

Sediment cores will be collected from ten locations in the canal. Sample locations are identified on Figure 1. The sample locations were selected to provide full coverage of the areas potentially to be dredged. Based upon an average channel width of 20 ft. (to maintain a safe distance from existing bulkheads), a design depth of 5 feet below Mean Low Water (which would yield an average depth of cut of 2.5 ft.), and a canal length of 8,000 ft., the estimated quantity of sediment to be dredged is 15,000 cubic yards.. This estimate of the potential dredge volume was made based on review of past and current bathymetry data and may be adjusted pending the results of ongoing studies of the canal.

Core samples will be collected using a hand held AMS Soggy Bottom Sampler system to a minimum depth of one foot below the proposed dredging depth. Sample collection will follow established protocols and procedures, consistent with the sediment sampling guidance provided in Appendix C of NYSDEC *Technical & Operational Guidance Series (TOGS) 5.1.9 In-Water and Riparian Management of Sediment and Dredge Material*.

At each location, a sediment core will be taken that extends through the full depth of the dredge and into what will be the newly exposed bottom for a depth of 1 foot (Table 1 and Figure 2). At each location, the core will be split into the dredge portion (segment A) and the new-bottom portion. The dredge portion is to be composited into one sample for testing. However, prior to compositing, a discrete (grab) sample will be taken from the core (based on observed contamination, or otherwise arbitrarily) to be used for VOC analysis (if necessary). The new-bottom cores will be split into the upper 6” (the 0”-6” segments, or segments B) and the lower 6” (the 6”-12” segments, or segments C). Each of the upper 6” samples will be composited for testing. However, just as with the dredge samples, prior to compositing a grab sample is to be taken for VOC testing, if that proves necessary. The lower 6” samples will be preserved, undisturbed, and retained for future testing, if that proves necessary. A photographic log will be generated to depict these processes.

Sample containers will be supplied by the testing laboratory. The containers will be laboratory cleaned, pre-preserved and sealed with the appropriate documentation. All sample containers will be labeled using a permanent marker to indicate the date, time, sample location, and sample identification number. This information will be recorded on a chain of custody form that will follow the samples. Once each sample container is filled, capped and labeled, it will be appropriately packaged to prevent breakage and placed in an ice-filled insulated cooler until the samples are delivered to the laboratory.



SITE PLAN

Grand Canal

Environmental Assessment Project

SHEET 1 OF 3

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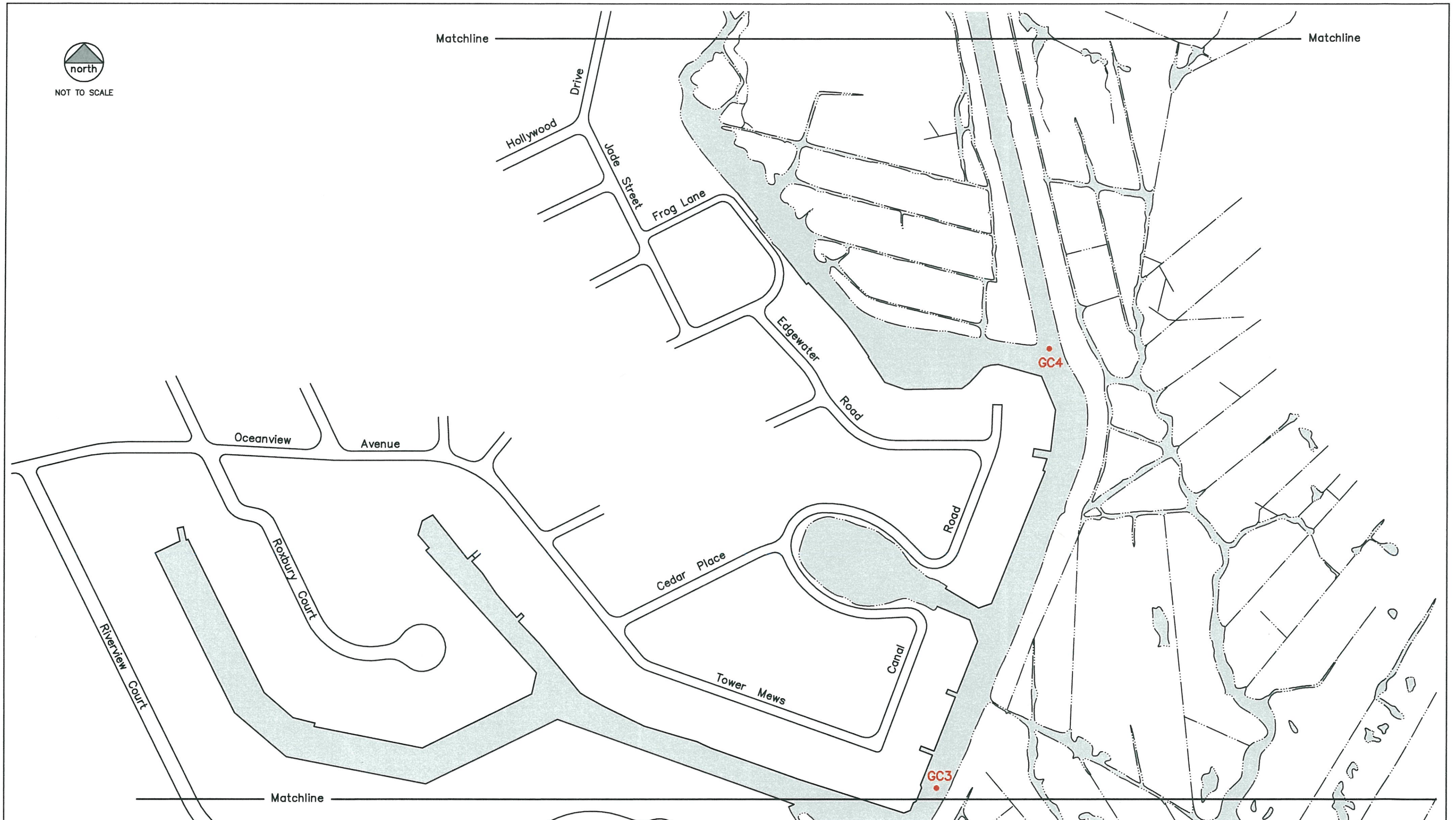

SITE PLAN

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SHEET 2 OF 3

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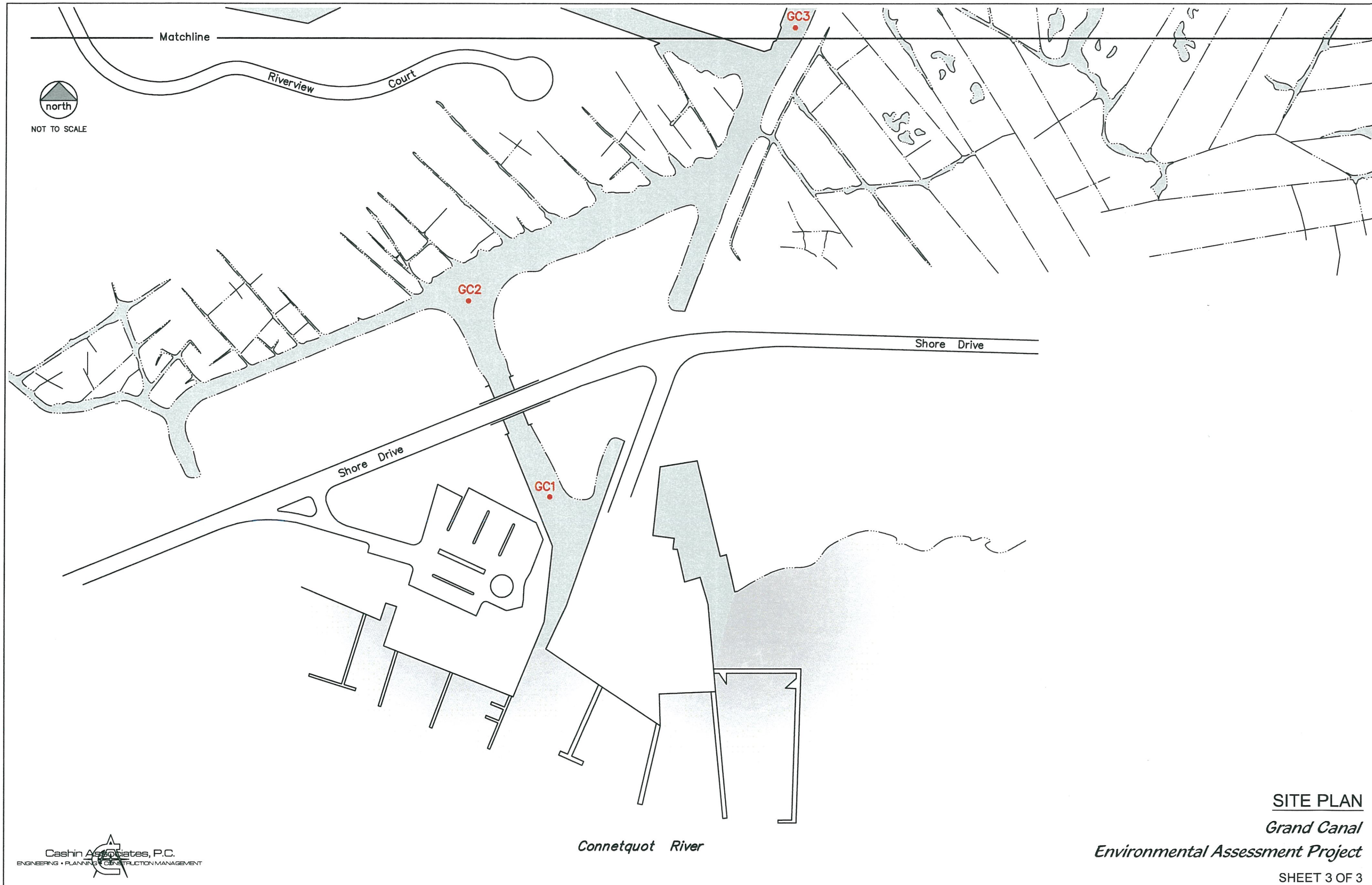

SITE PLAN

Grand Canal

Environmental Assessment Project

SHEET 3 OF 3

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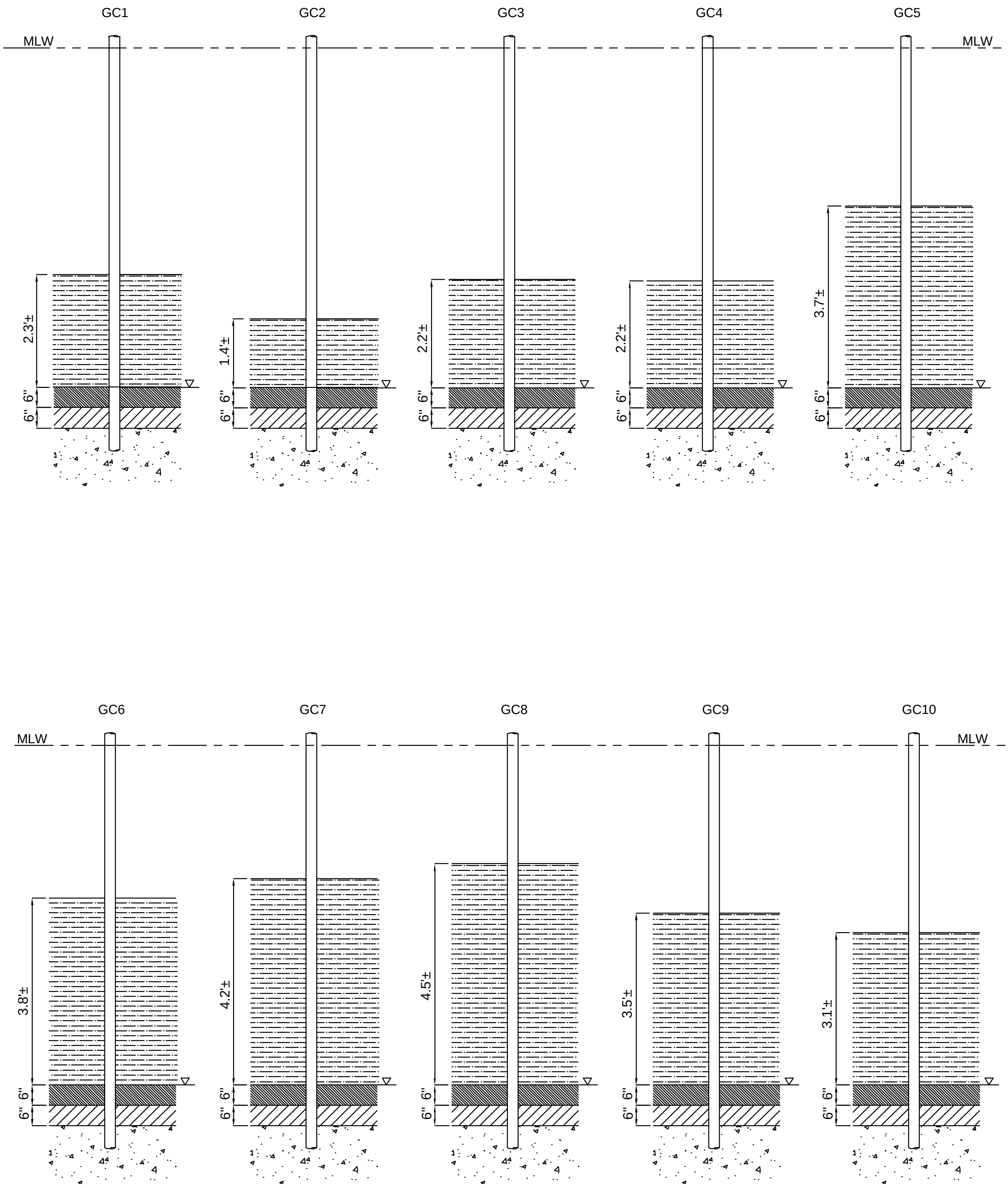
Table 1. Sample numbering and identification for Grand Canal Analysis and Assessment Study.

Site	Identification
GC-1A	Surface to proposed dredging depth
GC-1B	0” to 6” below post-dredge bottom
GC-1C	6” to 12” below post-dredge depth
GC-2A	Surface to proposed dredging depth
GC-2B	0” to 6” below post-dredge bottom
GC-2C	6” to 12” below post-dredge depth
GC-3A	Surface to proposed dredging depth
GC-3B	0” to 6” below post-dredge bottom
GC-3C	6” to 12” below post-dredge depth
GC-4A	Surface to proposed dredging depth
GC-4B	0” to 6” below post-dredge bottom
GC-4C	6” to 12” below post-dredge depth
GC-5A	Surface to proposed dredging depth
GC-5B	0” to 6” below post-dredge bottom
GC-5C	6” to 12” below post-dredge depth
GC-6A	Surface to proposed dredging depth
GC-6B	0” to 6” below post-dredge bottom
GC-6C	6” to 12” below post-dredge depth
GC-7A	Surface to proposed dredging depth
GC-7B	0” to 6” below post-dredge bottom
GC-7C	6” to 12” below post-dredge depth
GC-8A	Surface to proposed dredging depth
GC-8B	0” to 6” below post-dredge bottom
GC-8C	6” to 12” below post-dredge depth
GC-9A	Surface to proposed dredging depth
GC-9B	0” to 6” below post-dredge bottom
GC-9C	6” to 12” below post-dredge depth
GC-10A	Surface to proposed dredging depth
GC-10B	0” to 6” below post-dredge bottom
GC-10C	6” to 12” below post-dredge depth



NOT TO SCALE

KEY

- MATERIAL TO BE DREDGED
- 0"-6" BELOW DREDGE DEPTH
- 6"-12" BELOW DREDGE DEPTH

FIGURE 2
SAMPLE DEPTHS

Grand Canal
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14040.1

IV. Quality Assurance and Quality Control

Field and laboratory QA/QC procedures will be consistent with the requirements outlined in Appendix C of the NYSDEC *In-Water and Riparian Management of Sediment and Dredged Material* (TOGS 5.1.9). Testing for samples will be in accordance with the following procedures and methods:

Contaminants	United States Environmental Protection Agency (USEPA) SW-846 Method
Pesticides (Including Mirex)	8081 A
Herbicide (Silvex)	8151
Total Aroclors of PCB's	8082
Volatile Organics (VOC's)	8260 B
Semi-Volatile Organics (SVOC's)	8270 C
Metals	6010 B
Hexavalent Chromium	7196A
Cyanide	9012A
Total Organic Carbon (TOC)	9060 A
Dioxin	1613B

a. Field Documentation Procedures

The following information shall be collected and documented on an appropriate data sheet and submitted with the test results:

- Field Conditions
- Weather Conditions
- Pertinent observations that may bear influence on the analyses of the samples
- Name of sampler
- Sample designation
- Collection method
- Detailed description of soil (estimation of soil composition)

The sampler shall document each sample taken with photographs and take other photographs to document the surrounding conditions, sampling procedures, etc.

V. Analyses to be Performed

The following analyses will be performed on sample segments A (material to be dredged) and B (0" to 6" below the post-dredging bottom) from each sample location before the maximum allowable holding time for testing is exceeded.

a. Grain Size Distribution

Grain size distribution of each sample segment will be determined by a sieve analysis performed in accordance with ASTM C136-95.

b. Total Organic Carbon

The Total Organic Carbon (TOC) of each sample segment will be determined in accordance with EPA Method 415.1.

c. Testing Sequence

According to the NYSDEC protocol, if the grain size and TOC analyses determine that the composition of any sample is at least 90% sand or larger material (less than 10% of the material passes through the No. 200 sieve) and less than 0.5% TOC, no further testing of that sample is required by the NYSDEC. All samples that fall below this limit should be tested for contaminant parameters identified in (Table 2) and in accordance with the testing methods provided. Results should be calculated and summed as indicated and all data should be reported in the units listed.

Segment A and segment B from each sample location containing more than 10% of material passing through the No. 200 sieve or greater than 0.5% TOC will be analyzed for all parameters identified in Table 2. If the analysis of segments indicates that the level of any contaminant is significantly higher in Segment B relative to Segment A or that Class C levels of contaminants are present and would not be removed by the proposed dredging, contaminant analysis should also be conducted on Segment C (6" to 12" below the proposed dredging depth) for all parameters identified in the table below to determine if alteration of the dredging depth would mitigate the problem.

If the results of the sediment analyses determine that there is risk of significantly higher contaminant levels becoming exposed in the post-dredging bottom or that existing Class C levels are not removed by the proposed dredging depth, and if Suffolk County proceeds with filling an application to dredge Grand Canal it will provide a proposed plan to mitigate the problem of elevated contaminant levels, as necessary. The mitigation plan will be submitted to the NYSDEC for review and comment along with the results of the sediment analyses.

d. Proposed Cost Reduction Strategy

The surrounding urban area of the Grand Canal is mostly residential use and highly unlikely that dioxin would be associated with these uses. Therefore one composite sample comprised of the material to be removed (Segment A) from all ten sites will be collected and analyzed for the presence of dioxin. A composite sample comprising of all ten 0-6 inch (Segment B) and one from the 6-12 inch (Segment C) will also be collected, archived and only analyzed if the presence of Dioxin is detected in the dredge material.

Table 2. NYSDEC Contaminant Parameters, Methods and Thresholds

Physical Properties

Grain Size	ASTM C136 or D422
Total Organic Carbon	EPA 9060A

NYSDEC Technical Reviewing Unit	Parameter Sediment/Soil	Suggested EPA Analytical Method CLP\RCRA	CAS Number	S&HM Unrestricted Use (ppm)	MHP Class B Threshold[1] (mg/kg)	MHP Class C Threshold (mg/kg)
Metals						
MHP, S&HM	Arsenic	EPA 6010B	7440-38-2	13[c]	14 (8.2)	53
S&HM	Barium	EPA 6010B	7440-39-3	350[c]		
S&HM	Beryllium	EPA 6010B	7440-41-7	7.2		
MHP, S&HM	Cadmium	EPA 6010B	7440-43-9	2.5[c]	1.2	9.5
MHP	Chromium	EPA 6010B			26 (81)	110 (370)
S&HM	Chromium, hexavalent[c]	EPA 7196A	18540-29-9	1[b]		
S&HM	Chromium, trivalent[c]	EPA 6010B	16065-83-1	30[c]		
MHP, S&HM	Copper	EPA 6010B	7440-50-8	50	33	207 (270)
S&HM	Total Cyanide[e,f]	EPA 9012A		27		
MHP, S&HM	Lead	EPA 6010B	7439-92-1	63[c]	33(47)	166(218)
S&HM	Manganese	EPA 6010B	7439-96-5	1600[c]	460	1100
MHP, S&HM	Mercury	EPA 6010B, 7470		0.18[c]	0.17	1.6 (1.0)
MHP, S&HM	Nickel	EPA 6010B	7440-02-0	30	16 (21)	50 (52)
S&HM	Selenium	EPA 6010B	7782-49-2	3.9[c]		
MHP, S&HM	Silver	EPA 6010B	7440-22-4	2	1.0	2.2 (3.7)

NYSDEC Technical Reviewing Unit	Parameter Sediment/Soil	Suggested EPA Analytical Method CLP\RCRA	CAS Number	S&HM Unrestricted Use (ppm)	MHP Class B Threshold[1] (mg/kg)	MHP Class C Threshold (mg/kg)
MHP, S&HM	Zinc	EPA 6010B	7440-66-6	109[c]	120 (150)	270 (410)
			Pesticides			
S&HM	2,4,5 – TP Acid (Silvex)[f]	EPA 8151	93-72-1	3.8		
S&HM	4,4'- DDE	EPA 8081A	72-55-9	0.0033[b]		
S&HM	4,4' – DDT	EPA 8081A	50-29-3	0.0033[b]		
S&HM	4,4' - DDD	EPA 8081A	72-54-8	0.0033[b]		
MHP	Sum of DDT+DDE+DDD	EPA 8081A			0.003	0.03
S&HM	Aldrin	EPA 8081A	309-00-2	0.005[c]		
S&HM	Alpha - BHC	EPA 8081A	319-84-6	0.02		
S&HM	Beta – BHC	EPA 8081A	319-85-7	0.036		
S&HM	Delta – BHC[g]	EPA 8081A	319-86-8	0.04		
S&HM	Chlordane (alpha)	EPA 8081A	5103-71-9	0.094		
MHP	Chlordane	EPA 8081A			0.003	0.036
S&HM	dibenzofuran[f]	EPA 8270	132-64-9	7		
MHP, S&HM	Dieldrin	EPA 8081A	60-57-1	0.005[c]	0.11	0.48
S&HM	Endosulfan I [d,f]	EPA 8081A	959-98-8	2.4		
S&HM	Endosulfan II [d, f]	EPA 8081A	33213-65-9	2.4		
S&HM	Endosulfan sulfate[d,f]	EPA 8081A	1031-07-8	2.4		
S&HM	Endrin	EPA 8081A	72-20-8	0.014		
S&HM	Heptachlor	EPA 8081A	76-44-8	0.042		
S&HM	Lindane	EPA 8081A	58-89-9	0.1		
MHP	Mirex	EPA 8081A			0.0014	0.014
			PCBs			
MHP, S&HM	PCBs (sum of aroclors)	EPA 8082	1336-36-3	0.1	0.1	1
			Semi-Volatile Organics			
MHP	2-chloronaphthalene	EPA 8270	91-58-7			

NYSDEC Technical Reviewing Unit	Parameter Sediment/Soil	Suggested EPA Analytical Method CLP\RCRA	CAS Number	S&HM Unrestricted Use (ppm)	MHP Class B Threshold[1] (mg/kg)	MHP Class C Threshold (mg/kg)
MHP	2-methylnaphthalene	EPA 8270	91-5706			
MHP, S&HM	Acenaphthene	EPA 8270	83-32-9	20	0.016	0.5
MHP, S&HM	Acenapthylene[f]	EPA 8270	208-96-8	100[a]	0.044	0.64
MHP, S&HM	Anthracene[f]	EPA 8270	120-12-7	100[a]	0.085	0.11
MHP, S&HM	Benz(a)anthracene[f]	EPA 8270	56-55-3	1[c]	0.261	1.6
MHP, S&HM	Benzo(a)pyrene	EPA 8270	50-32-8	1[c]	0.43	1.6
MHP, S&HM	Benzo(b)fluoranthene[f]	EPA 8270	205-99-2	1[c]		
MHP, S&HM	Benzo(g,h,i)perylene[f]	EPA 8270	191-24-2	100		
MHP, S&HM	Benzo(k)fluoroanthene[f]	EPA 8270	207-08-9	0.8[c]		
MHP, S&HM	Chrysene[f]	EPA 8270	218-01-9	1[c]	0.384	2.8
MHP, S&HM	Dibenz(a,h)anthracene[f]	EPA 8270	53-70-3	0.33[b]	0.063	0.26
MHP, S&HM	Fluoranthene[f]	EPA 8270	206-44-0	100[a]	0.6	5.1
MHP, S&HM	Fluorene	EPA 8270	86-73-7	30	0.019	0.54
MHP, S&HM	Indeno(1,2,3-cd)pyrene[f]	EPA 8270	193-39-5	0.5[c]		
S&HM	m-Cresol[f]	EPA 8270	108-39-4	0.33[b]		
MHP, S&HM	Naphthalene[f]	EPA 8270	91-20-3	12	0.16	2.1
S&HM	o-Cresol[f]	EPA 8270	95-48-7	0.33[b]		
S&HM	p-Cresol[f]	EPA 8270	106-44-5	0.33[b]		
S&HM	Pentachlorophenol	EPA 8270	87-86-5	0.8[b]		
MHP, S&HM	Phenanthrene[f]	EPA 8270	85-01-8	100	0.24	1.5
S&HM	Phenol	EPA 8270	108-95-2	0.33[b]		
MHP, S&HM	Pyrene[f]	EPA 8270	129-00-0	100	0.665	2.6
MHP	Total PAH[2]	EPA 8270			0.33	4
Volatile Organic Compounds						
S&HM	1,1,1 - trichloroethane[f]	EPA 8260B	71-55-6	0.68		
S&HM	1,1 - Dichloroethane[f]	EPA 8260B	75-34-3	0.27		
S&HM	1,1 - Dichloroethene[f]	EPA 8260B	75-35-4	0.33		
S&HM	1,2 - Dichlorobenzene[f]	EPA 8260B	95-50-1	1.1		
S&HM	1,2 - Dichloroethane	EPA 8260B	107-06-2	0.02[c]		

NYSDEC Technical Reviewing Unit	Parameter Sediment/Soil	Suggested EPA Analytical Method CLP\RCRA	CAS Number	S&HM Unrestricted Use (ppm)	MHP Class B Threshold[1] (mg/kg)	MHP Class C Threshold (mg/kg)
S&HM	cis 1,2 - Dichloroethene[f]	EPA 8260B	156-59-2	0.25		
S&HM	trans 1,2 - Dichloroethene[f]	EPA 8260B	156-60-5	0.19		
S&HM	1,3 - Dichlorobenzene[f]	EPA 8260B	541-73-1	2.4		
S&HM	1,4 - Dichlorobenzene	EPA 8260B	106-46-7	1.8		
S&HM	1,4 – Dioxane	EPA 8260B	123-91-1	0.1[b]		
S&HM	Acetone	EPA 8260B	67-64-1	0.05		
MHP, S&HM	Benzene	EPA 8260B	71-43-2	0.06	0.59	2.16
S&HM	n-Butylbenzene[f]	EPA 8260B	104-51-8	12		
S&HM	Carbon tetrachloride[f]	EPA 8260B	56-23-5	0.76		
S&HM	Chlorobenzene	EPA 8260B	108-90-7	1.1		
S&HM	Chloroform	EPA 8260B	67-66-3	0.37		
S&HM	Ethylbenzene[f]	EPA 8260B	100-41-4	1		
S&HM	Hexachlorobenzene[f]	EPA 8260B	118-74-1	0.33[b]		
S&HM	Methyl ethyl ketone	EPA 8260B	78-93-3	0.12		
S&HM	Methyl tert-butyl ether[f]	EPA 8260B	1634-04-4	0.93		
S&HM	Methylene chloride	EPA 8260B	75-09-2	0.05		
S&HM	n-Propylbenzene[f]	EPA 8260B	103-65-1	3.9		
S&HM	sec-Butylbenzene[f]	EPA 8260B	135-98-8	11		
S&HM	tert-Butylbenzene[f]	EPA 8260B	98-06-6	5.9		
S&HM	Tetrachloroethene	EPA 8260B	127-18-4	1.3		
S&HM	Toluene	EPA 8260B	108-88-3	0.7		
S&HM	Trichloroethene	EPA 8260B	79-01-6	0.47		
S&HM	1,2,4-Trimethylbenzene[f]	EPA 8260B	95-63-6	3.6		
S&HM	1,3,5- trimethylbenzene[f]	EPA 8260B	108-67-8	8.4		
S&HM	Vinyl chloride[f]	EPA 8260B	75-01-4	0.02		
S&HM	Xylene (mixed)	EPA 8260B	1330-20-7	0.26		
MHP	Total BTEX[3]	EPA 8260B			0.96	5.9
	Dioxin					
MHP	2,3,7,8-TCDD[4] (Toxic Equivalency Total)	EPA 1613B			0.0000045	0.00005

[1] Threshold values lower than the Minimum Detection Limit are superseded by the Minimum Detection Limit.
[2] Total PAHs – sum the concentrations of the 18 semi-volatile analytes identified as MHP parameters
[3] Total BTEX – The sum of benzene, toluene and xylene concentrations
[4] TEQ calculation as per the NATO – 1988 method. For more information see TEQ Calculation for Dioxin/Furan below.

[a] The Soil Cleanup Objectives (SCOs) for unrestricted use were capped at a maximum value of 100 ppm. See Technical Support document, section 9.3
[b] For constituents where the calculated SCO was lower than the contract required quantitation limit (CRQL), the CRQL is used as the Track 1 SCO value.
[c] For constituents where the calculated where the calculated SCO was lower than the rural soil background concentration, as determined by the Department and the Department of Health rural soil survey, the rural soil background concentration is used as the track 1 SCO value for this use of the site.
[d] SCO is the sum of endosulfan I, endosulfan II and endosulfan sulphate.
[e] The SCO for this specific compound (or family of compounds) is considered to be met if the analysis for the total species of this contaminant is below the specific SCO.
[f] Protection of ecological resources SCOs were not developed for contaminants identified in Table 375-6.8(b) with "NS". Where such contaminants appear in Table 375-6.8(a), the applicant may be required by the Department to calculate a protection of ecological resources SCO according to the TSD.

TEQ CALCULATION FOR DIOXIN/FURAN

The 2,3,78-TCDD equivalent for a congener is obtained by multiplying the concentration of that congener by its Toxicity Equivalency Factor (TEF) from the table below. The TEQ is the sum of the products.

CONGENER	TEF
2,3,78 -Tetrachlorodibenzo-p-dioxin	1
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.5
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.01
Octachlorodibenzo-p-dioxin	0.001
2,3,7,8-Tetrachlorodibenzofuran	0.1
1,2,3,7,8-Pentachlorodibenzofuran	0.05
2,3,4,7,8-Pentachlorodibenzofuran	0.5
1,2,3,4,7,8-Hexachlorodibenzofuran	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.01
Octachlorodibenzofuran	0.001

TEQ calculation as per: NATO.1988. International Toxicity Equivalency Factors (I-TEF) Method of Risk Assessment for Complex Mixtures of Dioxins and Related Compounds. North Atlantic Treaty Organization. Report Number 176.

Appendix F

Water Quality Monitoring Plan

Draft Water Quality Monitoring Plan

for Grand Canal, Oakdale, New York

Prepared for:
Suffolk County Department of Health Services
335 Yaphank Avenue
Yaphank, NY 11980

Prepared by:
Cashin Associates
1200 Veterans Memorial Highway
Hauppauge, NY 11788

June 2015

1. Introduction

In recent years the Grand Canal, Oakdale, NY has been the subject of complaints by area residents concerned with progressive shoaling and with conditions potentially associated with a reduction in tidal flushing. Some of the issues raised include the potential for mosquito breeding, potential West Nile virus and other epizootic activity, the possible contamination of canal waters with Vector Control pesticides, and general water quality deterioration. .

In June 2004 a meeting was held among representatives of the Suffolk County Executive's Office, Suffolk County Department of Health Services (SCDHS) and Suffolk County Department of Public Works (SCDPW) and as a result of this meeting, a multi-agency strategy was adopted to assess environmental conditions of the Grand Canal. The objective of this strategy was to document existing conditions and determine whether a risk to public health exists, and if dredging of the canal would reduce that risk. The SCDHS Office of Ecology was assigned the tasks of assessing water quality conditions, coordinating monitoring efforts, and compiling a draft report. The SCDHS Division of Public Health was to evaluate mosquito and viral epizootic activity and assess the potential for public health implications. The SCDPW was assigned to evaluate adjacent wetland and ditch conditions as they relate to mosquito breeding, in addition to determining sediment conditions for potential dredging.

In January 2005, a Grand Canal Environmental Assessment report was produced by the SCDHS and SCDPW concluding that the water quality in the canal is significantly impacted by nutrient enrichment and potentially, by pathogen contamination. The excessive levels of nitrogen found in the canal suggest that algal blooms, and the consequential reduction in water clarity and depleted levels of dissolved oxygen, are a common occurrence. Potential sources of contamination include stormwater runoff from fertilized lawns and roadways, area wildlife, and perhaps, improperly functioning residential septic systems. The effect of these sources is exacerbated by the canal's low tidal prism and lack of flushing. The suggestion that these conditions collectively may represent a public health risk has prompted the need for this plan.

This plan will review all existing water quality data for the Grand Canal and adjacent waters of the Connetquot River that may be useful in assessing the conditions contributing to the water quality issues of the canal. In conjunction with this review, a series of surface water sampling events will be conducted to augment, fill data gaps of existing data, and further investigate the issues identified in the 2005 report.

2. Site Description and History

The Grand Canal is a man-made waterway and is a tributary or branch of the Connetquot River, located in Oakdale, New York in the Town of Islip. According to the 2005 report the canal was built sometime prior to 1920 to serve the former "Idle Hour" estate of William K. Vanderbilt.

The main channel of the canal is approximately 8,000 feet in length and 20 feet wide and variable. The canal system also includes a number of branch channels that extend into residential areas, providing access to the main channel. The Grand Canal is unique in that it has two interfaces that open into the Connetquot River. One opening is in the midsection of the tidal portion of the river and the second opening is in the southern section of the tidal portion of the river. This creates a situation where the river flow may have an influence on the currents and tidal flow in the canal. The Grand Canal is also integral to an extensive wetland system. The canal's northern opening is surrounded by residential properties and the southern opening is bordered on either side by commercial properties, including a marina and restaurant. The land area surrounding the northern section of the main canal, that runs east-west, is residential. For the north-south section of the main channel, the land to the west is a mixture of residential properties and tidal wetlands. The adjacent land area to the east is dominated by and extensive tidal and freshwater wetland complex known as the Pickman-Remmer Wetlands owned by the State of New York and managed by the New York State Department of Environmental Conservation (Figure 1).

3. Plan Objectives

The primary objective of this document is provide a Water Quality Monitoring Plan in accordance with Subtask 3.e. of section 4C of the Suffolk County contract No. 525-5200-1180-00-00001. This plan will build upon existing water quality for Grand Canal and the surrounding area and further investigate the water quality issues identified in the Grand Canal Environmental Assessment Final Report (2005). Prior to executing this plan a draft will be provided to the Department's Division of Environmental Quality for review and approval. Below is a detailed description of existing water quality data, the new study design, the analytes of concern, and the sampling protocols pursuant to subtask 3.e. A-B.

a. Review of Existing Water Quality Data

Cashin Associates (CA) has reviewed the existing water quality data from the Grand Canal Environmental Assessment Final Report (2005). According to the 2005 report twelve locations throughout Grand Canal were analyzed for the following parameters: temperature, salinity, dissolved oxygen, water transparency, pesticides, herbicides, volatile organic compounds, semi-volatile organic compounds, coliform bacteria, and nutrients. Per the requirements of the aforementioned contract, all of the above listed parameters will be analyzed for during the Grand Canal Surface Water Assessment (GCSWA) and Storm Water Runoff Monitoring Study (SWRMS). In addition, the inclusion of hydrogen

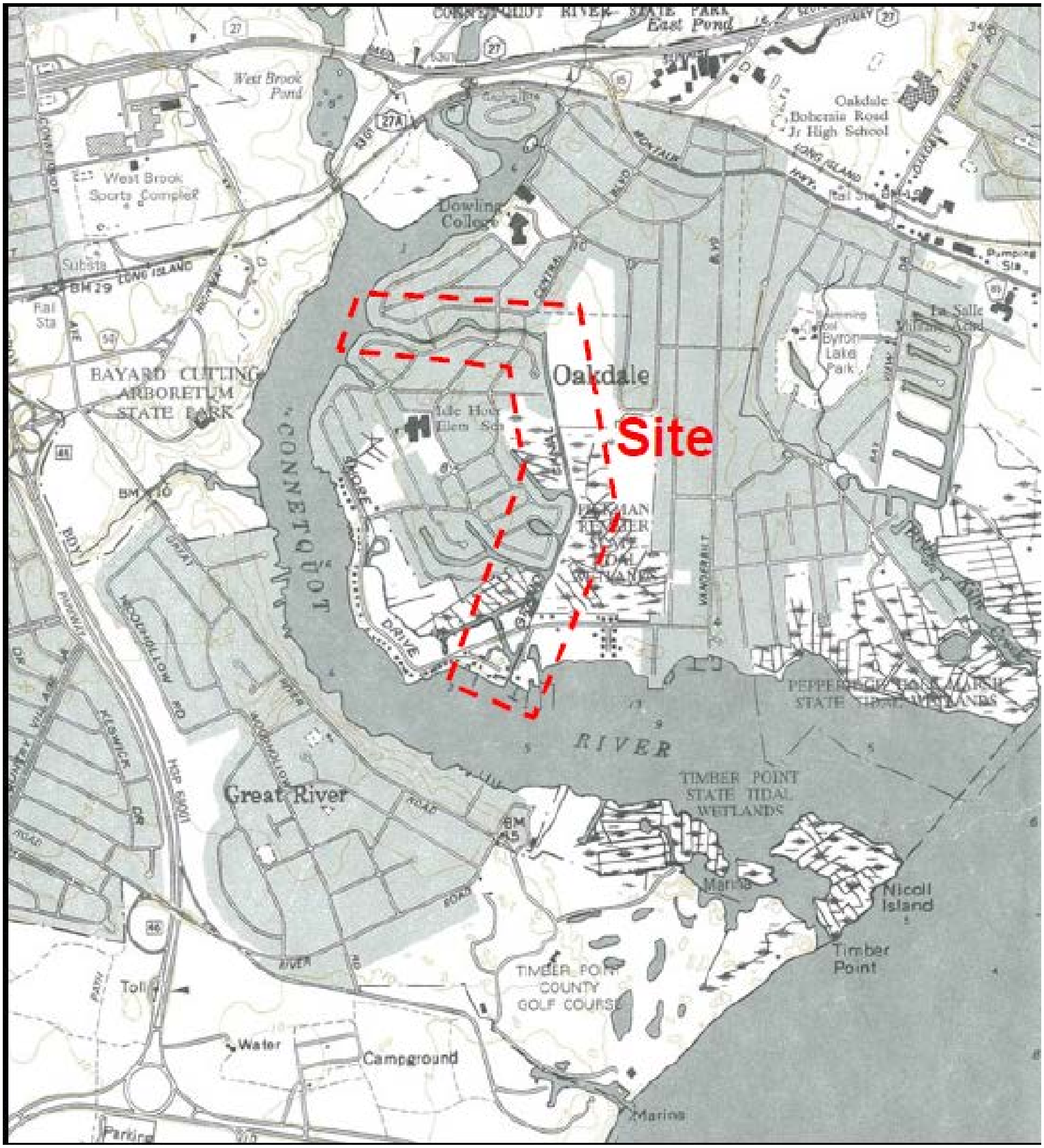

Figure 1. Site Location

sulfide as an analyte of concern will also be sampled and analyzed. During the 2005 report the only identified deficiency was a limited number of samples were taken for organics analysis. The report describes this deficiency to be related laboratory limitations. For the GCSWA, this limitation will be overcome with proper planning and identification of an appropriate analytical laboratory.

The water quality analyses conducted for the 2005 report provides a comprehensive and representative source of information that will aid in the GCSWA. To promote the most effective comparative use of this data the sampling locations for the GCSWA will mirror those location previously used for the 2005 study. The exception to this will be the removal of site GC 3, as illustrated in 2005 report (Figure 2), as a sampling location. The removal of this sampling site is due to its lack of utility in providing a unique representative location of the canal based on its close proximity to other sampling sites. The locations will be based on the GPS coordinates listed in Table 1.

Table 1. Depicts the GPS coordinates to be used for the water quality sampling.

Station	Latitude	Longitude
GC 1	40.72918333	73.14933333
GC-2	40.73046667	73.14691667
GC-3	40.73125	73.14966667
GC-4	40.73196667	73.15243333
GC-5	40.73208333	73.15043333
GC-6	40.7321	73.1473
GC-7	40.73323333	73.14573333
GC-8	40.73441667	73.1482
GC-9	40.73666667	73.14668333
GC-10	40.73838333	73.14693333
GC-11	40.73905	73.15063333
GC-12	40.73898333	73.15498333

Additional water quality data from the surrounding area (if available) will be evaluated during the analysis of the GCSWA. In addition, a “healthy” reference wetland will be identified in collaboration with department personnel. CA has identified one potential reference wetland located two miles to the east of Grand Canal along the western boundary of the Hard Estate-West Sayville County Park (the West Sayville Golf Course). However, consultation with department personnel and a site visit would be required to confirm if the site is appropriate for use.

b. Sampling Protocols

As discussed above, the following parameter will be sampled for both the GCSWA and SWRMS: temperature, salinity, dissolved oxygen, water transparency, pesticides, herbicides, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), coliform bacteria (total coliform, fecal coliform, and Enterococcus), hydrogen sulfide and nutrients (nitrogen and phosphorus). All GCSWA samples will be analyzed by an approved NYS Department of Health laboratory with Environmental Lab Approval Program (ELAP) certification.

i. Procedure

Sampling methods for both the GCSWA and SWRMS will follow the same procedures differing and in sample locations listed in Table 1 and displayed in Figure 2.

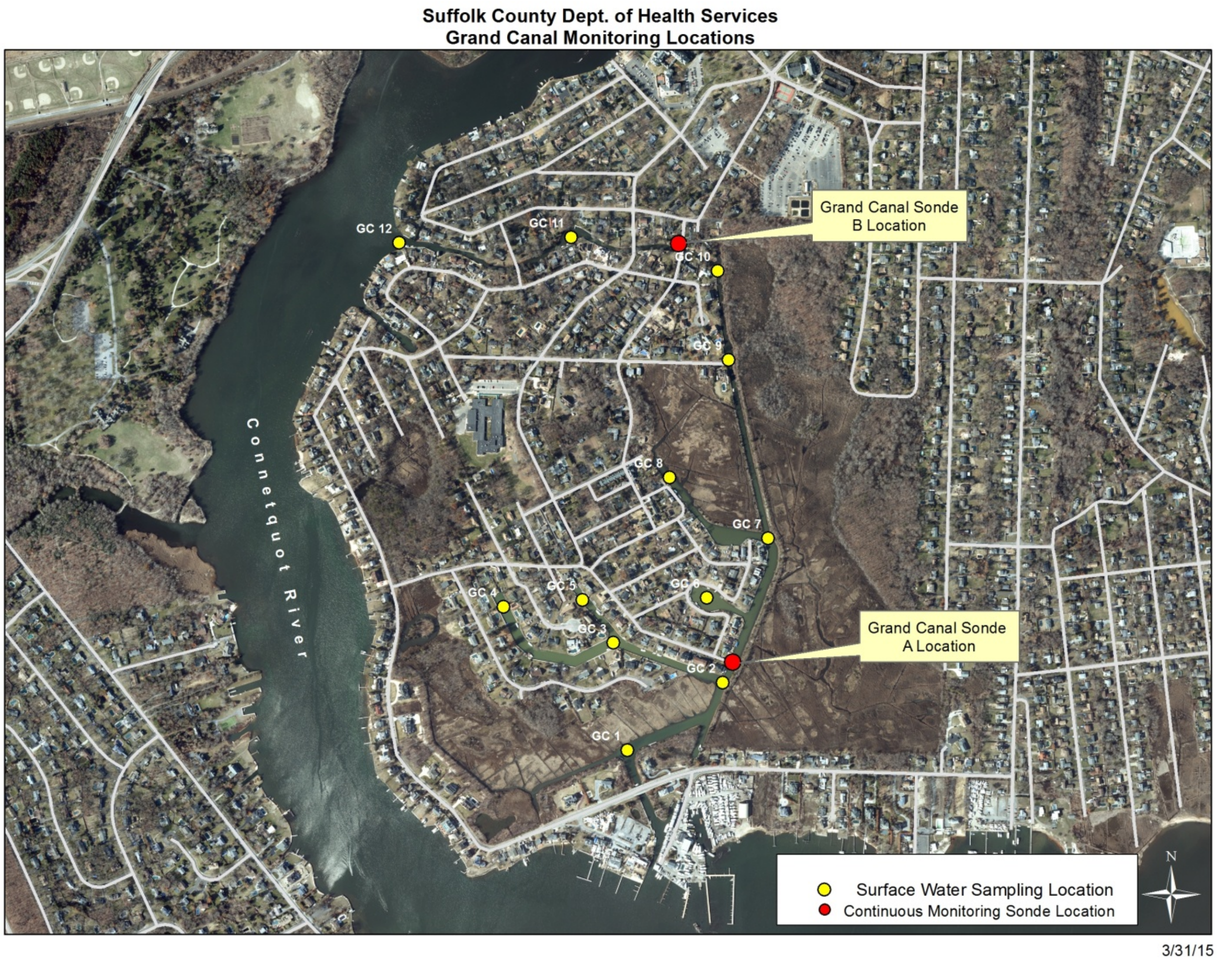

Figure 2. Existing sample locations provided by Suffolk County Department of Health Services.

a. At each location the following information must be recorded: GPS coordinates, depth, water temperature, salinity, dissolved oxygen, and water transparency or secchi.
b. In following the same sampling protocol used for the 2005 report, water samples will be collected from a depth approximately six inches below the surface. Samples must

be collected by submerging the sample containers to the six inch depth and carefully removing the cap to fill the container.

c. The sampler must wear a new pair of clean disposable powderless gloves for each sampling location.
d. Utilize the appropriate containers and preservatives for each parameter in accordance with table 1 of this document.
e. For samples collected for VOCs and SVOCs the containers should be slowly opened underwater on an angle to allow the container to fill slowly. The cap should be replaced prior to removing the bottle from the water.
f. For samples collected for VOCs it important that no headspace is present in the container. After the sample has been retrieved invert the bottle and tap the side to check for bubbles. If bubbles are present resample the location with a clean unused container.
g. To the extent feasible sampling locations should be approached from downstream to avoid disturbing bottom sediments that could contaminate water samples. In the event a downstream approach is not feasible careful attention must be given to minimize sediment disturbance.
h. For each sampling event trip blanks will be collected for VOCs and pesticides. One set of containers used for sampling VOCs and pesticides must be filled with distilled water and sealed prior to initiating the sampling event and must be present on the boat during the sampling event.
i. For each sampling event one replicate samples will be taken for each parameter analyzed at one sampling location.

c Grand Canal Surface Water Assessment

According to the aforementioned contract, sampling events must be taken during four distinct tidal conditions: low tide, midpoint of incoming tide, high tide and midpoint of outgoing tide. A minimum of ten locations must be sampled during the four distinct tidal conditions. Tidal conditions will be obtained from the National Oceanic and Atmospheric Administration Tide Prediction website and will be confirmed with onsite observations. During each sampling event, the tidal stage will be recorded by measuring the depth to water of a DPW reference point or other fixed land-based monument. The sampling locations will mirror those used for the 2005 report with the exception of site GC3 as previously discussed. Therefore a total of eleven location will be sampled as part of the GCSWA. The eleven sites will be sampled during four distinct tidal events for a total of 44 sample sets. This sampling convention will be conducted twice with at least fourteen days between events for a total of 88 samples sets for the GCSWA.

d Storm Water Runoff Monitoring Study

The purpose of this study is to determine the contaminant load from storm water runoff into Grand Canal. To properly characterize this contaminant loading to the canal a minimum of six locations will be identified for sampling prior to a significant rainfall event (baseline) and during a significant rainfall event (storm runoff) for a minimum total of twelve samples. The baseline sampling event will be conducted following a period of dry weather of at least 72 hours. The storm water runoff sampling event will take place within the first three hours of a significant rainfall event defined as being at least one-half inch of precipitation. Sampling equipment will be prepared prior to both events to allow for a rapid response once the “dry” and “wet” periods conditions have been met. Sampling events will be scheduled based on data from the National Weather Service and general observations. Pertinent weather data will be recorded and included in the field data.

e Continuous Monitoring

The physical water quality data collected by the Department at two locations within the canal will be included in the overall water quality analysis. At a minimum that data will be analyzed for tidal, diurnal, and seasonal trends. An attempt will also be made to couple the department’s data with that obtained through the GCSWA and SWRMS.

Appendix G

Water Quality Laboratory Results

(July 2015 Event)

(August 2015 Event)

(Wet Sampling Event - August 2015)

(Dry Sampling Event - September 2015)

Sediment Analysis Results

See attached CD.

Appendix H

Wetland Habitat Condition and Health Assessment Report

DRAFT

Wetland Habitat Condition and Health Assessment Report

Grand Canal
Suffolk County, Oakdale, New York

January 29, 2016 (Draft)

Prepared by: NewEarth Ecological Consulting
169 Watson Mill Road
Saco, ME 04072

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1.0 INTRODUCTION

This report presents the results of a wetland assessment performed to document a number of baseline conditions for hydrology, vegetation, soils and avian species within the wetlands associated with the Grand Canal, and to provide an assessment of the current health of those wetlands. The specific Tasks performed include:

1. Background data collection and review
2. Cover type mapping;
3. Field data collection; and,
4. Wetland habitat characterization and health evaluation.

1.1 PROJECT DESCRIPTION AND BACKGROUND

Describe project, setting. Identify Suffolk County (County), Reference Figure 1.

2.0 METHODS

The methodology used in this wetland habitat characterization and health assessment follows the United States Environmental Protection Agency's (USEPA) 3-tiered approach to wetland assessments, which combines: 1) landscape-level analysis; 2) a rapid assessment and scoring of overall wetland health; and, 3) a component of more intensive field-based data collection for user-defined parameters (USEPA 2015). More specifically, tier 2 of this assessment utilized many of the concepts from the USEPA-recommended Mid-Atlantic Tidal Rapid Assessment Method; which was modified slightly to meet the specific characteristics of the Grand Canal area and goals and objectives of the project (Mid-TRAM 2010). Tier 3 included additional field-based data collection for several biological parameters such as vegetation, soils, and avifauna, and follows the methodology outlined the New York State Salt Marsh Restoration and Monitoring Guidelines (Niedowski 2000).

Collectively, the wetlands of the Grand Canal area are referred to as the Pickman-Remmer wetlands. However, for study purposes the three marsh complexes that comprise the Pickman-Remmer marsh system were demarcated based on clear physical separations between the marsh areas, and were labeled based on their geographic position within the site; the southwest marsh, east marsh, and northwest marsh (Appendix A, Figure 2).

2.1 BACKGROUND DATA COLLECTION AND REVIEW

This wetland habitat assessment utilized available maps, aerial photography, and background reports and data, as well as field data collected on site to document and assess conditions of the Grand Canal marsh system. The following resources provided valuable background information in that effort:

- Google Earth, current and historic satellite imagery;
- Mid-Atlantic Tidal Rapid Assessment Method (Mid-TRAM);
- Natural Resource Conservation Service Riverhead Service Center, information on soil properties/leaching potential;

- New York State Department of Environmental Conservation,
  - Bureau of Marine Resources (tidal wetlands inventory and other wetland GIS data)
  - GIS data clearinghouse
  - Division of Fish, Wildlife and Marine Resources
  - Natural Heritage Program
- Suffolk County;
  - GIS Data (property maps, environmental resources/concerns)
  - Project reports and background information
- U.S. Department of Agriculture, online soil survey data;
- U.S. Department of Agriculture, invasive species information;
- U.S. Fish and Wildlife Service Long Island Field Office, information on Rare, Threatened and Endangered (RTE) species and habitats;
- U.S. Fish and Wildlife Service, National Wetland Inventory (NWI) database; and,
- U.S. Geological Survey 7.5-minute series topographic maps.

2.2 COVER TYPE MAPPING

A Geographic Information System (GIS) wetland data layer was created for the study area using ArcMap™ 10.1, ArcToolbox™ and Conversion Tools (ESRI™ 2015), and was based on a desktop overlay and evaluation of the relevant spatial data. The data layer included potential locations of wetlands that are hydrologically-connected to the Grand Canal and that could be potentially affected by future project activities. Preliminary wetland boundaries were overlaid onto satellite imagery maps and hardcopies were produced for use by biologists in the field to assess boundaries and identify any needed boundary modifications. In addition, an IPad™ was preloaded with the preliminary wetland boundaries which allowed biologists to identify their real-time location in the field relative to locations of wetland boundary lines to facilitate the wetland verification effort.

Wetland biologists then performed systematic field verifications, or “ground-truthing”, of the wetland data layer while on site for avian and vegetation survey efforts performed between March and October, 2015, to confirm that the preliminary wetland layer was an accurate representation of wetland boundary shapes and sizes. Biologists also classified the wetland type per the widely accepted Cowardin wetland classification system (Cowardin et. al., 1979) and dominant plant community type, and also noted the locations of abutting upland areas as well as large infestations of the invasive species common reed (*Phragmites australis*).

Where necessary, revisions to wetland locations and boundaries were documented on hardcopy maps and used to update the project GIS wetland data layer using ArcMap™ 10.1. It should be noted that this effort did not include a delineation of wetland boundaries per USACE wetland delineation requirements (Environmental Laboratory 1987, USACE 2012), as such the boundaries depicted in project data and maps are not intended to be used for permitting purposes.

2.3 FIELD DATA COLLECTION

2.3.1 Avian Surveys

The goal of the avian survey effort was to document the presence of bird species in the project area to **(a)** identify which species are utilizing habitats associated with the Grand Canal, **(b)** help the County to evaluate/anticipate if there are birds which may be negatively affected by changes to the marsh, and, **(c)** ensure the County is aware of the presence of any state or federally-lists species in the project area.

Avian surveys were performed by qualified biologists on March 16-17, May 21-22, and June 25-26, 2015. Surveys closely followed the methodology of the US Geologic Survey (USGS) Standardized North American Marsh Bird Monitoring Protocol (Conway 2009), and US Fish and Wildlife Service (USFWS) Landbird Monitoring Protocol (Knutson 2008). The focus of the survey effort was to identify as many bird species possible in the Project area, as opposed to surveys performed for the purpose of documenting specific habitat associations and population trends. As such, surveys included several methods (point counts and area searches) which were performed under different tidal amplitude conditions, and the points were placed in locations that captured the broadest area and as many different habitat types as possible at any given survey point. Birds were recorded if seen/heard within the marsh and open water complexes of the study area and adjacent upland/developed habitats. Survey locations are shown in Appendix A, Figure 2, and the x, y coordinates of those locations are provided in Appendix B.

Point Counts

A distance point count consisted of standing at a predetermined location and recording visual and/or auditory observations of birds, and distances to those observations, during a 10-minute time period on an Avian Survey Data Form (Appendix B). Nine point count stations were established at key vantage points around each of the marsh complexes and were placed at least 250m (820ft.) apart to minimize duplication of detections (Appendix A, Figure 2). An additional three points were established for use during broadcast call surveys. These points were spaced in different locations than the point count stations due to the long distances that the broadcast call sounds travel, and the increased ability of observers to detect calls across larger areas during these survey periods. In an effort to capture avian activity in a broad range of land uses, vegetative communities, soil types, and topographic locations, each of the point count stations were situated in locations that would capture several habitats and land uses within the survey area of each point. All points were surveyed at least twice during each monthly survey event (e.g., March, May, and June). Surveys were conducted between sunrise and three and a half hours after sunrise.

March and May survey events also included surveys at three broadcast call stations (Appendix A, Figure 2), to target nocturnal species such as owls and nightjars, and were conducted beginning at least ½ hour after sunset up to one hour before sunrise. The May and June events included surveys at the same broadcast stations to target secretive marsh bird species such as bitterns and rails, and were conducted beginning at least two hours before sunset and ending at sunset.

Upon arrival at each point, observers waited for 2 minutes before recording birds to allow birds to acclimate to the disturbance of the approach as well as the observers' presence. Weather conditions were noted on each data form, however, surveys were not conducted during rain, under windy conditions (i.e., > 10 mph), or when hearing was significantly impaired due to temporary adjacent activities (e.g., loud trucks or boats, construction activities). With the exception of late day marsh bird surveys and nocturnal surveys (which included the use of marsh bird and owl broadcast calls) observers did not use sounds to attract birds to the point or induce calling. No "spishing", "squeaking", recorded calls, or any other methods that encourage birds to alter their behavior were used.

Area Searches

Area searches were conducted following each morning point count survey and involved meandering slowly along a specified survey area (Appendix A, Figure 2). The area search method is not a timed or fixed point event, which allows the observers more flexibility in spending any amount of time needed to evaluate bird activities and to survey a variety of habitats. In this case, surveyors focused efforts along the earthen berm which abuts approximately 3,800 feet (ft.) of the east side of the Grand Canal since this area was easily navigable by observers and also provided good coverage of each of the target marsh areas. Visual and/or auditory observations were recorded on the Avian Survey Data Form (Appendix B). No specific time periods were used during area searches; surveys were performed during daylight hours and were made until no new avian species could be recorded for the area.

Incidental Observations

Incidental observations were recorded for any species that was seen/heard in the study area, but not otherwise recorded during formal point count or area surveys; including other wildlife species. Incidental observations were recorded in field log books and on the Avian Survey Data Form (Appendix B).

Rare, Threatened and Endangered Species

The USFWS and New York Department of Environmental Conservation, Division of Fish, Wildlife and Marine Resources (DFWMR) were consulted to identify any known occurrences of federal or state listed species in the project area (NYSEDC 2014, USFWS 2015).

2.3.2 Vegetation Surveys

The goal of the vegetation survey effort was to **(a)** document the characteristics of vegetation within the dominant plant communities in the project area, **(b)** establish baseline conditions which will help the County to evaluate/anticipate if changes are/will occur on the marsh, and, **(c)** ensure the County is aware of the presence of invasive species in the project area.

Vegetation sampling was conducted within 1.0 square meter (m^2) quadrats situated along seven survey transects; labeled A through G (Appendix A, Figure 2). Transects extended across the marsh surfaces from areas of lowest elevation and hydrologic input (i.e., the canal or primary tidal channels from the canal) to highest elevation along a marsh-upland edge. Since changes to marsh conditions are typically most noticeable at transition zones where slight differences in chemical and physical parameters can quickly affect the flora and fauna species, surveys targeted transition zones from the canal/marsh edge to the upland edge, and also targeted locations within the marsh that had notable differences in the density/height of the invasive species common reed. From three to five zones were targeted along each transect, and three quadrats were sampled at each of the zone transitions, for a total of 78, 1.0 m^2 quadrats. Transect and plot locations were marked with semi-permanent wooden stakes and the locations were recorded using a Global Positioning System (GPS) with sub-meter accuracy. Survey locations are shown in Appendix A, Figure 2, and the coordinates of sample quadrats are provided in Appendix B.

Various vegetation metrics were collected within each quadrat and recorded on a Vegetation Sampling Data Form (Appendix B), including a list of all live and dead standing vascular plants and macro-algae species (with distinction made between native and non-native species), stem density, plant height, and percent (%) cover of bare ground, trash, rock, micro-algae, fungus, dead plant material (not standing), and wrack.

The vegetation survey effort also included the establishment of photo-stations to document baseline conditions and to facilitate visual comparisons of baseline and future marsh conditions. Photo-stations were established at the center quadrat (i.e., the quadrat located on the transect line) of each transition zone along the transect. Four photographs were collected per photo station facing each cardinal direction (i.e., N, S, E and W) in sequence. Additional photographs were collected as needed to document overall marsh conditions in the vicinity of each transect. Photo Station locations were marked with semi-permanent stakes and the locations were recorded using a GPS with sub-meter accuracy. The coordinates of photo station locations are provided in the photographic documentation in Appendix D.

2.3.3 Soil Surveys

The goal of the soil survey effort was to **(a)** document the characteristics of soils within the dominant plant communities in the project area, and **(b)** establish baseline conditions which will help the County to evaluate/anticipate if changes are/will occur on the marsh. Soil metrics were collected within many of the same 1.0 m^2 quadrats as used in the vegetation sampling and were collected concurrent to the vegetation survey effort (Appendix A, Figure 2). Data forms from the survey effort and the coordinate locations of survey quadrats are provided in Appendix B.

Soil compaction was measured in the center of one 1.0 m^2 quadrat per each survey transect and transition zone (i.e., 26 sample quadrats) using a DICKEY-John® soil penetrometer with a ¾ inch probe tip. The probe tip was inserted with steady and even pressure into the soil to 18-inches depth, or until full resistance was met. Any resistance was recorded in pounds per square inch.

Soil electrical conductivity was measured using a FieldScout® Direct Soil Electrical Conductivity Meter. Samples were taken in the center of all 1.0 m^2 quadrats (i.e., 3 quadrats per transects and transition zone for 78 total samples) by inserting the probe tip to a depth of 4 inches below the soil surface. Conductivity values were recorded in microsiemens (uS) then converted to salinity in parts per thousand (ppt).

Soil organic matter from marsh substrates was measured by loss on combustion. A 5 cm diameter cylindrical push corer was used to remove a sediment core to the depth of 10 cm from the center of one 1.0 m^2 survey quadrat per transect and zone (i.e., 26 sample quadrats). Samples were dried, weighed, combusted at 500 degrees Celsius for ~8 hours, then weighed again. The difference in weight between the dried and combusted samples, expressed as a percentage of the dried weight, represents the organic matter content of the marsh soil sample.

The local Natural Resources Conservation Service (NRCS) was also consulted for information on the soil types and leaching potential of project area soils (USDA 2014).

2.3.4 Wetland Condition and Health Assessment

Concurrent to all field survey efforts, biologists gathered information to identify potential stressors in the area surrounding each survey transect using a rapid assessment approach recommended by the USEPA EPA; the Mid-Atlantic Tidal Rapid Assessment Method (Mid-TRAM 2010). Evaluation parameters included field evidence of stressors affecting key marsh functions such as: altered hydroperiod; which included ditches/channelization, deeply cut or slumping channels, drains/culverts/pipes, upland plant species encroaching into wetlands, vegetation die-off, tidal restrictions, dikes, fill, filamentous algae, excavation, riprap, inlets/outlets; stormwater input such as habitat/vegetation disturbance, such as mowing, cutting, herbicide use, excessive herbivory, insect damage, and invasive species; and, residential stressors, for example. adjacent and on-site land uses, infrastructure, and dumping of yard waste or other debris. The goal of the wetland condition and health assessment was to **(a)** document the overall health of wetlands in the project area, **(b)** identify the stressors affecting wetland health, and **(c)** establish baseline conditions which will help the County to evaluate/anticipate if changes are/will occur on the marsh.

Field based information regarding site stressors and actual data from the vegetation and soil surveys were combined with a landscape evaluation to produce a wetland score by closely following the methodology of the Mid-Atlantic Tidal Rapid Assessment Method (Mid-TRAM 2010). The approach uses high resolution variables that can be quickly assessed to help predict stress responses and relationships. The assessment includes metrics in four major attribute categories that are significant in driving the overall health of a wetland: buffer, hydrology, habitat/plant community (biotic and physical structure), and shoreline characteristics (Table xx).

Each metric is given a score between three and 12 and then combined into attribute scores by summing the metric scores and dividing by the total possible value, depending on the number of metrics in that group. That value is calculated then adjusted to be on a 0-100 scale using the following formula:

Buffer = ((((∑(B1…B6))/72)*100)-25)/75)*100

Hydrology = ((((∑(H1…H4))/48)*100)-25)/75)*100

Habitat = ((((∑(HAB1…HAB5))/60)*100)-25)/75)*100

Shoreline = ((((∑(S1 + S2))/24)*100)-25)/75)*100

Table 1. Attributes Evaluated for Grand Canal Marsh Complexes.

Attribute	Metric	Description
Buffer/Landscape	Percent of Perimeter with 5m-Buffer	Percent of perimeter that abuts at least 5m (16 ft.) of natural or semi-natural condition land cover
Buffer/Landscape	Average Buffer Width	The average buffer width that is in natural or semi-natural condition
Buffer/Landscape	Surrounding Development	Percent of developed land within 250 m (280 ft.) from the edge of the area
Buffer/Landscape	Landscape Condition	Landscape condition within 250 m (820 ft.) surrounding the area based on the nativeness of vegetation, disturbance to substrate and extent of human visitation
Buffer/Landscape	Barriers to Landward Migration	Percent of landward perimeter of wetland that has physical barriers preventing wetland migration inland
Hydrology	Ditching & Draining	The presence of ditches in the wetland area
Hydrology	Fill & Fragmentation	The presence of fill or wetland fragmentation from anthropogenic sources in the wetland
Hydrology	Wetland Diking / Tidal Restriction	The presence of dikes, berms, culverts or other tidal flow restrictions
Hydrology	Point Sources	The presence of localized sources of pollution
Habitat	Bearing Capacity	Soil resistance measured with a penetrometer
Habitat	Vegetative Obstruction	Visual obstruction by vegetation < 1 m (3 ft.)
Habitat	Number of Plant Layers	Number of plant layers in the wetland based on plant height
Habitat	Percent Dominant/Co-dominant Invasive Species	Percent of co-dominant invasive species in the wetland
Habitat	Percent Invasive	Percent cover of invasive species in the wetland
Shoreline	Shoreline Alteration	Percent of shoreline that has been unnaturally altered
Shoreline	Shoreline Erosion	Score based on amount of shoreline that is eroding/stable/accreting

A final score is also calculated for each site by averaging the four attribute group scores:

Health Score = ((Buffer + Hydrology + Habitat + Shoreline)/4)

A **Comparative Health Score** was also calculated based on three of the four metrics (buffer, hydrology, and habitat) and placed into three condition categories; minimally stressed (scores $\geq$ 83), moderately stressed (scores from 83 to 61), or severely stressed (scores < 61). These condition class breakpoints were determined from scores form 90 sites assessed using Mid-TRAM in Pennsylvania (PA), New Jersey (NJ), and Delaware (DE) (Jennette et. al., 2014, Pedeletti et. al., 2012) since data comparable to the Mid-TRAM approach was not available for the Suffolk County study area. The fourth category, shoreline, was not included since it was not a component of the DE/NJ/PA data. It should be noted that category breakpoints could vary somewhat from site to site depending on the ranges of health scores included in the assessment. Nonetheless the stressors and general landscape setting of the locations used in DE/NJ/PA are likely similar to those of the Grand Canal study area, and although not in the same region, the breakpoints are a suitable starting point for comparative discussions of overall marsh health.

3.0 RESULTS AND DISCUSSION

3.1 Cover Type Map

Six vegetated community types, and two open water types (excluding the grand canal) covering 131 acres, were differentiated and mapped in the Grand Canal study area to create a project cover type map (Appendix A, Figure 3) and included:

- Forest_Scrub-shrub;
- Intertidal marsh;
- High marsh_pool_panne;
- High marsh_Marsh elder (*Iva frutescens*);
- Common reed_stunted growth form;
- Common reed_tall growth form;
- Pond; and,
- Tidal channels.

In addition, significant features such as culverts and sampling station locations were recorded using GPS and included as additional layers on the cover type map and related project area figures (Appendix A, Figures 2 and 3).

3.2 Avian Surveys

The study area falls within the NYSCDEC-designated South Shore Tidal Wetlands Bird Conservation Area (NYSDEC 2004). The area is designated as such due to its unique assemblages of tidal salt marshes, upland habitats and open water creeks, channels and ditches, which are known to support a diverse mix of uncommon bird species such as seaside sparrow (*Ammodramus maritimus*), saltmarsh sparrow (*Ammodramus caudacutus*), common tern (*Sterna hirundo*), osprey (*Pandion haliaetus*), clapper rail (*Rallus crepitans*), and northern harrier

(*Circus cyaneus*), while the uplands provide critical migration habitat for birds crossing the ocean and bays.

Sixty-three bird species were observed in the study area, including 36 unique species identified in March before many of the migrant species had arrived, 52 observed in May, and 47 in June (Table 2). Survey results excluded species that were observed flying over the site unless the species was known to be utilizing marsh resources (e.g., northern harrier, swifts and swallows, and terns seen foraging over the marsh open water areas). In comparison, eBird (a professionally maintained and monitored web-based bird data portal that allows birders to record local bird observations), has 70 recorded unique species near the Grand Canal area that would typically be associated with the habitat types of the Grand Canal (eBird 2016). The species most commonly observed during all Grand Canal survey events were common grackle (*Quiscalus quiscula*), red-winged blackbird (*Agelaius phoeniceus)*, and song sparrow (*Melospiza melodia*); consistent with the most commonly reported birds on eBird for similar habitat types in the vicinity. While many of the species observed within the study area utilize a diversity of habitats during their life cycle, 24 species are closely associated with marsh and open water habitats of the study area and are the most susceptible to changes in the availability and quality of marsh habitats (Table 2). This includes species that while they may be associated with upland habitats for breeding and nesting activities, depend on the marsh habitats for food.

Focused evening surveys for nocturnal species detected two separate eastern screech owls (*Megascops asio*). One was detected during both the March and May survey events and was located in the forest at the north end of the east marsh. The second owl was detected along the tree line/residential area at the west end of the southwest marsh, and was heard during the May survey. No marsh bird species were detected during dusk marsh bird broadcast call surveys.

Table 2. Avian Species Documented in the Grand Canal Study Area.

Common Name	Scientific Name	March	May	June	Predominant Habitat Association	Listed or Special Concern Species
American Crow	*Corvus brachyrhynchos*	1	1	1	Upland	No
American Goldfinch	*Spinus tristis*		1	1	Upland	No
American Redstart	*Setophaga ruticilla*		1	1	Upland	No
American Robin	*Turdus migratorius*		1	1	Upland	No
Barn Swallow	*Hirundo rustica*		1	1	Wetland/Open Water	No
Black-capped Chickadee	*Poecile atricapillus*	1	1	1	Upland	No
Belted Kingfisher	*Megaceryle alcyon*	1		1	Wetland/Open Water	No
Brown-headed Cowbird	*Molothrus ater*	1	1	1	Upland	No

Table 2. Avian Species Documented in the Grand Canal Study Area (continued).

Common Name	Scientific Name	March	May	June	Predominant Habitat Association	Listed or Special Concern Species
American Black Duck	*Anas rubripes*	1			Wetland/Open Water	No
Blue Jay	*Cyanocitta cristata*	1	1	1	Upland	No
Blackpoll Warbler	*Setophaga striata*		1		Upland	No
Canada Goose	*Branta canadensis*	1	1	1	Wetland/Open Water	No
Carolina Wren	*Thryothorus ludovicianus*	1	1	1	Upland	No
Cedar Waxwing	*Bombycilla cedrorum*		1	1	Upland	No
Chimney Swift	*Chaetura pelagica*		1	1	Wetland/Open Water	No
Common Grackle	*Quiscalus quiscula*	1	1	1	Upland	No
Common Tern	*Sterna hirundo*		1		Wetland/Open Water	State-Threatened
Common Yellowthroat	*Geothlypis trichas*		1	1	Upland	No
Downy Woodpecker	*Picoides pubescens*	1	1	1	Upland	No
Eastern Kindbird	*Tyrannus tyrannus*		1	1	Upland	No
Eastern Phoebe	*Sayornis phoebe*		1	1	Upland	No
Eastern Screech-Owl	*Megascops asio*	1	1		Upland	No
European Starling	*Sturnus vulgaris*	1	1	1	Upland	No
Fish Crow	*Corvus ossifragus*	1	1	1	Upland	No
Great Blue Heron	*Ardea herodias*			1	Wetland/Open Water	No
Great Crested Flycatcher	*Myiarchus crinitus*		1		Upland	No
Gray Catbird	*Dumetella carolinensis*		1	1	Upland	No
Great Egret	*Ardea alba*		1	1	Wetland/Open Water	No
Green Heron	*Butorides virescens*		1	1	Wetland/Open Water	No
Greater Yellowlegs	*Tringa melanoleuca*		1		Wetland/Open Water	No
Hairy Woodpecker	*Picoides villosus*	1		1	Upland	No
Herring Gull	*Larus argentatus*	1	1	1	Wetland/Open Water	No

Table 2. Avian Species Documented in the Grand Canal Study Area (continued).

Common Name	Scientific Name	March	May	June	Predominant Habitat Association	Listed or Special Concern Species
House Finch	*Haemorhous mexicanus*	1	1	1	Upland	No
Hooded Merganser	*Lophodytes cucullatus*	1			Wetland/Open Water	No
House Sparrow	*Passer domesticus*	1	1	1	Upland	No
House Wren	*Troglodytes aedon*			1	Upland	No
Killdeer	*Charadrius vociferus*	1	1	1	Upland	No
Laughing Gull	*Leucophaeus atricilla*			1	Wetland/Open Water	No
Mallard	*Anas platyrhynchos*	1	1	1	Wetland/Open Water	No
Marsh Wren	*Cistothorus palustris*		1	1	Wetland/Open Water	No
Mourning Dove	*Zenaida macroura*	1	1	1	Upland	No
Mute Swan	*Cygnus olor*	1	1	1	Wetland/Open Water	No
Northern Cardinal	*Cardinalis cardinalis*	1	1	1	Upland	No
Northern Flicker	*Colaptes auratus*	1	1	1	Upland	No
Northern Harrier	*Circus cyaneus*	1	1		Wetland/Open Water	State-Threatened
Northern Mockingbird	*Mimus polyglottos*	1	1	1	Upland	No
Baltimore Oriole	*Icterus galbula*		1		Upland	No
Osprey	*Pandion haliaetus*		1	1	Wetland/Open Water	Special Concern
Ring-billed Gull	*Larus delawarensis*	1	1		Wetland/Open Water	No
Red-bellied Woodpecker	*Melanerpes carolinus*	1	1	1	Upland	No
Ring-necked Duck	*Aythya collaris*	1			Wetland/Open Water	No
Rock Pigeon	*Columba livia*	1	1	1	Upland	No
Red-tailed Hawk	*Buteo jamaicensis*	1			Upland	No
Red-winged Blackbird	*Agelaius phoeniceus*	1	1	1	Wetland/Open Water	No
Savannah Sparrow	*Passerculus sandwichensis*		1		Upland	No
Snowy Egret	*Egretta thula*		1		Wetland/Open Water	No
Song Sparrow	*Melospiza melodia*	1	1	1	Upland	No

Table 2. Avian Species Documented in the Grand Canal Study Area (continued).

Common Name	Scientific Name	March	May	June	Predominant Habitat Association	Listed or Special Concern Species
Tree Swallow	*Tachycineta bicolor*	1		1	Wetland/Open Water	No
Tufted Titmouse	*Baeolophus bicolor*	1	1	1	Upland	No
Willow Flycatcher	*Empidonax traillii*		1	1	Wetland/Open Water	No
White-throated Sparrow	*Zonotrichia albicollis*	1			Upland	No
Yellow-billed Cuckoo	*Coccyzus americanus*		1		Upland	No
Yellow Warbler	*Setophaga petechia*		1	1	Upland	No
63	**TOTAL**	**36**	**52**	**47**		

Correspondence with federal and state natural resource agencies did not reveal any rare, threatened or endangered species that are known to be present, or were identified as likely to occur in the study area (NYSEDC 2014, USFWS 2015). However, two listed birds, northern harrier and common tern were observed foraging over the marsh surfaces and open water areas of the Grand Canal during survey events (Table 2). These listed species were also confirmed in the general vicinity of the study site during the spring and summer of 2015 through postings of rare bird sightings on eBird (eBird 2016). In addition, several ospreys (a state species of special concern), were also documented during surveys. Two man-made osprey nest platforms are located adjacent to Shore Road along the south border of the study area and a natural nest is located within the Grand Canal marsh complex study area (Appendix A, Figure 2); all were active during the 2015 breeding/nesting season. Additional state or federally-listed listed avian species and those of special concern are known to utilize tidal marsh habitats similar to those in the study area and have been reported nearby (eBird 2015). These species could potentially be found in habitats of the project area; the most probable being king rail, least tern, and seaside sparrow. Most listed and special concern species are very uncommon and/or secretive in nature, and would require additional focused surveys to confirm their presence/absence in the study area.

Efforts did not include surveys for other wildlife species, although several medium to large-sized mammal species that are generalists and commonly associated with highly-developed urban settings were noted. Based on direct observation, or as evidenced by tracks or scat, additional wildlife species in the study area include: white-tailed deer (*Odocoileus virginianus*); raccoon (*Procyon lotor*); muskrat (*Ondatra zibethicus*); red fox (*Vulpes vulpes*); gray squirrel (*Sciurus carolinensis*); and, chipmunk (*Tamias striatus*). Numerous sighting of the non-native house cat (*Felis catus*) were also observed throughout the study area, and a cat feeding station is located within 100 ft. of bird survey point #9. Outdoor cats are voracious opportunistic predators that can have devastating impacts on ground and low-shrub nesting species such as birds. Overall, the study site and much of the surrounding area of Long Island lack the large high-quality undisturbed habitats needed to support most of the mammal species that occurred in this region prior to urban development. Nonetheless, forested areas adjacent to the east marsh may provide roosting habitat for bats. Several bats, including the northern long-eared bat (*Myotis septentrionalis*), are federal or state-listed protected species.

3.3 VEGETATION SURVEYS

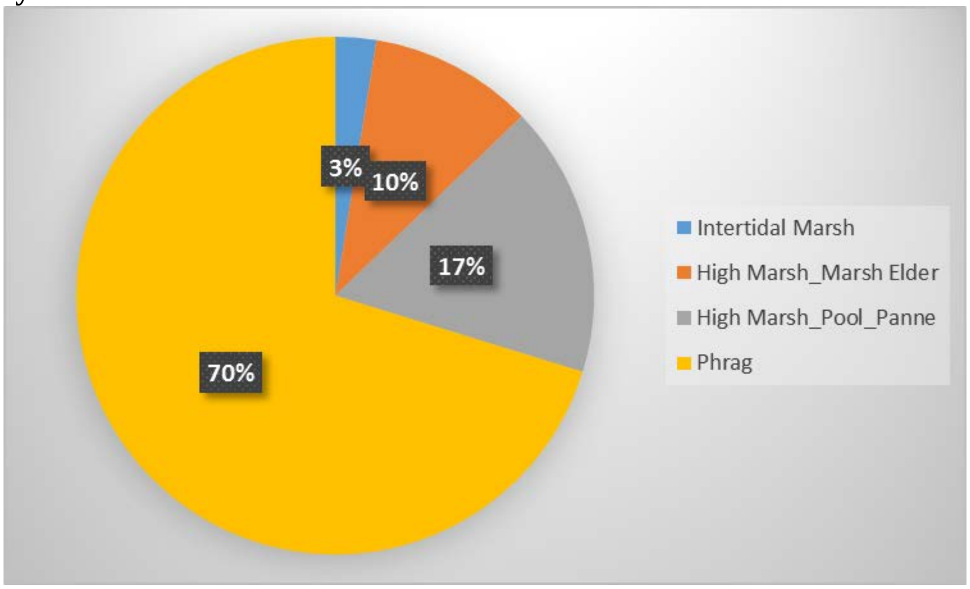
Wetland communities within each of the three major marsh areas of the site (east, southwest, northwest sites), were delineated for survey based on the dominant plant species present, resulting in four major community types: intertidal marsh; high marsh/pool/panne; high marsh/marsh elder; and common reed. Each of these community types were targeted during survey efforts, which involved surveys at 26 sampling points established along 7 transects; for a total of 78 1m^2 data plots (Appendix A, Figure 2). In most cases plots were placed along the transition zones from one community type to another, since these areas would be most likely to show shifts in plant species composition over time, should marsh conditions change. Three transects (A, B, and C) and a total of 39 plots were sampled within the southwest marsh, two transects (D and E) with 21 plots were sampled within the northwest marsh, and two transects (F and G) with 18 plots were sampled in the east marsh (Appendix A, Figure 2). Additional plots were not needed in the east and northwest marsh complexes due to the lack of diversity of the marsh communities encountered.

Estuarine emergent marsh wetlands comprise 88 acres in the Grand Canal study area: 50 acres in the east marsh complex; 16 acres in the southwest complex; and, 12 in the northwest complex (Table 3). The common reed community type dominates in all three marsh complexes; comprising 70% of all emergent wetlands in the project area (Graph 1). Within each complex, common reed comprises 39 acres (78%) of the wetlands found in the east marsh, 8 acres (66%) of the wetlands in the northwest marsh, and 8 acres (50%) of wetlands in the southwest marsh. Additionally, although not considered a wetland marsh community type, tidal channels (excluding the Grand Canal) cover 3.5 acres of the east marsh, 0.7 in the northwest marsh, and 0.9 acres in the southwest marsh (Table 3).

Table 3. Acres of Marsh Community Types and Tidal Channels in Grand Canal Marsh Complexes.

Community Type	East Marsh (Transects A, B, C)	Southwest Marsh (Transects D and E)	Northwest Marsh (Transects (F and G)
Intertidal Marsh	0	2.0	0
High Marsh_Pool_Panne	7.2	2.5	3.5
High Marsh_Marsh Elder	3.6	3.7	0.7
Common Reed	38.7	8.0	7.9
Tidal Channels	3.5	0.9	0.7
Total	53.1	17.0	12.8

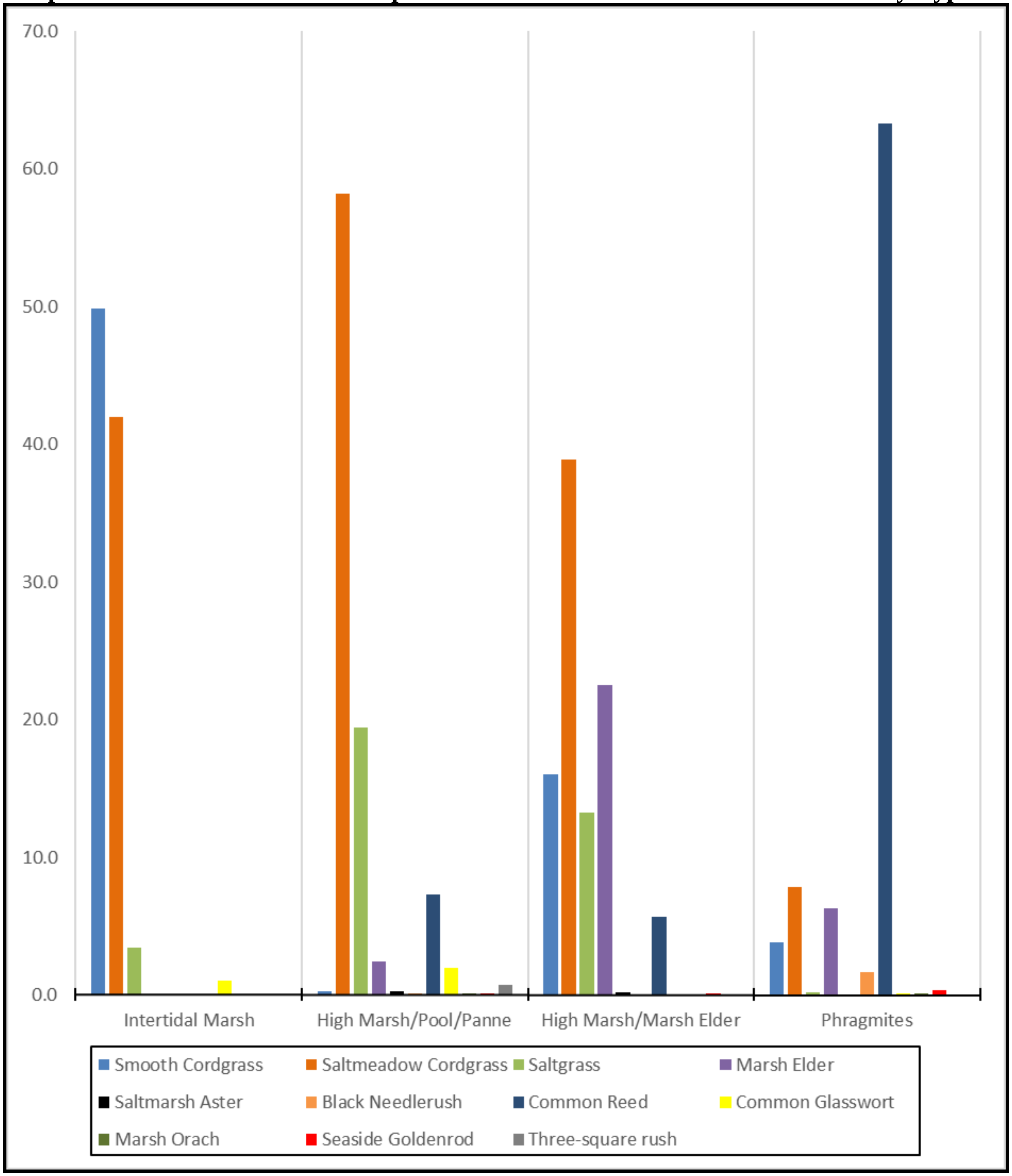
Graph 1. Percent of Each Estuarine Emergent Marsh Community Type in the Grand Canal Study Area.



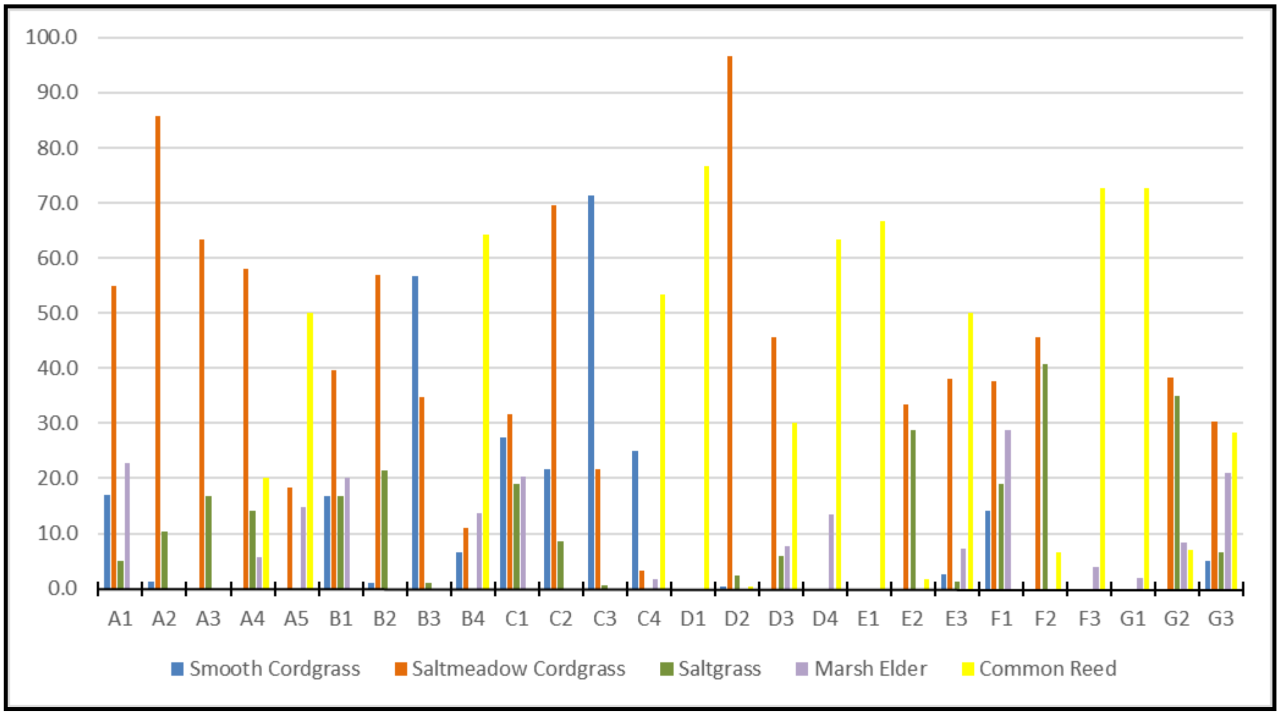
Intertidal Marsh **–** covers 2.0 acres (2.6 %) of the 78 acres of estuarine emergent marsh wetlands of the Grand Canal study area, and occurs in regularly flooded areas that typically receive daily tidal flooding and by definition have at least 50% cover of smooth cordgrass (*Spartina alterniflora*) (Graph 2). The smooth cordgrass found throughout the study area is the short form which is generally less than 1.5 ft. (45 cm) tall. This community is located in relatively protected areas between mean sea level and mean high tide, and are typically flooded and exposed by the tide twice a day. The average cover of smooth cordgrass in this community ranged from 57% to 72%, followed by saltmeadow cordgrass (*Spartina patens*) (Graph 2). Other much less common species include saltgrass (*Distichlis spicata*) and common glasswort (*Salicornia depressa*). Algae and bare ground were also encountered and occupied from 1% to 18% of the plot area.

The intertidal marsh community was found only within the southwest marsh complex (Appendix A, Figure 3), where it comprises 12.3% of the wetlands and is represented by data from survey plots B3 and C4 (Graph 3). However, the primary plant indicator for this community type, saltmeadow cordgrass, was also found in lower densities within other community types in the southwest marsh (plots A1, A2, B1, B4, C1, C2, C5), northwest marsh (plots D2 and E3), and east marsh (plots F1 and G3) (Graph 3). This suggests that these marsh complexes may have originally supported this community type before major land and hydrological alterations occurred in the area.

Graph 2. Percent Cover of Plant Species in Grand Canal Salt Marsh Community Types.



Graph 3. Average Percent Coverage of Dominant Salt Marsh Plant Species Per Survey Plot[1].



[1]Southwest Marsh = Plots A, B and C; Northwest Marsh = Plots D and E; East Marsh = Plots F and G

High Marsh/Pool/Panne – this community type occurs in areas on the marsh system that are typically flooded only during higher than average high tides, and therefore tend to be somewhat drier and to have less salinity than intertidal marsh areas. The high marsh/pool/panne community covers 13.2 acres (16.9 %) of the estuarine emergent wetland communities on the site and is found in all marsh complexes: southwest, 2.5 acres; northwest, 3.5 acres; and, 7.2 in the east marsh (Graph 2). Pools and panne features are included within this community and are bare or sparsely vegetated concave depressions situated within the high marsh vegetation. The Pools typically retain water through the summer, whereas pannes do not. With the exception of the relatively bare pool and panne areas, this community by definition is dominated by at least 50% cover of saltmeadow cordgrass and co-dominated by another quintessential high marsh species saltgrass (Graph 2). Other less common species include smooth cordgrass, marsh elder, glasswort, and common reed and to a lesser extent saltmarsh aster (*Symphyotrichum subulatum*), marsh orach (*Atriplex patula*), seaside goldenrod (*Solidago sempervirens*), and three-square rush (*Scirpus Americanus*) (Graph 2). Higher elevations along the margins of this community are typically only flooded during spring tides and storm surges and in many areas are also influenced by freshwater input from adjacent upland areas; particularly in developed areas along the edges of each marsh complex. These areas can have a broad diversity of plant species; however, in most cases in the Grand Canal study area these areas while dominated by saltmeadow cordgrass have a prevalence of the stunted form of the invasive common reed.

The high marsh community was found throughout all three marsh complexes; east (plots F2 and G2); southwest (plots A2, A3, A4, B2, C1, C2, and C3); and, northwest (plots D2, D3, and E2) (Appendix A, Figure 3) (Graph 3). In addition, the primary plant indicator for this community type, saltmeadow cordgrass, was also found (in lower densities) in every plot sampled with the exception of D1, D4, E1, G1, and F3, all of which are areas that are dominated by common reed (Graph 2). This suggests that common reed will, and has obviously, displaced this community type.

High Marsh/Marsh Elder – this community includes roughly the same species composition as the high marsh/pool/panne community type, but this community also has marsh elder as a co-dominant plant; by definition with at least 20 % cover (Graph 2). The high marsh/marsh elder community covers 8.0 acres (10.3 %) of the wetlands of the study site and is found in all marsh complexes: southwest, 3.7 acres; northwest, 0.7 acres; and, 3.6 in the east marsh. The community is typically found along the more elevated margins of the high marsh community where the marsh complex transitions into adjacent upland areas, but in the Grand Canal area, this community is also found along the tidal channels, and in a relatively extensive area within the southwest marsh complex where it is also comprised of relatively high densities of smooth cordgrass; a low marsh species (Appendix A, Figure 3).

The marsh elder community is represented by survey plots in the southwest marsh (A1 and B1) and east marsh (plots F1 and G3), but is also found in lower densities in plots A4, A5, B4, C5, D4, E3, F3, G1, and G2 (Graph 3). Marsh elder is commonly found within common reed dominated areas and appears to be the last salt marsh species to occupy an area before complete dominance by the invasive common reed.

Common Reed Dominated (tall and stunted forms) – common reed is an aggressive invasive wetland plant that by definition, dominates at least 50% cover this community type. This community covers 54.6 acres (70.2%) of wetlands of the site and is found in all marsh complexes: southwest, 8.0 acres; northwest, 7.9 acres; and, 38.7 in the east marsh) and is the most common community type encountered (Graph 2). Two distinct phenotypes of this community are found in the study area: a stunted growth form; where the average height is < 5 ft. and stalks are weak (< ¼ inch diameter); and, a tall form with robust stalks (> ¼ inch diameter) and height is > 5 ft. In most areas of the marsh the stunted form is found in narrow transition zones from the high marsh to the tall form of common reed along the marsh upland edge; except in the northwest complex, where the stunted form is dominant; in wide transition zones from the high marsh/pool/panne community into the tall common reed community along the upland edge, as well as in fingerlike growth into the high marsh (Appendix A, Figure 3).

The common reed community is represented by survey plots in the southwest marsh (A5, B4 and C5), where it makes up 49.6% of the wetlands on site and occurs primarily in the western most portion of the complex and at transition zones into adjacent upland areas and occupies approximately (Appendix A, Figure 3, and Graph 3). In the northwest marsh, this community is extensive covering 65% of the wetlands on site and was dominant in plots D1, D4, E1, and E3. Transects were placed in a linear fashion from the edges of tidal areas (Plot D1 and E1) and extended across the marsh to the upland (plot D4 and E3). In this marsh, the stunted form of common reed completely surrounds the remaining high marsh community and the marsh edges are dominated by the tall form of common reed. Within the east marsh, the common reed community is represented by plots F3 and G1 and occupies 78.1% of the wetlands on the site. However, common reed is also present in plots F2, G2, and G3. Similar to the northwest marsh, high marsh habitat in the east marsh are only found in relatively small low-lying pockets and in the east marsh nearly all of them are completely surrounded by dense stands of the tall and robust form of common reed.

3.4 Soil Surveys

Soils within approximately 53% of the study area, which includes a portion of developed areas adjacent to the marsh complexes (Appendix A, Figure 4), are classified as Tidal Marsh (TM); a frequently flooded/ponded hydric soil with deep organic composition (Table 4). The remaining soils are found along the marsh margins and urban areas and are comprised primarily of highly disturbed, filled and/or graded soils covering approximately 12 percent of the study area, and areas of coastal sandy-loam/loamy-sand soil types which occur within undeveloped forest-scrub-shrub communities and cover about 35 % of the site (Table 4).

Table 4. Soil Types of the Grand Canal Project Area.

Map Unit Symbol	Unit Name	Hydric Soil	% coverage in Study Area	Soil Description
De	Deerfield sand	Yes	2.5	Gently sloping, moderately well-drained soils comprised of a shallow organic layer (< 3 inches) over sandy material. The water table is generally at a depth of about 18 to 36 inches. Includes areas classified as Farmlands of Statewide Importance.
Du	Dune		.2	Sand
Fd	Fill (dredged material)		2.9	Highly disturbed, fill.
Fs	Fill (sandy)	Yes	3.0	Some areas occur in former wetlands and are hydric.
PIA	Plymouth loamy sand		1.4	Gently sloping, excessively-drained soils comprised of up to 27 inches of loamy sand over gravelly coarse sand material. Includes areas classified as Farmlands of Statewide Importance.
RdA	Riverhead sandy loam		13.4	Gently sloping (0 to 3 percent slope), well-drained soils comprised of up to 27 inches of sandy loam over 8 inches of gravelly loamy sand material, then stratified coarse sand/gravelly sand to a depth of 65 inches. All areas are classified as Prime Farmlands.

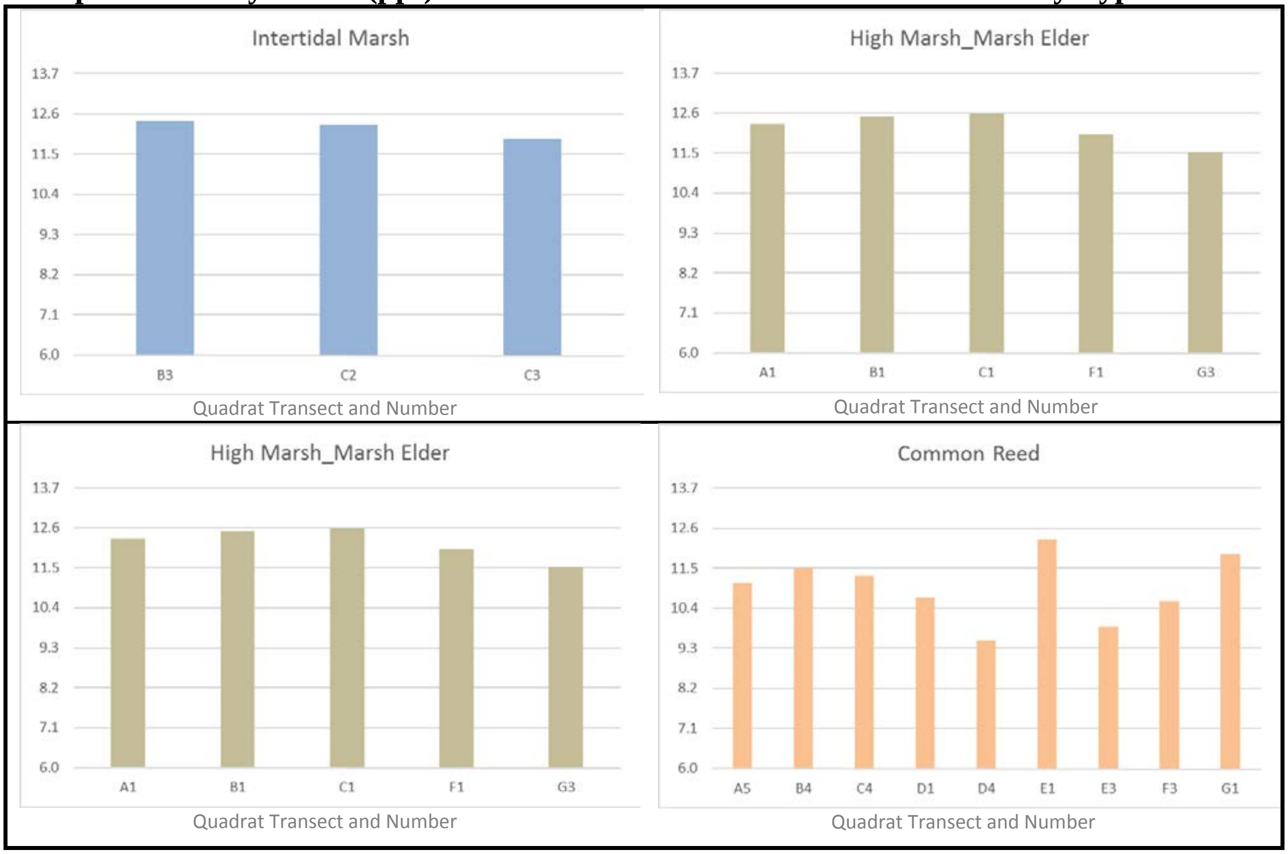
Table 4. Soil Types of the Grand Canal Project Area (continued).

Map Unit Symbol	Unit Name	Hydric Soil	% coverage in Study Area	Soil Description
RhB	Riverhead and Haven (modified-graded)		3.9	Graded, gently sloping (0 to 8 percent slope), well-drained soils. Riverhead soils are comprised of up to 27 inches of sandy loam over 8 inches of gravelly loamy sand material, then stratified coarse sand/gravelly sand to a depth of 65 inches. Haven soils are comprised of up to 19 inches of loam over 9 inches of gravelly loam material, then stratified gravelly sand to a depth of 60 inches.
Tm	Tidal marsh	Yes	53	Concave to gently sloping (0 to 1 percent slope), very well-drained soils comprised of up to 80 inches of organic material. The water table is at the surface and areas are frequently flooded and/or ponded.
Ur	Urban		0.8	Highly disturbed, filled, developed.
Wd	Walpole sandy loam	Yes	17.9	Gently sloping (0 to 3 percent slope), poorly-drained soils comprised of a shallow layer ($\leq$ 1 inches) of peat, over up to 21 inches of sandy loam, over 4 inches of gravelly sandy loam material, then very gravelly sand to a depth of 65 inches. The water table is generally at about 4 inches. Some areas are classified as Farmlands of Statewide Importance.

Based on field data collection, soils throughout the marsh complexes were typical of the TM soil unit type and were comprised of highly saturated deep organic material, greater than 18 inches deep. When evaluated with a soil penetrometer, less than 200 pounds per square inch (psi) of resistance was encountered; indicating no compaction, as is typical for moist soils with high organic composition. Where slight resistance was encountered, it was primarily due to a dense root system, not compacted soil or fill material. There are undoubtedly some areas within the marsh complexes, particularly along the marsh edges and berm, that contain fill material as evidenced by areas of exposed gravel and dumped fill. But these are uncommon and do not appear to be driving factors in the health or vegetative composition within the marsh.

Salinity, which is often identified as one of the major contributing factors that drives the vegetative communities present on a site, were inconclusive. Typical salinity levels in intertidal and high marsh areas of estuarine tidal marsh systems in New York range from 18–30 parts per thousand (ppt) (citation xxx). Results for the study area range form 9.4 to 12.6 (Graph 4) and appear to indicate that the marsh system is mesohaline (i.e., salinity from 5 to 18 ppt). Results are not consistent with reported salinities for the Long Island area and an alternate, more intensive, survey approach to should be investigated for future marsh salinity monitoring.

Graph 4. Salinity Levels (ppt) in Grand Canal Estuarine Marsh Community Types.



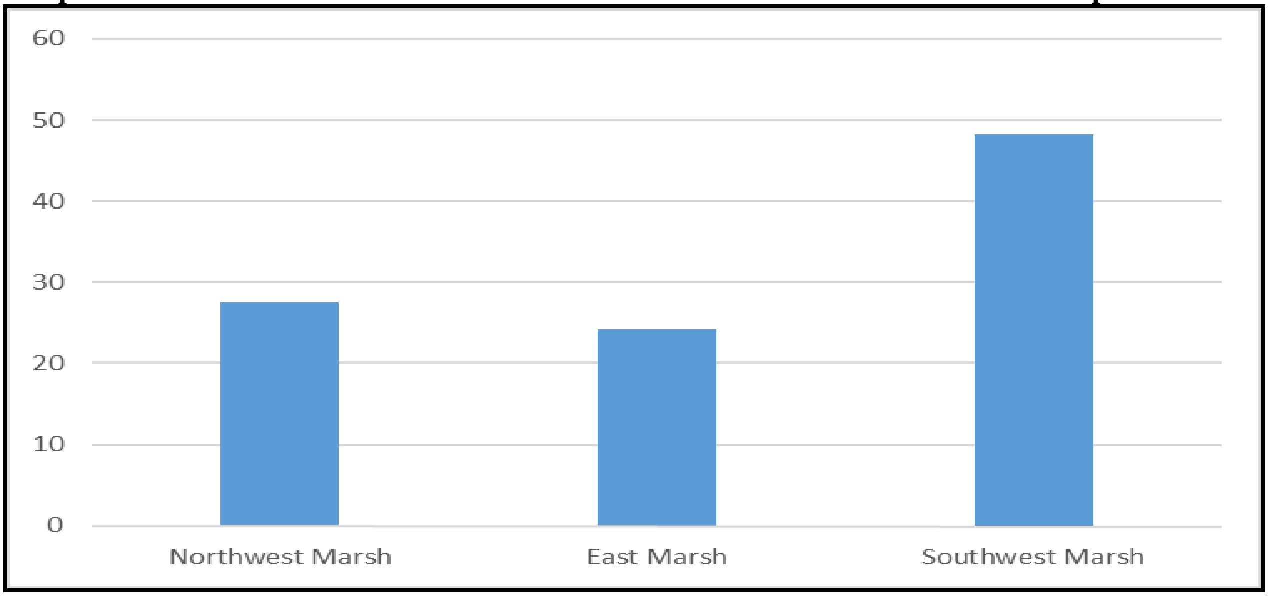
3.5 WETLAND CONDITION AND HEALTH ASSESSMENT

Wetlands throughout the United States have experienced dramatic losses throughout history; primarily a direct result of human expansion (Dahl 2011). Despite the laws and ordinances put in place since the 1970's to protect wetlands, the losses continue; although the rate of loss is substantially less than those reported through the 1980's. The United States reportedly experienced an estimated 2.4% loss of intertidal estuarine wetland alone habitat between 2004 and 2009 (Dahl 2011). The wetlands that remain are typically substantially smaller than their original size, located within highly-developed landscapes, and are subjected to a wide variety of additional stressors that can undoubtedly have a negative affect on the ability of the wetlands to perform key functions such as nutrient transformation, sediment retention, surface water detention, and to serve as wildlife habitat.

This loss of wetland function is captured in the results of the study area wetland health assessment. The Collective Comparative Total Health Score for wetlands assessed in the Grand Canal area is 35, which when using the stress categories identified for wetlands evaluated using

Mid-TRAM in Pennsylvania, New Jersey, and Delaware (Jennette et. al., 2014, Pedeletti et. al., 2012), indicates that the wetlands of the Grand Canal area are severely stressed (severely stressed = a Comparative Total Health Score < 61). When assessed individually to evaluate Total Scores among the three complexes of the Grand Canal study area, each complex also falls within the severely stressed category: northwest marsh (Total Health Score = 28); east marsh (Total Health Score = 24); and, southwest marsh (Total Health Score = 48); of these, the southwest marsh is the least stressed and this is evidenced by the diversity of tidal marsh communities and somewhat higher ratio of native vegetation to invasive species (51:49) observed in the marsh system (Graph 5).

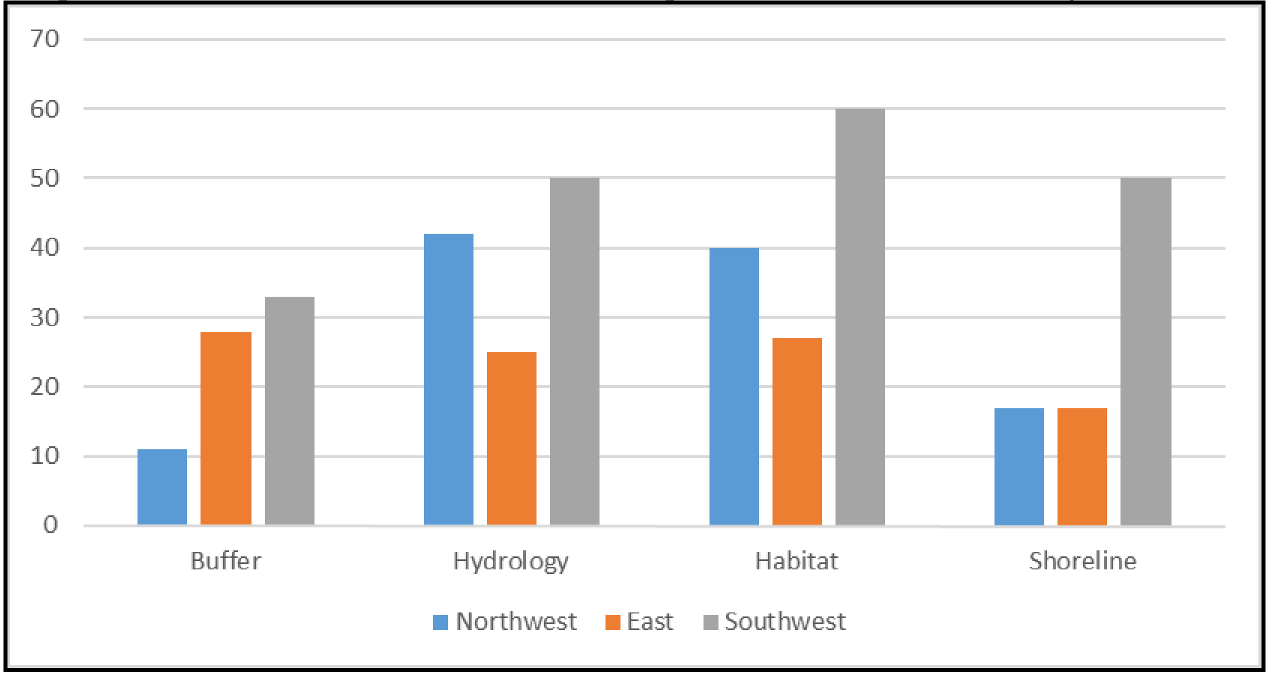
Graph 5. Total Wetland Health Condition Scores for Grand Canal Marsh Complexes[1].



[1] Health condition categories = minimally stressed (scores $\geq$ 83), moderately stressed (scores from 83 to 61), or severely stressed (scores < 61)

The total wetland health scores are based on the variables assessed within four attribute groups: buffer, hydrology, habitat and shoreline condition. A review of these attribute scores, as shown in Graph 6, helps to identify which attributes are contributing the least (or most) to the overall wetland condition and overall health scores.

Graph 6. Attribute Scores for Each Marsh Complex of the Grand Canal Study Area.



The average score for the **buffer** attribute group was 24, with attribute scores ranging from 11 to 33 (Graph 6). The northwest marsh system scored lowest (11), followed by the east marsh (28), then the southwest marsh (33). Each of the marsh systems evaluated are completely surrounded by urban development and impervious surfaces; most of which are immediately abutting the perimeter of the marsh system. Notable factors and stressors which are contributing to the low buffer attribute scores include (Table 5):

1) Lack of suitable vegetated buffer > 5 m (16 ft.) wide around the marsh perimeter which can lead to influx of pollutants and sediments.
2) Residential development and roadways covering at least 50% of the 250 m (820 ft.) area surrounding the marsh, which contributes to direct disturbance, nutrient/pollutant loading, and dumping of debris along wetland edges.
3) Nearly complete barriers to landward migration along the wetland/upland boundaries, which does not allow the tidal wetlands to respond to rising sea levels by migrating inland.

Table 5. Summary of Most Notable Stressors Affecting Marsh Health in the Grand Canal.

Evaluation Metric/Dominant Stressor	Northwest Marsh	East Marsh	Southwest Marsh
Buffer			
< 60% of marsh perimeter has a buffer ≥ 5 m wide	x	x	
> 50% of surrounding landscape is developed	x	x	x
> 75% of marsh perimeter is obstructed (unable to expand)	x	x	x
Hydrology			
> 50% of marsh is ditched/drained		x	x
Alterations that have resulted in > 25% of normal tidal range being altered	x	x	
At least one source of pollutant/nutrient loading via storm drains identified	x	x	x
Habitat			
The density of vegetation is significant enough to impede wildlife	x	x	
> 45 % of plant strata are dominated or co-dominated by the invasive species common reed	x	x	x
> 50% of the marsh complex is dominated by common reed	x	x	
Shoreline			
> 25% of shoreline has been altered	x	x	
Shoreline is unstable/eroding[1]	x		x

[1]Not unstable in east marsh due to presence of a man-made berm that is now the shoreline

The average score for the **hydrology** attribute group was 39, with attribute scores ranging from 25 to 50 (Graph 6). The east marsh system scored lowest (25), followed by the northwest marsh (42), then the southwest marsh (50). Each of the marsh systems have been affected by human-induced alterations of the natural channels and marsh surfaces which have changed the flow and hydroperiod (duration that a marsh is inundated). Notable factors and stressors which are contributing to the overall poor condition of the hydrology attribute of marshes in the study area include (Table 5):

1) Ditching within a significant amount of the wetland complex, which can carry tidal water into the complex but also allows it to drain rapidly thus lowering the hydroperiod.
2) Alterations, such as a 900 ft. earthen berm which forms a partial barrier between the northwest marsh and its primary source of tidal flow (i.e., Grand Canal), and a 3,800 ft. berm which forms a nearly complete barrier between the northwest marsh, and its sole source of tidal flow.
3) Four undersized culverts within the earthen berm are the only direct sources of tidal flow from the Grand Canal into the east marsh. One low lying breach area on the south end of the berm allows periodic tidal input.
4) Stormwater drains on adjacent roadways that deposit sediment, contaminants, and surges of freshwater directly into the marsh complex.

5) Other observations - gray water deposition into the canal from residences, high turbidity in canal water, stormwater runoff via storm drains into marshes, oil sheen on marsh and open water surfaces, stagnant areas of the canal and marshes, and erosion.

The average scores for the **habitat** attribute group were slightly better than all of the other attribute groups assessed; scoring 42, with scores ranging from 27 to 60 (Graph 6). The east marsh system scored lowest (27), followed by the northwest marsh (40), then the southwest marsh (60). Although the scores are marginally better than the other attribute scores, the habitat attribute for wetlands of the Grand Canal area are still considered to be severely stressed; and this is primarily due to the prevalence of the invasive species common reed. Each of the most notable factors and stressors which are contributing to the overall condition of the habitat attribute of marshes in the study area (Table 5) are directly the result of the presence of common reed. Notable factors and stressors which are contributing to the overall poor condition of the habitat attribute of marshes in the study area include:

1) The east marsh complex is nearly entirely dominated by a robust tall growth form of common reed which completely surrounds a few remaining remnant pockets of high marsh/pool/panne habitat.
2) Common reed occupies over 50% of the northwest marsh, and occurs there in both a robust tall form around the marsh perimeter, as well and a weak-stemmed short growth form that is a common species even within other high marsh community types in the complex.
3) The southwest marsh still has relatively large areas of low and high marsh habitat remaining that do not have high densities of common reed, although the reed is found in both the tall form along the marsh margins and in the stunted form along tidal channels and the transitions from high marsh to the tall form.
4) The tall form of common reed occurs in monocultures; at the expense of native vegetation species.
5) The high density growth of vegetation (primarily common reed) inhibits wildlife maneuverability.

The average score for the **shoreline** attribute group was 28, with attribute scores ranging from 17 to 50 (Graph 6). The northwest and east marsh systems were tied for the lowest score (17), whereas the southwest marsh scored 50. Only two parameters are evaluated for the shoreline attribute: alteration and erosion. Notable factors and stressors which are contributing to the overall poor condition of the shoreline attribute of marshes in the study area include (Table 5):

1) A significant portion of the northwest marsh shoreline has been altered by the 900 ft. earthen berm. The berm itself is experiencing some erosion, but overall is stable.
2) Remaining portion of the northwest marsh complex that is not altered, is experiencing erosion (some of which can be attributed to boat use and wave action in the Grand Canal and adjacent channels).
3) The east marsh has much higher alteration due to the 3,800 ft. berm along its entire length, but the berm itself is protecting the wetland itself from erosion, resulting in a lower erosion score. The berm itself is experiencing some erosion, and several areas appear to be somewhat unstable.

4) Southwest complex shoreline is unaltered, but wave action is resulting in some instability and erosion.
5) Elsewhere along the Grand Canal, the shoreline is lined with retaining walls or other hardened structures; many are in poor condition and in need of significant repair.

4.0 SUMMARY AND RECCOMENDATIONS

Based on field data and the wetland health assessment, the marshes in the study area are all severely-stressed, particularly when compared to large salt marsh complexes in less disturbed landscape settings. Each assessed marsh in the Grand Canal Pickman-Remmer system is surrounded by intensive development which has reduced protective buffers, halted the ability of the marsh to shift landward with increasing sea levels, and has subjected the marshes to inputs of contaminants, sediments, freshwater, yard waste and other debris. All marshes are artificially ditched, two of the three marshes (northwest and east) have significant restrictions in tidal flow from the Grand Canal (which itself is somewhat restricted), and all are experiencing some shoreline erosion from wave action. In addition, invasive common reed occurs throughout all marsh complexes and is dominant in two of the three systems (east and northwest). Wetlands of the east marsh, which is nearly completely impounded, are comprised of xx% of the tall robust form of common reed. Further, a review of historic aerial images (Suffolk County 2015) and hydric soil mapping (USDA 2014) show significant loss of wetlands in the Grand Canal study area, as well as throughout Long Island, and those wetlands that remain have been experiencing changes in the vegetation types within the complexes over time.

Results from water quality monitoring conducted in the Grand Canal study area in 2004 further support these findings (Levy 2005). Those results indicate the canal and connected tidal areas are significantly impacted by sediment and nutrient enrichment, as evidenced by low dissolved oxygen levels, high levels of nitrogen and phosphorus, elevated coliform bacteria levels, high levels of volatile organic compounds (VOCs) and semi-volatile organics (SVOCs), highly turbid water, and brown algae blooms. Poor tidal flushing, petroleum products used in boats, and stormwater runoff input from adjacent developed areas and storm drains were identified as significant contributing factors. During this study, brown algal blooms, gray water deposition into the canal from residences, high turbidity in canal water, stormwater runoff via storm drains into marshes, oil sheen on marsh and open water surfaces, stagnant areas of the canal and marshes, and erosion, were all observed.

To address the declining condition of the Pickman-Rimmer marshes, the following general recommendations are offered:

1. Increase tidal flow into the marsh systems where and when possible.
2. Increase hydroperiod on marshes (plug ditches to allow water to be retained longer).
3. Identify and address locations of stormwater inputs into the marsh system - assess for opportunities to reduce sediment loading, contaminates, and freshwater input into marshes.
4. Identify and address sources of trach, debris, cutting, fertilizer use along marsh perimeter.
5. Identify opportunities to reduce wave action from boats, jet skis, etc., which are contributing to shoreline erosion and degradation of bulkheads and berms.

6. Perform targeted surveys for state or federally-listed species and those of special concern. Presence of these can also improve grant/funding opportunities for restoration.
7. Continue monitoring. Increase level of effort and/or add sampling efforts for parameters deemed most important in restorations efforts.

Several recommendations have been made and are currently under consideration by the County to address the declining state of wetlands in the study area; an equally important component involves the potential of each to also address flooding issues. Three of the more prominent recommendations include: 1) dredging the canal to increase tidal flow in the cannel; 2) removal of portions of the man-made berm along the west perimeter of the east marsh complex to allow for increased tidal flow throughout the marsh; and, 3) plugging many of the man-made ditches on the marsh surfaces to improve normal marsh surface flow and hydroperiod. This assessment supports the premise that while the Grand Canal area is still supporting a notable suite of flora and fauna, the marshes are in a highly stressed condition, and the stressors contributing to this condition must be addressed else most of the remaining functions and values provided by the Pickman-Remmer marsh complexes will undoubtedly continue to decline. Each of the recommended strategies to address the stressors and overall flooding issues has merit; however, the options and potential consequences of each must be carefully considered.

Additional work is needed to fully evaluate options and assess the cost-benefits of the various management recommendations. However, based on the information currently available, the highest gains in terms of measures that would likely improve the health of the marsh system and potentially also provide flood control, for the least cost/effort, would involve removing portions of the berms along the northwest and east marsh complexes and allowing the water to enter the natural marsh system where it can be contained and slowly absorbed. These efforts, when combined with efforts to manage water at the sources of the problems, through practices that will slow, spread, and filter water and allow it to slowly reabsorb, would likely address most of the flooding issues and benefit the overall health of the marsh without the need for high-risk and costly dredging efforts. At a minimum, since some berm removal would likely be necessary even if the dredging option were pursued, berm removal should be attempted first; followed by dredging if necessary.

Dredging is primarily a tool for improving navigation, but is also often considered a tool to address flooding issues. While dredging may improve tidal flow in the Grand Canal and may have some effect on addressing flooding, its use as a means of dealing with flooding in the vicinity of the Grand Canal may have unintended consequences. For example:

- The holding capacity of the canal (even after dredging) is extremely small relative to the surrounding area of stormwater input during a major flood event.
- Many of the developed areas which are experiencing repeated flooding will still fall within the lowest elevations (former flood plains) in the area. Water will continue to flow to these low points.
- Bridges, culverts and the already highly deteriorating bulkheads and retaining walls along the canal may be exposed and/or undermined.
- Expense – costly studies, engineering planning and design, construction, disposal – once dredged these often are required over the long-term due to maintenance requirements.

- Potential release of toxins in the dredge sediment.
- Disposal needs – locations may be limited and costs are high (particularly if sediments are contaminated).
- Consequence of a potential increase in boat size, use, and traffic on the environment and adjacent residences (noise, activity levels, contaminants).
- Impacts of faster flow on existing marsh shorelines and developed upland areas along canal.
- Deepening channel may contain some additional flow (beneficial during flood events), but over the long term will likely result in less water entering adjacent wetlands.
- Removal of some portions of the berms that are currently restricting tidal flow from the canal into the east and northwest marsh complexes would still be necessary if marsh health is to be improved and to get the full benefit of flood control.

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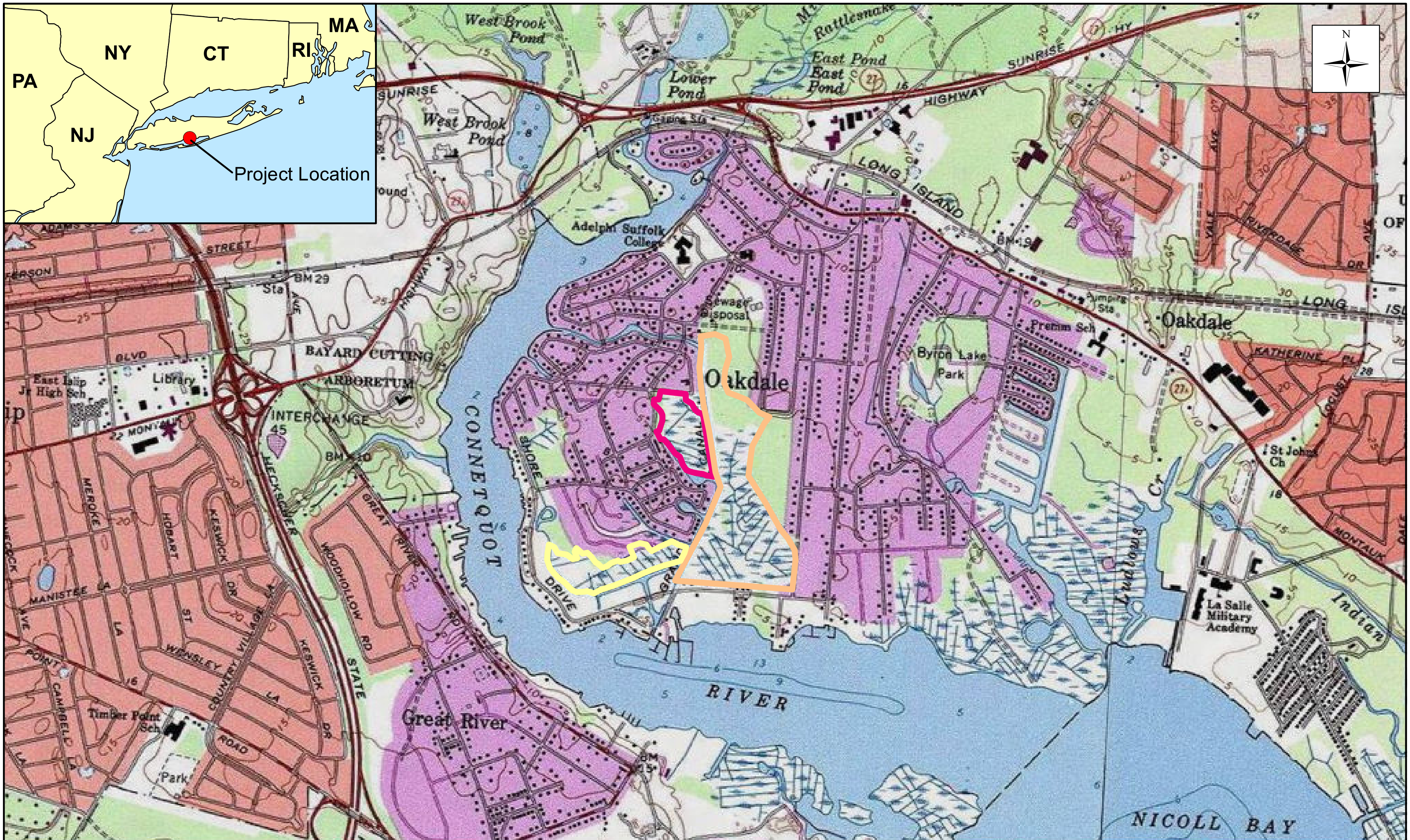


Prepared For:

Prepared By:

NewEarth
ECOLOGICAL CONSULTING, LLC

Legend

East Marsh

Southwest Marsh

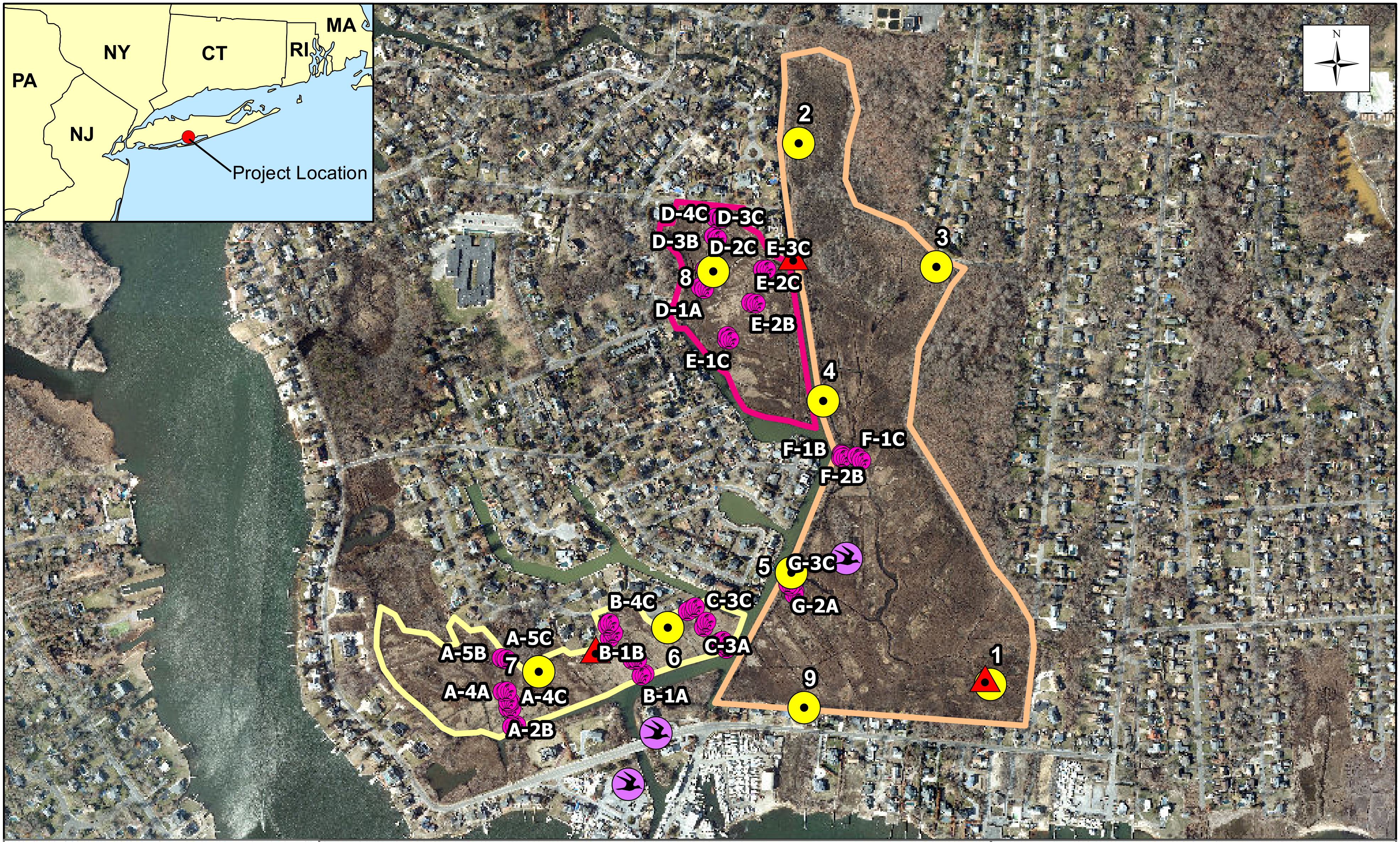
Northwest Marsh

0 0.5 1 Miles

Figure 1. Site Location
Grand Canal Project Area
Oakdale, New York.

Source: Copyright:© 2013 National Geographic Society, i-cubed

Date: 1/29/2016



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Prepared By:

NewEarth
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Legend

East Marsh
Northwest Marsh
Southwest Marsh
Bird Sample Location
Broadcast Call Station
Osprey Nest Sites
Vegetation Plots

0 500 1,000 2,000 Feet

Figure 2. Assessment Areas and Survey Locations
Grand Canal Project Area
Oakdale, New York.

Source: United States Department of Agriculture, 2013.
NewEarth Ecological Survey, October 2015.

Date: 1/29/2016

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Legend

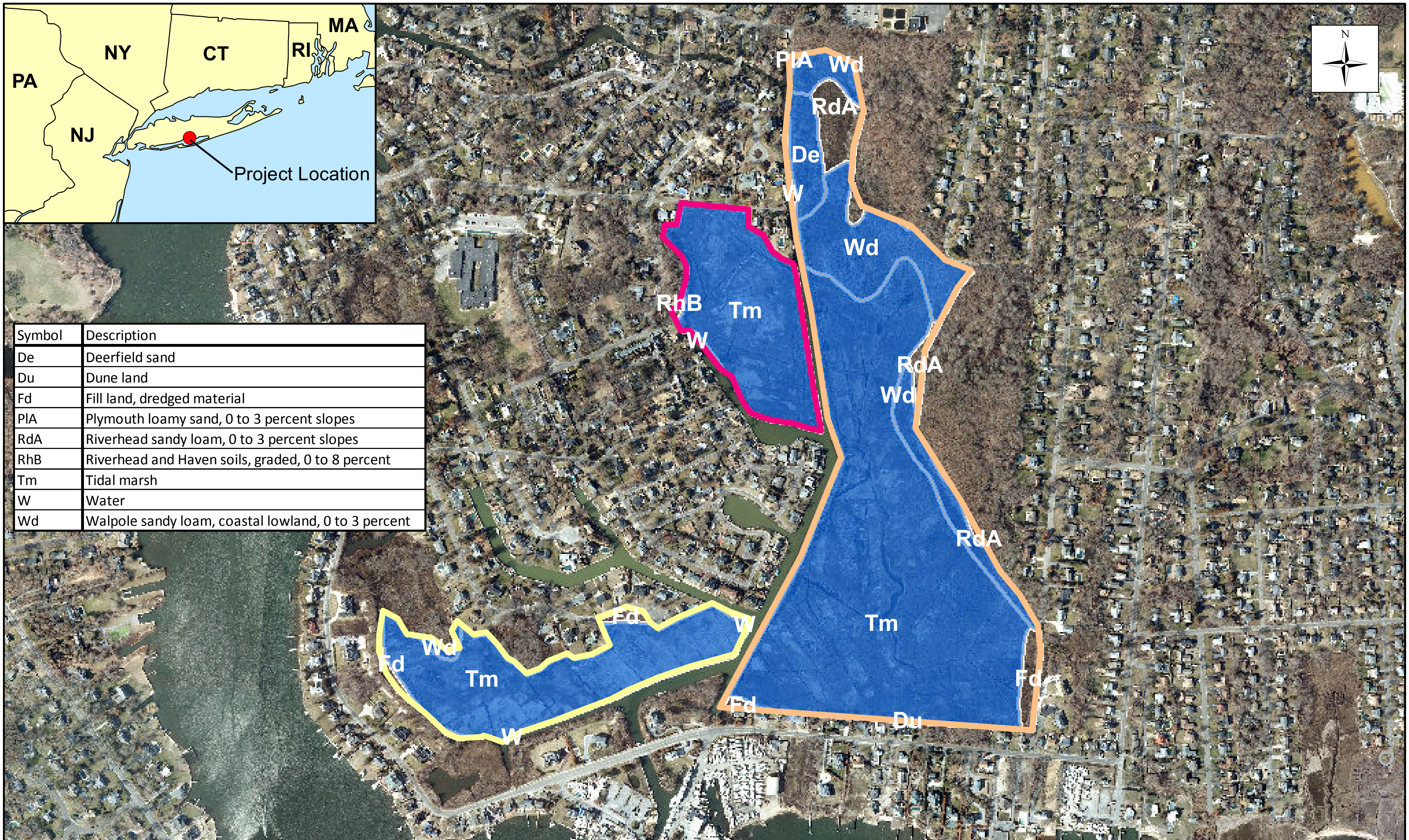
- Forest_Scrub-Shrub
- Common Reed_Tall
- Common Reed_Stunted
- High Marsh_Marsh Elder
- High Marsh_Pool_Panne
- Intertidal Marsh
- Tidal Channels
- Pond

0 500 1,000 2,000 3,000 Feet

Figure 3. Major Community Types
Grand Canal Project Area
Oakdale, New York.

Source: United States Department of Agriculture, 2013.
NewEarth Ecological Survey, October 2015.

Date: 1/29/2016



Symbol	Description
De	Deerfield sand
Du	Dune land
Fd	Fill land, dredged material
PlA	Plymouth loamy sand, 0 to 3 percent slopes
RdA	Riverhead sandy loam, 0 to 3 percent slopes
RhB	Riverhead and Haven soils, graded, 0 to 8 percent
Tm	Tidal marsh
W	Water
Wd	Walpole sandy loam, coastal lowland, 0 to 3 percent

Prepared For:

Prepared By:

NewEarth ECOLOGICAL CONSULTING, LLC

Legend

East Marsh

Southwest Marsh

Northwest Marsh

Hydric

0 500 1,000 2,000 3,000 Feet

Figure 4. Soil Types
Grand Canal Project Area
Oakdale, New York.

Source: United States Department of Agriculture, 2013.
NewEarth Ecological Survey, October 2015.

Date: 1/29/2016

Appendix I

Grand Canal Ecological Health Assessment Report

DRAFT

ECOLOGICAL HEALTH EVALUATION REPORT

Grand Canal
Suffolk County, Oakdale, New York

Prepared for:

Suffolk County Department of Health Services
Division of Environmental Quality

Prepared by:

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Section 1. Introduction

In 2006, Suffolk County enacted a resolution (#1040-2006) to add Ecological Health and Marine Productivity as Acceptable Criterial for County Dredging Projects. This resolution enabled these factors to be used as a criterion for justification of county dredging projects as being in the public interest. A dredging project shall be deemed to be in the public interest if it supports, advances or improves environmental/ecological health and/or marine productivity, based upon a certification from the Suffolk County Department of Health Services, Office of Ecology, or the Suffolk County Department of Environment and Energy.

The document titled 'Environmental Dredging Factors Considered for Improving Environmental Quality, Ecological Health and Marine Productivity' (Appendix A) was used as a guide to perform an analysis and evaluation of the ecological health of the Grand Canal and adjacent wetlands. The document formulates a process for the evaluation of Environmental Dredging Factors for determining whether a proposed dredging project is necessary to increase flushing rates to protect or enhance marine ecology and productivity. Three main types of ecological dredging factors are outlined: water quality (e.g., dissolved oxygen, coliform, salinity); sediment management (e.g., modification of features to improve stream flow, removal of toxic sediments); habitat/living resources (e.g., elimination of harmful algal blooms, improving fish access).

This report, the 'Grand Canal Ecological Health Evaluation Report', describes the results of the analysis and evaluation of the ecological health of the Grand Canal and adjacent wetlands. It fulfills Task 5 of the Grand Canal Ecological and Public Health Assessment Statement of Work. The assessment was based on data collected by Cashin Associates (CA) from 2014 through 2016 as part of the overall Grand Canal Ecological and Public Health Assessment Project. Full details on the data collection and analysis, as well as a description of results, are provided in the overall 'Grand Canal Ecological and Public Health Assessment Report'. Here, key results are discussed and placed in context of the 'Environmental Dredging Factors Considered for Improving Environmental Quality, Ecological Health and Marine Productivity' in order to determine the ecological health of the Grand Canal and adjacent wetlands, as well as to demonstrate if dredging will improve existing conditions.

This report also summarizes conclusions drawn from the microbial, chemical, and vector data collected within the Grand Canal in 2004 as part of the 'Grand Canal Environmental Assessment Report' (2005) published by Suffolk County Department of Health Services (SCDHS) and Suffolk County Department of Public Works (SCDPW). These data are used to show how conditions within the Grand Canal have changed within the last decade, and indicates that many of the observed impairments within the Grand Canal system are longstanding.

Section 2. Physical Characteristics of the Grand Canal

A hydrographic survey of the Grand Canal was conducted by CA to define physical characteristics of the canal system. This included a bathymetric survey to provide canal cross sections and profiles, characterization of bottom sediments, an assessment of stream flow and tidal flushing in the canal and adjacent wetlands, as well as identification of any potential restrictions to water flow and flushing.

2.1 Bathymetric Survey and Tidal Flushing/Flow Assessment

Detailed methods and results for the bathymetric survey performed in 2015 by CA can be found in the overall 'Grand Canal Ecological and Public Health Assessment Report'. The bathymetric survey indicated that the main section of the Grand Canal was found to vary in width from approximately 75-feet at it widest point (just south of the Shore Drive Bridge) to approximately 30-feet at is narrowest point (just east of the Idle Hour Boulevard Bridge). The main channel of the canal varies in depth from the deepest point of approximately five feet below mean low water (MLW) near the southern entrance to approximately two feet below MLW at its shallowest along the northern transect of the canal. These shallow areas lead to reduced navigability of the Grand Canal, as well as restricted tidal flow. In addition to the bathymetric survey, CA conducted a stream flow assessment and tidal flushing measurement (details provided in the 'Grand Canal Ecological and Public Health Assessment Report'). These analyses indicated restrictions to the Grand Canal's flow.

It can be concluded that sedimentation within the Grand Canal has resulted in reduced channel depths and reduced tidal flow into the canal. Qualitative observations by CA also indicated high levels of debris (e.g., limbs) throughout channels. These factors can have considerable impacts on navigation throughout the Grand Canal. The CA field team experienced situations in which navigation throughout the canal was difficult with a boat due to shallow depths and debris, particularly during low tides.

If dredging were conducted in the Grand Canal to create a five food MLW channel (where applicable), the navigational hazards of reduced channel depths and debris would be addressed.

However, dredging and deepening of inner portions of the canal, without widening or deepening of its connections to the Connetquot River or adjacent wetlands, will not improve flushing rates for the canal. In fact, deepening of the canal without increasing water in flow could result in greater volumes of stagnant water in the canal.

Section 3. Sediment Sampling Plan for Physical Parameters and Contaminants

Sediment sampling was conducted in the Grand Canal to determine if sediment quality was impacting the ecological health and marine productivity of the Grand Canal and adjacent wetlands. The Sediment Sampling Plan for the Grand Canal was approved by the NYSDEC. The Plan incorporated the information needs and sampling requirements of the NYSDEC's Division of Marine Habitat Protection and Division of Solid and Hazardous Material and was was developed based on the NYSDEC TOGS 5.1.9 ('In-Water and Riparian Management of Sediment and Dredge Material') and NYSDEC Remedial Program Soil Cleanup Objectives. The Sediment Sampling Plan was also based on findings from bathymetric data collection performed by CA as part of Task 3 of this project. Details on the sediment sampling plan and methodology can be found in the overall 'Grand Canal Ecological and Public Health Assessment Report'.

A total of ten sample sites were selected throughout the canal for sediment core sampling. Samples were collected from the Grand Canal by CA environmental personnel in 2015 in accordance with the approved Sediment Sampling Plan (methodological details provided in the overall 'Grand Canal Ecological and Public Health Assessment Report'). At each of the ten sites, three different segment samples were collected using the coring instrument. The three segment samples from each location were as follows: one sample of the material to be dredged (top layer of sediment); one sample of zero to six inches below the dredge depth; and one sample from six to 12 inches below the dredge depth. So, in total, 30 sediment samples for subsequent laboratory analysis were collected. In the event that the grain size and Total Organic Carbon (TOC) analyses determined that the composition of any of the sediment sample was at least 90 percent sand or larger, and less than one-half percent TOC, no further testing was required. All samples falling below the threshold were tested for priority pollutant parameters, as identified by NYSDEC. If the priority pollutant analysis from the dredge material and the first six inches below dredge depth revealed priority pollutant constituents above NYSDEC recommended limits, the archived samples were to be analyzed.

3.1 Sediment- Physical Parameters

Changes in canal sediments can affect the ecological health of a waterway in several ways, such as through the mechanical covering of immobile organisms and increased turbidity. The grain size distribution analysis for the sediment samples indicated that all of the samples were found to consist of at least 90% sand or larger material (less than 10% of the material passes through the No. 200 sieve).

3.2 Sediment- Contaminants

According to the NYSDEC protocol, two of the sediment samples met the required less than 0.5% of TOC requirement. Based on these results, 18 samples did not meet the minimum TOC requirement and therefore needed to be tested for contaminant parameters. Analysis of the sediments for priority pollutants, PAHs, metals, pesticides, and dioxin were performed on these samples to characterize the Grand Canal sediments in terms of potential contaminants.

The results of the sediment chemistry were compared to the NYSDEC's *Sediment Quality Thresholds for In-Water/Riparian Placement* guidelines and the following classifications:

- Class A – No Appreciable Contamination (No Toxicity Aquatic Life);
- Class B – Moderate Contamination (Chronic Toxicity to Aquatic Life); and
- Class C – High Contamination (Acute Toxicity to Aquatic Life).

The sum of DDT and its constituents (DDE and DDD) were detected in the dredge material at eight sites. The dredge sediment at one site (Site GC 1) met Class B criteria and sediment from seven sites (Sites GC 2 through GC 8) met or exceeded Class C criteria. The concentrations of this constituent in the sediment below the dredge material is lower than the dredge material but still in Class B and Class C criteria. No DDT, DDE or DDE were detected in two of the sampled sites (Sites GC 9 and GC 10).

Several metals were also detected in the dredge material and sediment below the dredge material. The metals met Class A and Class B criteria. Specific metals detected were: copper, arsenic, chromium, lead, nickel, zinc, and mercury. Copper, arsenic and chromium were most likely introduced into the sediment by the chromated copper arsenate (CCA) wood material used to construct bulk heading. Lead, zinc and mercury were most likely introduced into the sediment from boating activities.

The sediment analyses indicated that much of the sediment sampled within the Grand Canal showed DDT constituents and metal levels greater than levels that are shown to provide chronic or acute toxicity to aquatic life.

Dredging would result in the removal of contaminated sediments; however, the removal would not result in improved conditions unless the sources of contamination are controlled (e.g., storm water, sanitary waste, etc.). There are multiple sources of contamination associated with existing anthropogenic land uses that will continue to affect the canal unless long-term abatement measures are taken.

Section 4. Water Sample Analysis for Physical Parameters and Contaminants

4.1 Water- Physical Parameters

Physical water parameters of temperature, salinity, dissolved oxygen, and turbidity were taken at multiple sample locations during surface sampling event in the Grand Canal. Readings were taken by CA environmental personnel in 2015.

Adequate dissolved oxygen levels (DO) are necessary for the growth and reproduction of aquatic organisms. Adequate DO also is essential for the natural decomposition of organic wastes. A majority of the DO readings from the Grand Canal taken by CA in 2015 were found to be less than the minimum allowable DO level of 4.8 mg/L stipulated in New York Water Quality Standards for saline surface waters class (adverse impacts on aquatic organisms will begin to occur at levels below this level); there were several samples where DO readings were less than 2 mg/L. For saltwater, USEPA (2000) recommends a minimum DO level of 2.3 mg/l as a limit for continuous 24-hour exposure to protect juvenile and adult aquatic life.

During the tidal cycle sampling which occurred in July and August 2015, the average DO varied from a low 1.62 mg/l during the low tide to a high of 5.12 mg/l during the mid-outgoing tide. The lowest average DO readings occurred during the low tide during both sampling events. The average DO readings during the low and incoming off low tidal cycles indicated that the canal was experiencing a state of hypoxia (DO less than three mg/l). DO levels were generally slightly greater in the high tide and mid-outgoing tide samples versus samples collected at low tide or mid-incoming tide. During the storm water runoff surface water sampling which occurred in August and September 2015, DO readings during the dry sampling event ranged from 1.06 to 2.36 mg/L; during the wet sampling event they ranged from 2.33 to 4.21 mg/L. During the dry event it appeared that the DO readings (average of 1.84 mg/l) indicated that the canal was experiencing a state of hypoxia (DO less than three mg/l). The DO during the wet event appeared to have increased as a result of the colder storm water input and had an average DO of 3.35 mg/l. The low DO levels in the Grand Canal have the potential to impact the development and health of aquatic organisms as they are below the New York State Water Quality Standards for saline surface waters threshold (4.8 mg/L) which indicates levels where adverse impacts on aquatic organisms will occur. Some of the readings also fell below USEPA's (2000) recommendation of a minimum DO level of 2.3 mg/l as a limit for continuous 24-hour exposure to protect saltwater juvenile and adult aquatic life.

Low DO levels were also documented in the 2005 Grand Canal report, although generally DO levels were lower in 2015. In samples taken in 2004, 29.5% of surface measurements were below 5.0 mg/L, and over 65% of bottom measurements were less than 5.0mg/L. These results indicate that DO levels have been impaired in the Grand Canal for over a decade.

Based on the water quality data collected by CA in 2015, water temperature, salinity, and DO levels were found to be somewhat related to tidal fluctuations. Generally, higher water temperatures, salinity and DO levels were observed at high-tide and mid-outgoing tide conditions versus low-tide and mid-incoming tide conditions. However, the variations in readings over time and across the stations did not indicate considerable tidal flushing in the Grand Canal.

4.2 Water- Contaminants

Surface water samples collected by CA from the Grand Canal in 2015 were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), herbicides, pesticides, several nutrients (total and dissolved nitrogen, total and dissolved phosphorus, and dissolved total inorganic nitrogen), and three bacterial indicators (enterococci, total coliform, and fecal).

The results from the bacterial indicator testing indicated that that bacterial contamination is a significant issue throughout the Grand Canal, as elevated coliform levels were frequently observed. In many cases, exceedances were orders of magnitude above the recommended standard values. The bacterial analysis for the surface water samples indicated that bacterial levels frequently exceeded the standard values for all indicators in all months. The New York water quality standards for coliforms (6 CRR-NY 703.4) state that:

- For Total Coliforms (measured as number per 100 millimeters [ml]) "the monthly median value and more than 20 percent of the samples from a minimum of five examinations, shall not exceed 2,400 and 5,000, respectively."
- For Fecal Coliforms (measured as number per 100 ml) "the monthly geometric mean from a minimum of five examinations shall not exceed 200."

Additionally, USEPA's 2012 Recreational Water Quality Criteria recommend that:

- Enterococci should not exceed a geometric sample mean of 30-35 colony forming units (cfu)/100 ml or a statistical threshold value (STV; a value that should not be exceed by more than 10% of samples) of 110-130 cfu/100 ml. The range of values represent two recommendations based on differing acceptable illness rates from recreational activities in contaminated waters.

Fecal coliform levels in the Grand Canal ranged from 130-16,000 colonies/100ml. Total coliform levels ranged from 130-16,000 colonies/100ml. Enterococci levels ranged from 10-13,000 colonies/100ml. The fecal coliform and total coliform results for samples collected in 2015 exceeded those reported for samples reported in the 2005 Grand Canal report. In 2005, Coliform levels found in the Grand Canal were found to be consistently elevated, with total coliform averages ranging from 290 to 5,713 organisms/100 mL and fecal coliform averages ranging from 130 to 967 organisms/100 mL. In the 2005 report, the authors concluded that these levels would make the waters of Grand Canal unsuitable for bathing or shell fishing.

Surface water samples collected in 2015 were analyzed for several nutrients (total and dissolved nitrogen, total and dissolved phosphorus, and dissolved total inorganic nitrogen). Nutrients are essential for life in marine environments. However, nutrient enrichment can have adverse effects on aquatic species due to its promotion of algal blooms, reduced water transparency, and decreased DO levels. Results indicated significant nutrient enrichment in the Grand Canal as evidenced by high nitrogen and phosphorus levels. Total nitrogen was detected in most of the surface water samples with concentrations ranging from 1300 to 4700 µg/L. Total phosphorus was also detected in most surface water samples collected with the concentrations ranging from 50 to 329 µg/L. Based on a comparison of average reported concentrations, the Grand Canal study area concentrations of total nitrogen and total phosphorous were generally greater than regional data reported for nitrogen and phosphorous. The total and dissolved nitrogen and phosphorus concentrations reported for samples collected in the 2015 event were found to be greater than those reported for the 2015 sampling event. This suggests that nutrient enrichment has worsened over the past decade.

Nutrients are regulated in New York State Waters (NYSDEC 2015) by a narrative water quality standard rather than a numeric standard. A narrative standard lays out a descriptive condition that needs to be met. The narrative standard for phosphorus and nitrogen is: *None in amounts that result in the growths of algae, weeds and slimes that will impair the waters for their best usages*. It can be concluded that nutrient levels in the Grand Canal are exceeding these levels, as evidenced by the presence of algal growth, low DO levels, and levels of nutrients higher than in the surrounding region.

It can be concluded that water quality in the Grand Canal is impacting the ecological health and marine productivity, and that generally water quality has worsened over the past decade.

Section 5. Habitat/Living Resources

5.1 Wetland Health

The ‘Grand Canal Wetland Assessment Report’ documented baseline conditions for hydrology, vegetation, soils and avian species with the Grand Canal, and assessed the current health of the wetland system. The assessment found that habitats and wetland living resources were severely impaired.

Wetland communities within the Grand Canal were delineated based on the dominant plant species present, resulting in four major community types: intertidal marsh; high marsh/pool/panne; high marsh/marsh elder; and common reed. Common reed, an aggressive invasive wetland plant, was found at levels of 50% or greater in 70.2% of all Grand Canal wetland habitats surveyed. The east marsh complex was nearly entirely dominated by a robust tall growth form of common reed which completely surrounded the few remaining remnant pockets of high marsh/pool/panne habitat. Common reed occupied over 50% of the northwest marsh. The high presence of common reed and its high density growth occurs to the detriment of native marsh species, and is known to inhibit wildlife maneuverability.

The ‘Grand Canal Wetland Assessment Report’ concluded that the wetlands in the Grand Canal are considered highly stressed. Notable stressors which were found to contribute to the overall poor condition of Grand Canal marshes included several related to significant reductions in tidal flow into marshes from the Grand Canal:

- Alterations, particularly a 900 ft. earthen berm which forms a partial barrier between the northwest marsh and its primary source of tidal flow (i.e., Grand Canal), and a 3,800 ft. berm which forms a nearly complete barrier between the northwest marsh, and its sole source of tidal flow.
- Four undersized culverts within the earthen berm are the only direct sources of tidal flow from the Grand Canal into the east marsh. One low lying breach area on the south end of the berm allows periodic tidal input.

- Stagnant areas of the canal and marshes

The 'Grand Canal Wetland Assessment Report' proposed several recommendations to address the declining state of wetlands in the Grand Canal, including dredging the canal to increase tidal flow in the cannel and removing portions of the man-made berm along the west perimeter of the east marsh complex to allow for increased tidal flow throughout the marsh. If actions were taken to increase tidal flow into the Grand Canal system and adjacent wetlands, such as through removal of the berm, some of the identified stressors of the Grand Canal system would be reduced, ultimately enabling improvement in the ecological health of the Grand Canal system. Particularly, increased flow would result in reduced habitats dominated by the invasive common reed. This would enable native species to return and thrive, yielding increased vegetative diversity, and would assist in promoting wildlife maneuverability throughout the wetland system. In Sunken Meadow State Park, a storm resulted in the natural opening of restricted wetland system. Prior to the opening, the marsh was characterized by a high prevalence of common reed, particulary *Phragmites australis.* After the opening, *Phragmites australis* communities were considerably reduced, and native marsh vegetation returned.

5.2 Mosquito Breeding

The 2005 Grand Canal report found that routine monitoring of mosquito larval surveillance conducted by the SCDPW Division of Vector Control indicated that mosquitoes were not breeding within the Grand Canal. However, several major breeding locations were identified within freshwater and tidal wetlands adjacent to the Canal. The 2005 report notes that breeding potential in these areas may be exacerbated by the berm bordering the Grand Canal which causes water accumulation on the marsh surface and ideal mosquito breeding grounds. It was concluded that restoration work, including dredging, be conducted to restore proper hydrology to the wetlands adjacent to the Grand Canal to reduce mosquito breeding. As restoration efforts and dredging have not been conducted in the Grand Canal since the 2005 report, it still can be concluded that dredging efforts may serve to reduce mosquito breeding in the wetlands adjacent to the Grand Canal.

Section 6. Dredging Project Application

Once a final decision has been made regarding actions at the Grand Canal, a Dredging Project Application will be submitted if dredging is a selected action. This application summarizes the results of the investigation for the Grand Canal into the Environmental Dredging Factors.

Section 7. Discussion

This ecological health assessment was based on sediment, water quality data, and wetland/living resource analyses conducted from 2014 through 2016 for the Grand Canal and adjacent wetlands. These results were also compared to findings from data collected from the Grand Canal in 2014 to determine how conditions have changed over the past decade. It can be concluded that the canal system is severely impaired in terms of water quality, sediments, and habitat/living resources, and dredging may be used to alleviate these conditions.

Table 1 lists the environmental dredging factors that will be improved by actions taken within the Grand Canal. Actions in the Grand Canal (e.g., berm removal) is expected to be environmentally beneficial, resulting in:

- Increased tidal flushing
- Increased levels of dissolved oxygen in the water column
- Improved water quality
- Reduced abundance of invasive common reed and increased native vegetation
- Reduced bacterial and nutrient retention times, resulting in lower observed levels
- Increased navigability
- Removal of toxic sediments
- Increased fish access and reduced stagnant waters in wetlands

Table 1. Key environmental factors that can be improved through actions.

Category	Impaired Factor	Predicted Improvement by Actions
Water Quality	High levels of Coliform	Although increasing water flow into the canal and surrounding wetlands will help to improve the overall water quality, action must be taken to eliminate the sources of the coliform input such as treatment of stormwater runoff and residential septic system improvements.
	Low levels of dissolved oxygen	Increasing tidal flow (oxygenated water) into the canal and surrounding wetlands will help to increase the overall dissolved oxygen level in the canal. However, action should be taken to reduce nutrient input into the canal system which is most likely the source that initiates the biological reaction that results in the decrease dissolved oxygen levels in the canal system.
	Nutrient (nitrogen and phosphorus) enrichment	Although increasing water flow into the canal and surrounding wetlands will help to improve the overall water quality. Action must be taken to eliminate the sources of the nutrient enrichment, such as treatment of stormwater runoff and residential septic system improvements.
Sediment Management	Sedimentation resulting in reduced channel depth.	Although, some of the sedimentation may be a result of material entering the system through the southern and northern canal entrances. The majority of sedimentation appears to be the result of failing bulkheads and erosion to the berms separating the canal from the adjacent wetlands. Even if dredging was to be considered in order to deepen the canal, without addressing the issues of failing bulkheads and berm erosion, the canal will continue to experience sediment deposition.
	Sediment contaminations	Analysis of the sediment appears to indicate elevated levels of pesticides and metals. The sources of these containments reflect contributions from a wide variety of anthropogenic sources, including routine pesticide use, emissions from common combustion sources, CCA treated lumber for bulkheads and recreational boating activities. Although, removing of the fine contaminated sediment within the canal may improve the benthic community diversity, difficulty in remediating and controlling the re-suspension of this material into the water column may increase human health concerns. In addition to removal issues, the transport and deposition of this material will also need to be evaluated.
Habitat/Living Resources	Highly stressed wetlands	Increasing tidal flow into the surrounding wetlands will help to improve the overall habitat and increase the diversity of flora and fauna within the wetland system. Removal of the berms surrounding the wetlands adjacent to the canal will increase the movement of tidal driven water flow into and out of the existing wetland. In addition, allowing for flood waters to move onto a larger area will help remediate flooding issues for the residents surrounding the canal.
	Mosquito Breeding	Integrated Marsh Management (IMM) has been proven to be an effective way to reduce mosquito breeding. By incorporating IMM practices in the surrounding wetlands may result in the reduction of mosquito breeding and reduced chemical treatment to the surrounding wetlands.

Section 8. Summary and Conclusion

It can be concluded that the Grand Canal has experienced impaired environmental quality due to inadequate stream flow and tidal flushing. This is evidenced by the poor water quality observed within the canal system, particularly the low levels of dissolved oxygen, high levels of bacterial contaminants (coliforms), and high nutrient enrichment. Water quality in the canal has been significantly impacted by nutrient enrichment which can adversely affect marine productivity, and dissolved oxygen readings were frequently found below levels necessary for healthy aquatic life. These impairments in water quality have been documented for over a decade in the Grand Canal system as evidenced in the 2005 report on the Grand Canal. Although the 2005 report concluded that water quality in the Grand Canal was impaired, generally conditions have been observed to have worsened over the past decade. Furthermore, the inadequate flow and flushing within the Grand Canal has been listed as a major contributor to the highly stressed condition of the marshes surrounding the Grant Canal. A major characteristic of these stressed marshes is the abundance of invasive species, particularly the common reed. In addition to poor water quality, sediments sampled from multiple locations throughout the Grand Canal were found to be acutely and chronically toxic to aquatic life. Therefore, these toxic sediments are impairing the ecological quality of the Grand Canal.

Bathymetric surveys of the Grand Canal indicated reduced channel depths throughout the canal system, which act to reduce tidal flushing and also impede navigation. Observations documented during the current Grand Canal study also indicted an abundance of debris within the canal. IMM measures in the canal would provide long-term water quality and habitat improvements. These measures can include creation of additional channels and areas of open water, removal of invasive species, and grading modifications to provide water flow. These actions can serve as a means to increase tidal flushing into the canal system. This flushing will facilitate fish access and reduce stagnant waters in wetlands, both of which may reduce mosquito breeding near the Grand Canal. Increased tidal flushing should also help to reduce the retention time of bacteria and nutrients within the canal, resulting in lower observed coliform and nutrient levels, as well as improve impaired water quality parameters, such as DO. Increased tidal flushing can also serve to improve the health of the wetlands near the Grand Canal by: reducing common reed populations;

increasing native vegetation; increasing vegetative diversity; and improving wildlife maneuverability throughout marshes adjacent to the Grand Canal. Lastly, dredging the Grand Canal can increase canal navigability by deepening channels and removing debris, but dredging will not ultimately increase tidal flow or address sources of contamination to the canal system.

References

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Appendix A.

Environmental and Ecological Criteria for County Dredging Projects

Environmental Dredging Factors Considered for Improving Environmental Quality, Ecological Health and Marine Productivity

Section III, Attachment 9

Background
The County of Suffolk enacted Resolution Number 1040-2006 a Local Law to Add Ecological Health and Marine Productivity as Acceptable Criteria for County Dredging Projects (Local Law No. 50-2006, Added 09-19-2006) which amended the Suffolk County Administrative Code and added an eleventh criterion that could be utilized to justify county dredging projects as being "in the public interest." This added criterion provides that the Suffolk County

Department of Health Services Office of Ecology (OE) (or Department of Environment and Energy [DEE]) shall evaluate such Environmental Factors to determine and certify whether a proposed dredging project is needed to improve the ecological health or marine productivity. If certified, the application and supporting documentation will be forwarded to the County's Dredging Project Screening Committee for consideration of the proposed project as being "in the public interest."

§ A8-5. Criteria for County Dredging Projects.

B. A dredging project shall be deemed to be in the public interest if it supports advances or enhances the following types of uses, activities and/or facilities:

(11) improves environmental/ecological health and/or marine productivity, based upon a certification from the Suffolk County Department of Health Services, Office of Ecology, or the Suffolk County Department of Environment and Energy. Such determination shall consider factors including, but not limited to, flow rates, contaminant levels, nitrogen levels, phosphorus levels, coliform levels, algal growth rates, salinity levels, pH levels, dissolved oxygen, water temperature, oxygen levels and other such considerations that may jeopardize the health of the marine ecology or productivity

This document formulates a process for evaluation of Environmental Dredging Factors for determining whether a proposed dredging project is necessary to increase flushing rates to protect or enhance marine ecology and productivity. This document also outlines the information and data the applicant may submit to support obtaining certification under these criteria. It is incumbent upon the applicant to sufficiently document that environmental/ecological health and/or marine productivity will be improved by the proposed dredge project to the satisfaction of the Office of Ecology (or Dept. of Environment and Energy).

This certification does not imply the Dredging Project Screening Committee will approve nor the County of Suffolk will fund the proposed project; that required permits from other agencies including the New York State Department of Environmental Conservation and the United States Army Corps of Engineers will be granted; or that the information and data submitted by the applicant are sufficient for any other departmental and agency purposes.

Environmental Dredging Factors

Environmental Dredging Factors are classified into three broad categories:

1. Water Quality – e.g., surface and bottom dissolved oxygen, temperature, nitrogen hydrogen sulfide, phosphorous, coliform, enterococcus, pH, salinity, other pollutants, etc.;

2. Sediment Management – to modify sedimentary features, thereby improving stream flow or tidal flushing rates of harbors or embayments with respect to current, circulation, salinity, etc.; and remove toxic/noxious/eutrophic sediments; and

3. Habitat/Living Resources – e.g., to improve environmental/ecological health and/or marine productivity, to improve tidal flushing or light penetration, eliminate harmful algal blooms, contaminated or potentially hazardous sediments, improve shellfish/finfish productivity, spawning, and/or fish access.

The applicant must affirmatively demonstrate, using accepted scientific methodology (data, models, status/trend studies, etc.) that an impairment or violation exists for sediment, water quality, and/or habitat/living resources, and that dredging will result in alleviating the impairment (i.e., attainment of objective standard). Such analysis must be based on numeric criteria, including, but not necessarily limited to: NYS standard for Dissolved Oxygen (or other ambient water quality standard), Estuary Plan nitrogen guidelines, estuary program eelgrass habitat criteria, shellfish sanitation bacteriological standards, sediment toxicity criteria (EPA, DEC, literature studies, etc.). Habitat/living resources impairments and mitigation must similarly be demonstrated using quantitative metrics (e.g., estuary program guidelines or generally accepted, published scientific indices), and accepted scientific methodology.

Dredging may be proposed to increase tidal flushing to meet NYS dissolved oxygen standards. As an example New York State Environmental Conservation Law §703.3 Water quality standards for dissolved oxygen (DO) state:

Chronic: Shall not be less than a daily average of 4.8 mg/L;
Acute: Shall not be less than 3.0 mg/L at any time.

Waters listed on the NYSDEC Atlantic/Long Island Sound Basin Priority Waterbodies List and ECL Part 41.3, Sanitary Condition of Shellfish Lands in Suffolk County, may also be considered where dredging is proposed to alleviate stressing factors.

The burden of proof is on the applicant to demonstrate both of the following:

1. A high likelihood of success of dredging as a mitigation measure to achieve the desired objective (based on data, models, studies, etc.). For example, a hydrodynamic model can be used to calculate dilution of nitrogen and other contaminants. Mere anecdotal or observational conclusions that dredging will improve water or sediment quality are not sufficient.
2. 2. Significant environmental improvement, i.e., mitigation of a measurable impairment to a significant resource, with meaningful environmental health benefits. Town/municipality must sponsor each application, and is responsible for all data, analyses, and/or studies.

A review fee, to be determined by the Commissioner of the Department of Public Works may be required for independent consultant review and analysis of the application, or the applicant may apply to and obtain necessary permits from the NYSDEC.

The applicant shall complete and submit the County's application contained herein as part of this document (Dredging Needs Application in the Public Interest to Improve Ecological Health and/or Marine Productivity). The information obtained to complete this checklist shall be considered in review of the Environmental Dredging Factors and may include any supporting observations, measurements, analyses and findings relating to the physical and chemical qualities of the water body and sediments in the areas of proposed dredging. Photographs may be taken of physical conditions such as impediments to flow, and included as an attachment(s). Other measurements such as tidal gauge and/or flow information, depth measurements, modeling data, historical data, and other hydrographic information may be provided as supporting records to be evaluated by the OE (or DEE) in the decision to of whether the proposed dredging project will improve environmental/ecological health and/or marine productivity.

Certification by the OE (or DEE) that dredging to remove sediments from a waterbody supports, advances or enhances the environmental quality and productivity of the water body shall be forwarded to the Committee in consideration of whether the project is in the public interest. The Legislative Intent behind adding environmental criteria factors to the Committee's decision making process, relating to a Dredging Project's benefit to the public interest, is the finding that dredging may, at times, be necessary to increase flushing rates in order to protect marine ecology and productivity.

Dredging projects in the public interest to improve the environmental quality of a water body shall be completed in water bodies including, but not necessarily limited to:

I. Those demonstrated to have impaired environmental quality due to inadequate stream flow and/or tidal flushing resulting in an excessive accumulation of sediments and/or impaired water quality within the water body;

II. Those shown to have a history of detrimental affects to the environmental quality caused by existing and/or former activities within the water body, or in the surrounding areas, impacting the water body; and

III. Those where a significant restriction or reduction of the flushing rates is causing detrimental changes in environmental conditions, impairing the water body's marine ecology and productivity.

A. Physical Characteristics of the Water Body

The applicant shall complete a bathymetric survey and may conduct stream flow and/or tidal flushing measurements. The bathymetric survey shall be completed to determine the stream/water body cross section and profile. Results from this investigation shall be used to identify whether or not there are restrictions to the water body's flow and/or tidal flushing, due to bottom features including, but not limited to, fluviomarine and anthropogenic features such as sediment bars, shoals, reefs, deep spots, jetties, groins, point-source discharge features, etc. This information shall be part of the hydrographic evaluation of the water body's physical characteristics and flushing rates, which will be combined with any water column and sediment testing conducted by the applicant to become part of the overall decision making process.

B. Sediment Sampling Plan

Where sediment quality is perceived as impacting the ecological health or marine productivity of a waterbody, the applicant shall follow the procedures and decision-making criteria contained in the attached the NYSDEC, Region 1, Office of Marine Habitat Protection, "Developing Sediment Sampling Plans for Proposed Dredging Projects in Region 1."

In situ sediments to be dredged often require sampling according to the Sediment Sampling Plan approved by the NYSDEC as per DEC's technical operation guidance (TOG's) on In-Water and Riparian Management of Sediment and Dredged material and or the attached document used by NYSDEC Region 1 for development of sediment sampling plans. The web site for the TOG's is http://www.dec.ny.gov/docs/water_pdf/togs519.pdf and the attached quick reference guidance on sediment testing.

Identifying sediment quality aids on identifying disposal options both for beneficial re-use or disposal facilities . This information will dictate how and when dredging is done and have significant implications regarding dredge window restrictions, operational restrictions and cost implications that weigh into moving a dredge project forward.

C. Sediment Sample Analysis for Physical Parameters and Chemical Contaminants

Sediment sampling may include procedures for identifying and characterizing sediment physical characteristics based on grain size, grain size distribution, mineralogy, layering, and possible sediment sources. Based on the sediment's physical characteristics, sediment samples collected may be further evaluated for physical and chemical parameters of concern, e.g., heavy metals, pesticides/herbicides.

If sediment samples are collected, they shall be analyzed for chemical contaminants according to the analytical methods and recommended method detection limits defined in the NYSDEC's guidance documents. The results of this set of sample analyses will provide evidence that sediments in the water body possess chemical contaminants at concentrations exceeding applicable Action Levels (USEPA, ACOE, NYSDEC, SCDHS), which may be affecting the water body's overall environmental quality. The removal of these sediments via dredging may be necessary, not only to possibly increase flushing rates, but also to reduce levels of chemical contamination in the water body, improving overall environmental quality.

The collection and analysis for additional chemical parameters may be conducted if other contaminants are suspected to be present in the sediments, based on knowledge of the existing and/or historical uses of the water body and/or lands surrounding it. The collection and analysis of sediment samples for these other contaminants shall be on a case by case basis in consultation with the County, New York State Department of Environmental Conservation, Army Corp of Engineers, and following state and/or federal guidelines.

D. Water Sample Analysis for Chemical Contaminants and Physical Parameters

Where water quality is perceived as impacting the ecological health or marine productivity of a waterbody, the applicant may collect and analyze samples from the water column to determine the environmental conditions (e.g., surface and bottom dissolved oxygen levels within the water column). This assessment is designed to determine whether dredging may be appropriate for the improvement of the water body's environmental quality. The applicant shall describe its reasoning for selecting the timing, tide, number, type(s) and locations of samples collected. The water quality samples shall be evaluated according to appropriate criteria (USEPA, ACOE, NYSDEC, SCDHS).

The collection and analysis of water samples for additional chemical parameters (e.g., nutrients, metals) may be necessary if other contaminants are suspected to be present in the water column or in the sediment pore waters, based on knowledge of the existing and/or historical uses of the water body and/or lands surrounding it. The need for further sampling and evaluation of other contaminants shall be determined on a case by case basis in consultation with the County, and also following New York State and/or federal guidelines.

E. Dredging Project Application

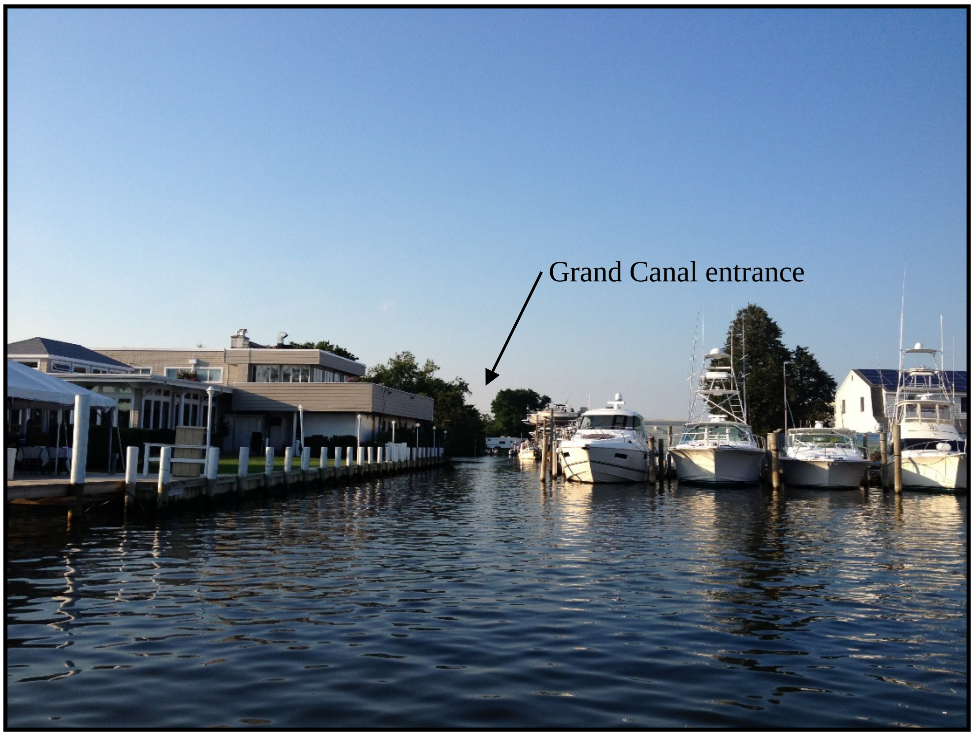
The decision by the OE (or DEE) whether or not to certify an application for a proposed dredging project shall be based on the submitted documentation relating to the Environmental Dredging Factors and the potential for the project to improve the health of the marine ecology or productivity. The attached application shall be completed by the applicant summarizing the results of the investigation of the Environmental Dredging Factors relating to the target water body.

It is incumbent upon the applicant to sufficiently characterize and document the Environmental Dredging Factors that will be improved by completing the proposed dredging project. If the OE (or DEE) determines that the information submitted by the applicant is not sufficient to support a certification decision, they may request additional information from the applicant. Upon certification, the application together with supporting documentation shall be forwarded to the Committee for the consideration. As stated previously, certification of an application does not guarantee Committee approval, or County funding for the project (if applicable). Also, additional approvals and permitting may be required by the NYSDEC and the US Army Corps of Engineers; as well as any other applicable requirements by government agencies, prior to proceeding with a proposed County Dredging Project.

Appendix J

Grand Canal Photography Log

Photo Log of Grand Canal



South entrance to Grand Canal is narrow, between restaurant and boatyard property, and restricts tidal exchange with canal.

Narrow south entrance of the canal.

<u>Photo Log of Grand Canal</u>

Much of canal is used for boat dockage along private properties.

Buildings and homes are in close proximity to canal edge.

Photo Log of Grand Canal

Portions of the canal shoreline are undeveloped

Much of the canal is characterized as visually pleasing, with historic aesthetic setting.

Photo Log of Grand Canal

A man-made eastern embankment separates the canal from extensive wetland areas (Pickman-Remmer Wetland).

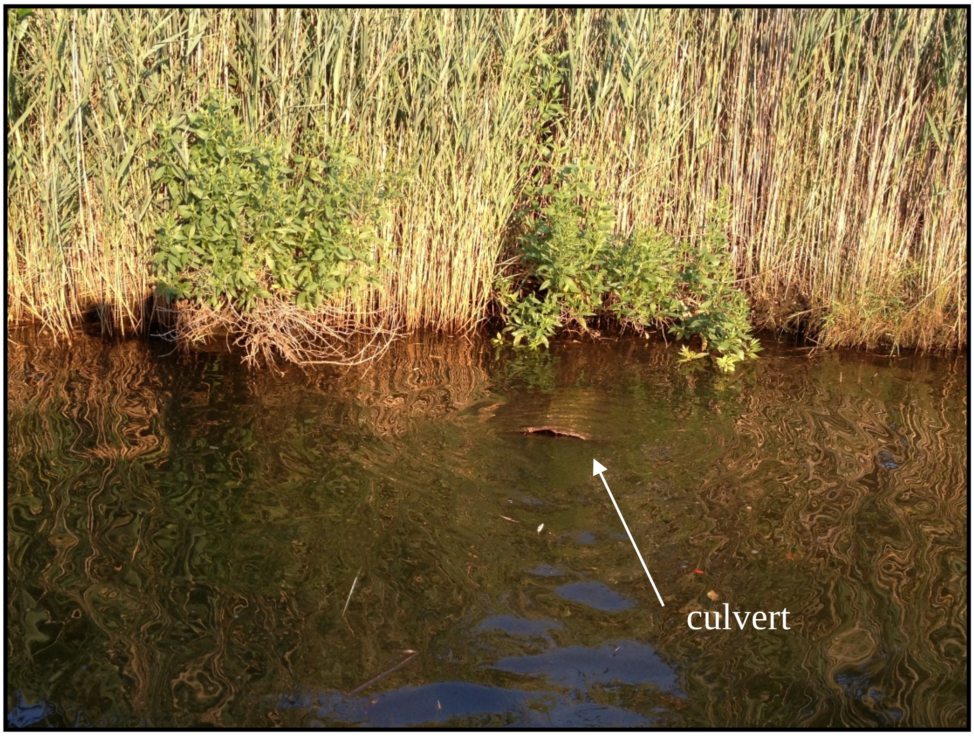
The embankment which separates the canal from the wetland areas is restricted with trees, many of which have exposed roots from erosion.

<u>Photo Log of Grand Canal</u>

Areas of the berm show evidence of extensive erosion, representing a continuing source of sediment to the canal.

Additional areas of eroded berm.

Photo Log of Grand Canal



Deteriorated culverts provide limited connection from wetlands to canal, through embankment

Culverts in poor condition provide little tidal exchange between canal and bermed wetlands.

Photo Log of Grand Canal

Culverts in poor condition provide little tidal exchange between canal and bermed wetlands.

Culverts in poor condition provide little tidal exchange between canal and bermed wetlands.

Photo Log of Grand Canal

Stormwater outfall pipe from roadway is shown above

Stormwater discharge pipes of various sizes are located along canal.

<u>Photo Log of Grand Canal</u>

Stormwater outfall discharge to the canal.

Stormwater outfall discharge to the canal.

Photo Log of Grand Canal

Stormwater outfall discharge to the canal.

Stormwater outfall discharge to the canal.

<u>Photo Log of Grand Canal</u>

Some wetlands along portions of canal not enclosed by embankment are in better ecological condition.

Many homes in close proximity to canal edge.

Photo Log of Grand Canal

Low bridges restrict access by large boats for much of the canal.

Portions of bulkheads along the canal shoreline on private property are in severe disrepair.

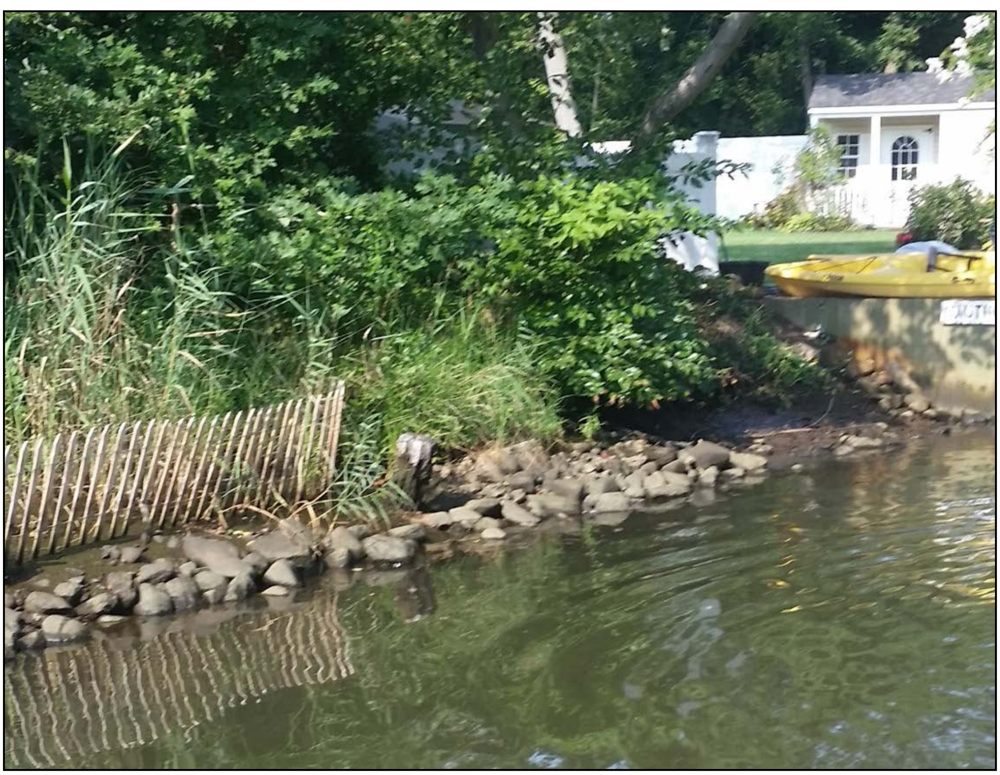
<u>Photo Log of Grand Canal</u>

Portions of bulkheads along the canal shoreline on private property are in severe disrepair.

Portions of bulkheads along the canal shoreline on private property are in severe disrepair.

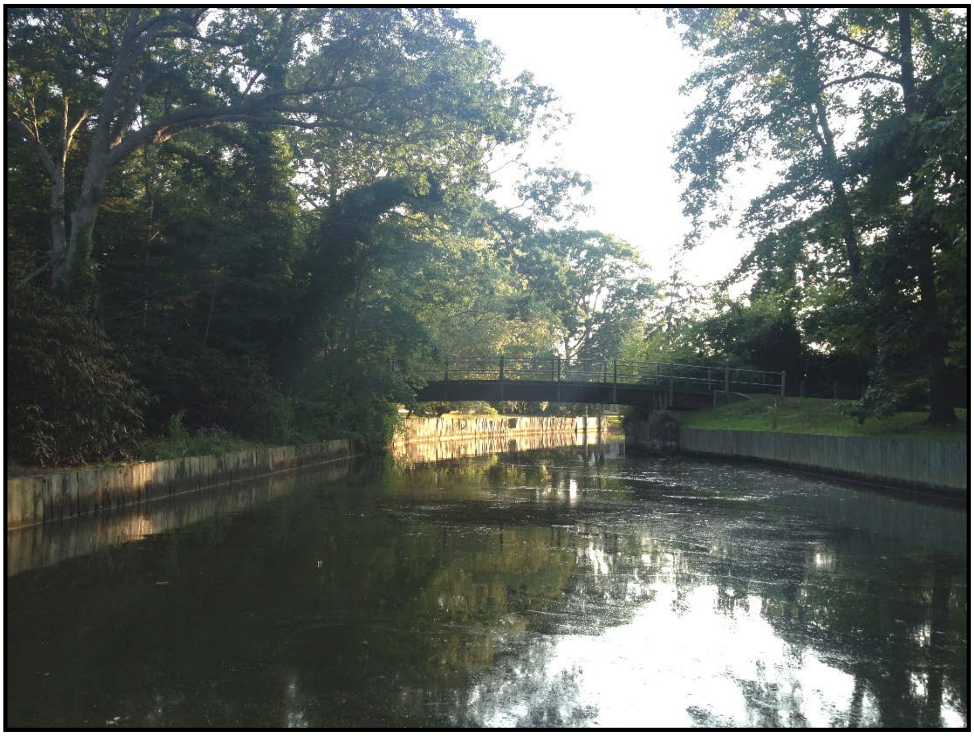
Photo Log of Grand Canal

Many bulkheads appear to be vulnerable to failure.



Portions of shoreline on residential properties have rock and debris reinforcement.

Photo Log of Grand Canal



Area of accumulated floating debris indicates zone of poorly circulated water in interior segments of the canal.