City-Wide Long Term CSO
Control Planning Project

Flushing Bay
Facility Plan Report

The City of New York
Department of Environmental Protection
Bureau of Wastewater Treatment

August 2011

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Executive Summary

The New York City Department of Environmental Protection (DEP) has prepared this Flushing Bay Waterbody/Watershed (WB/WS) Facility Plan Report as required by the Administrative Order on Consent between the DEP and the New York State Department of Environmental Conservation (DEC). Designated as DEC Case #CO2-20000107-8 (January 14, 2005, as modified April 14, 2008 as DEC Case #CO2-20070101-1 and September 3, 2009 as DEC Case #CO2-20090318-30) and also known as the Combined Sewer Overflow (CSO) Consent Order, the Administrative Consent Order requires the DEP to submit an "approvable WB/WS Facility Plan" for Flushing Bay and Flushing Creek to the DEC by June 2007.

DEP submitted a draft report in June 2007 for Flushing Bay and Flushing Creek and a revised plan in June 2009. The updated June 2009 Flushing Bay WB/WS Facility Plan included comments received from the DEC including a recommendation to submit separate Flushing Bay and Flushing Creek WB/WS Facility Plans. The DEP received comments from DEC in April 2010, and DEC requested that DEP finalize the revised Flushing Bay WB/WS Facility Plan report within 60 days of receipt of their comments but upon request from the DEP this date was extended to December 31, 2010. This report incorporates comments received on the December 2010 submittal. The Flushing Bay WB/WS Facility Plan Report builds upon analyses and planning work previously done in the 1989 Flushing Bay Water Quality Facility Plan. All WB/WS Facility Plans, including the Flushing Bay WB/WS Plan, contain all elements required by the *Federal CSO Policy* and the United States Environmental Protection Agency (USEPA). A final Citywide Long Term Control Plan (LTCP) incorporating the plans for all watersheds within the City of New York is scheduled for completion by 2017.

Purpose

The purpose of this WB/WS Facility Plan is to take the first step toward the development of an LTCP for Flushing Bay. This WB/WS Facility Plan assesses the ability of existing infrastructure to attain the existing water quality standards in Flushing Bay. Where these facilities will not result in attainment of the existing standards, certain additional alternatives have been evaluated.

Context

This WB/WS Facility Plan is one element of the City's extensive multi-phase approach to CSO control that was started in the early 1970s. As described in more detail in Section 5, New York City has been investing in CSO control for decades. DEP has already built or is planning to build over $2.9 billion in targeted grey infrastructure to reduce CSO volumes. This does not include millions spent annually on the Nine Minimum Controls that have been in place since 1994 to control CSOs.

Regulatory Setting

This WB/WS Facility Plan has been developed in fulfillment of and pursuant to the 2005 CSO Consent Order requirements. It represents one in a series of several WB/WS Facility Plans that will be developed prior to development of a final approvable Citywide LTCP. All WB/WS Facility Plans, including the Flushing Bay WB/WS Facility Plan, contain all the elements required by the USEPA of an LTCP.

Goal of Plan

The goal of this WB/WS Facility Plan is to reduce CSO overflows to Flushing Bay through a cost-effective reduction in CSO volume and pollutants to attain existing water quality standards. This WB/WS Facility Plan assesses the effectiveness of CSO controls now in place within New York City and those that are required by the CSO Consent Order to be put in place, to attain water quality that complies with the DEC water quality standards. Where existing or proposed controls are expected to fall short of attaining water quality standards, this WB/WS Facility Plan also assesses certain additional cost-effective CSO control alternatives and strategies (i.e., water quality standards revisions) that can be employed to provide attainment with the water quality standards. The goal of the LTCP will be to quantify effectiveness of the WB/WS Facility Plan recommended CSO controls and to evaluate additional CSO controls necessary to attain existing water quality standards and/or highest attainable appropriate use.

Adaptive Management Approach

Post-construction compliance monitoring, discussed in detail in Section 8, is an integral part of this WB/WS Facility Plan and provides the basis for adaptive management for Flushing Bay. Monitoring will commence just prior to implementation of CSO controls and will continue for several years thereafter in order to quantify the difference between the expected and actual performance once controls are fully implemented. Any performance gap identified by the monitoring program can then be addressed through design modifications, operational adjustments, or additional controls. If it becomes clear that the implemented plan will not result in full attainment of applicable standards, DEP will pursue necessary regulatory mechanism for a Variance and/or Water Quality Standards Revision.

If additional controls are required, protocols established by DEP and the City of New York for capital expenditures require that certain evaluations are completed prior to the construction of additional CSO controls. Depending on the technology implemented and the engineer's cost estimate for the project, these evaluations may include pilot testing, detailed facility planning, preliminary design, and value engineering. Each of these steps provides additional opportunities for refinement and adaptation so that the fully implemented program achieves the goals of the original WB/WS Facility Plan.

Project Description

Located in north-central Queens, Flushing Bay is bounded by the East River to the north between LaGuardia Airport and the community of College Point. The bay is designated as all the water south of this point to the mouth of Flushing Creek. The Flushing Bay assessment area is composed of 6,423 acres of land in Queens, NY. Combined sewers serve most of this area and discharge to ten CSOs, seven in the Tallman Island service area and three in the Bowery Bay service area. Generally, sewage generated in the area east of Flushing Bay is treated at the

Tallman Island Wastewater Treatment Plant (WWTP) and sewage generated in the area west of the bay is treated at the Bowery Bay WWTP.

Urbanization of the Flushing Bay watershed brought increased population, increased pollutants from sewage and industry, construction of sewer systems, and physical changes affecting the surface topography and imperviousness of the watershed. Consequently, the area has experienced a significant increase in the amount of runoff discharged to the waterbody. Runoff transported via roof leaders, street gutters and catch basins into the combined and separate sewer system discharge directly to Flushing Bay since the wetlands surrounding Flushing Bay have been eliminated. Thus, urbanization has simultaneously decreased retention and absorption of runoff during transport and decreased the travel time for runoff to reach the waterbody. When combined with the increased runoff due to increased imperviousness of the watershed, the end result is increased peak discharge rates and higher total discharge volumes to the waterbody during wet weather and lower flow volumes during dry weather periods.

Virtually no source of freshwater, other than CSOs and stormwater discharges, and minimal flow (~5 cfs) at the head of Flushing Creek, discharge to Flushing Bay. Thermohaline stratification can occur in Flushing Bay following large to moderate rainfall events, suppressing oxygen exchange between the surface and bottom water. Since stormwater and combined-sewer discharges are also significant sources of reactive organic carbon, the rainfall-induced stratification coupled with a high oxygen demand in the water and sediments can result in intervals of hypoxia and even anoxia in limited areas of inner Flushing Bay. The problem is exacerbated during the warmer months of the year, when organic decomposition is accelerated and oxygen saturation in water is naturally lower. In the absence of additional rainfall, thermohaline stratification in the bay usually breaks down within a few tidal cycles, due to vertical turbulent mixing and exchange of fluid with the East River.

Flushing Bay is classified by the State of New York as a Class I waterbody, with designated best uses of secondary contact recreation and fishing. Due to low dissolved oxygen concentrations and the presence of oxygen demanding substances, Flushing Bay is included in the New York State DEC 303d list under Part 3c – Waterbodies for which TMDL Development May be Deferred (Pending Implementation/ Evaluation of Other Restoration Measures).

Based on the evaluations of other restoration measures completed to date, a TMDL may not be required and may in fact delay the ability to meet the DO requirements as compared to the various control measures included in this WB/WS Facility Plan. If the WB/WS Plan for Flushing Bay attains the DO criterion or requirements for post-construction monitoring supports a Water Quality Standard revision, the waterbody would ultimately be removed from the 303(d) List.

According to CSO system numerical modeling results (for baseline conditions, with 1988 precipitation data), the combined sewer systems tributary to Bowery Bay and Tallman Island WWTPs discharge 2,328 million gallons (MG) of combined sewer overflow into Flushing Bay. Table ES-1 summarizes the annual overflow volume for each outfall under baseline conditions.

Table ES-1. Summary of Baseline Calculated Overflow Events(1, 2, 3)

Outfall	Baseline Annual CSO Volume (MG)	Number of CSO Events
BB-006	1,539	60
BB-007	179	18
BB-008	559	56
TI-012	6	See footnote 4.
TI-013	12	See footnote 4.
TI-014	2	32
TI-015	1	29
TI-016	28	45
TI-017(5)	0	10
TI-018	2	34
TOTAL	2,328	

(1) Baseline condition reflects design precipitation record (JFK, 1988), treatment plant capacity reaches 2003 sustained wet weather flow and projected sanitary flows for year 2045.
(2) Totals may not sum precisely due to rounding.
(3) Bowery Bay HLI – Operating Capacity 127 MGD (54% of 236 MGD). Tallman Island Operating Capacity 122 MGD.
(4) These discharges were all stormwater, thus the number of CSO events was zero.
(5) The model predicted only trace discharges, 0.4 MG, from TI-017

Under baseline conditions, it is projected that annual attainment of the DO WQS in Flushing Bay will be achieved greater than 90% of the time but in the summer months in certain critical areas this attainment could be as low as 56%. According to receiving water modeling results, exceedance of the pathogen numerical criteria is projected to occur during the colder months of November, January, and February, and at only two water quality monitoring locations in inner Flushing Bay (Station S06 and LMS Station 2). Figure ES-2 presents graphic displays of receiving water model results for total and fecal coliform levels for Flushing Bay under Baseline conditions. The Harbor Survey Floatables Monitoring program has rated Flushing Bay very good in terms of the floatables observer in the open waters. Currently, the Interim Floatables Containment Program (IFCP) is the major control currently in place in the Flushing Bay in conjunction with citywide programmatic source controls including the catch basin hooding program. According to the Citywide CSO Floatables reporting, only a small amount of materials are being collected at these IFCP facilities that indicate that the programmatic source controls are effective in this drainage area. There have been numerous odor complaints in this area but previous studies have linked the majority of these odors to H_2S releases in mud flats that are exposed during low tide. A variety of CSO control alternatives have been examined to reduce CSO pollution impacts to Flushing Bay. Evaluated alternatives achieve a range of CSO reductions from the Baseline condition up to approximately 100 percent CSO abatement. Full-year model simulations were performed for each engineering alternative and the results were compared to baseline conditions to determine the relative benefit of each alternative. The greatest benefit would result from alternatives that reduce CSO volumes discharged from outfalls BB-006 and BB-008, which combined account for most of the CSO discharge (almost 2 billion gallons of annual CSO volume). These alternatives were identified through a preliminary screening of all available CSO technologies and selected to provide a wide range of CSO reductions and associated cost.

All of the alternatives include the following elements: raising the weir elevation at regulator BB-R02, diverting the low lying sewers from BB HLI to BB LLI, and dredging. A description of each alternative along with the CSO volumes, associated CSO reductions, and costs of the aforementioned alternatives are summarized in Table ES-2.

Table ES-2. Costs and Benefits of Analyzed Alternatives

Alternative	Description	August 2011 PTPC ($ millions)	Total Annual Untreated CSO Volume (MG)	% CSO Reduction
Baseline		$0	2,328	0%
Alternative 5	Modifications to key Bowery Bay High Level Interceptor (BB HLI) regulators.	$72.5	1,877	19%
Alternative 7	Eight-foot diameter relief sewer for the BB HLI and all elements of Alternative 5.	$505.8	1,570	33%
Alternative 11	All the elements of Alternative 7, as well as inflatable dams at BB-006 & BB-008	$734.2	1,095	53%
Alternative 12	25 MG storage tunnel	$1,008.4	1,113	52%
Alternative 13	52 MG storage tunnel	$1,276.8	705	70%
Alternative 14	87 MG storage tunnel	$1,546.1	392	83%
Alternative 18	Storage Tunnel extendible to Flushing Creek CSOs and designed to limit discharges from BB-006 and BB-008 to zero CSO events per year.	$4,232.8	52	98%

The Selected Plan

After a complete examination of the costs and benefits of these CSO control alternatives, the scheme involving modifications to key BB HLI regulators was chosen as the selected alternative. Based on a "knee-of-curve" analysis, Alternative 5 is a cost-effective, highly-implementable CSO reduction plan for Flushing Bay that produces a 19 percent decrease in the annual CSO volumes discharged to the Bay and will also further reduce floatables. Odors will be reduced as a result of dredging to remove exposed CSO sediment mounds near the outfalls. During the critical summer months; DO attainment is projected to increase from 56 percent to 64 percent attainment with WQS and its projected that there will be no exceedances of existing pathogen standards in Flushing Bay.

Although the regulator modifications achieve a lower level of CSO removal than many of the larger storage projects, the modifications are cost-effective, implementable, and achieve satisfactory water quality benefits without precluding the future construction of additional controls, which will be investigated during the LTCP phase of facility planning in Flushing Bay. A complete summary with costs of each element of this selected plan is presented in Table ES-3.

Table ES-3. Recommended Plan PTPC

Elements of the Recommended Plan	PTPC [1] (Million)
Regulator Modifications	$17.1
Raise Weir at BB-R02 and associated diversion of low-lying sewers.	$6.7
Dredging of Flushing Bay	$48.7
Total PTPC	**$72.5**

(1) Probable Total Project Cost: Includes Hard and Soft Construction Costs - baselined to August 2011

Post-construction monitoring will provide feedback to facility operations, data for modeling, and information for compliance evaluations by DEC. Each year's data set will be compiled and evaluated to refine the understanding of the interaction between Flushing Bay and the CSOs tributary to it, with the ultimate goal of improving water quality and fully attaining the numerical water quality criteria protective of the existing designated uses. DEP will monitor the performance of the proposed elements of the Plan for a number of years, during which the SPDES Permit for the Bowery Bay WWTP may require variance relief from water quality-based effluent limits (WQBELs).

The *NYC Green Infrastructure Plan*, as described in section 5.8, includes five key components: construct cost effective grey infrastructure; optimize the existing wastewater system through interceptor cleaning and other maintenance measures; control runoff from 10 percent of impervious surfaces through green infrastructure; institute an adaptive management approach to better inform decisions moving forward; and engage stakeholders in the development/implementation of these green strategies.

As part of the LTCP process, DEP will evaluate green infrastructure in combination with other LTCP strategies to better understand the extent to which green infrastructure would provide incremental benefits and would be cost-effective. DEP models will be refined by including new data collected from green infrastructure pilots, new impervious cover data and extending predictions to ambient water quality for the development of the LTCP. Based on these evaluations, and in combination with cost effective grey infrastructure, DEP will reassess the green infrastructure strategy.

In addition to the proposed WB/WS Facility Plan and Citywide implementation of green infrastructure, DEP currently operates several programs designed to reduce CSO to a minimum and provide levels of treatment appropriate to protect waterbody uses. As the effects of implementation become understood through long-term monitoring, the following ongoing programs will be routinely evaluated based on receiving water quality considerations.

- The 14 BMPs for CSO control required under the City's 14 WWTP SPDES permits will continue. In general, the BMPs address operation and maintenance procedures, maximum use of existing systems and facilities and reduce contaminants in the combined sewer system, thereby reducing water quality impacts. A detailed discussion of the existing BMP program is included in Section 5.3.
- Maintaining the capability after completion of the ongoing headworks upgrade at the Bowery Bay WWTP to convey up to 300 MGD (2×DDWF) through preliminary

treatment, primary clarification and chlorination along with a portion of the wet weather flow through secondary treatment is a key component to capture CSO for all WB/WS Facility Plans in the Bowery Bay WWTP service area, including Flushing Bay.

- The Citywide Comprehensive CSO Floatable Plan (DEP, 2005a) provides substantial control of floatables discharges from CSOs throughout the City and provides for compliance with appropriate DEC and IEC requirements. The Floatables Plan is a living program that is expected to change over time based on continual assessment and changes in related programs.

The Flushing Bay WB/WS Facility Plan satisfies federal CSO policy requirements. Through extensive water quality and sewer system modeling, data collection, community involvement, and engineering analysis, the NYCDEP has developed a Plan that incorporates the findings of over two decades of inquiry to achieve the highest reasonably attainable water quality and associated use of Flushing Bay.

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1.0 Introduction

The City of New York owns and operates 14 wastewater treatment plants (WWTPs) and their associated collection systems. The system contains approximately 450 combined sewer overflows (CSOs) located throughout the New York Harbor complex. The New York City Department of Environmental Protection (DEP) operates and maintains the wastewater collection system and WWTPs and has executed a comprehensive watershed-based approach to address the impacts of these CSOs on water quality and uses of the waters of New York Harbor. As illustrated in Figure 1-1, multiple waterbody assessments are being conducted that consider all causes of non-attainment of water quality standards and identify opportunities and requirements for maximizing beneficial uses. This Waterbody/Watershed (WB/WS) Facility Plan Report provides the details of the assessment and the actions that will be taken to improve water quality in Flushing Bay.

New York City's environmental stewardship of the New York Harbor began in 1909 with water quality monitoring "to assess the effectiveness of New York City's various water pollution control programs and their combined impact on water quality" that continues today (annual DEP NY Harbor Water Quality Survey Reports, 2000-2007). CSO abatement has been ongoing since at least the 1950s, when conceptual plans were first developed for the reduction of CSO discharges into Spring Creek, other confined tributaries in Jamaica Bay, and the East River. From 1975 through 1977, the City conducted a harbor-wide water quality study funded by a Federal Grant under Section 208 of the Water Pollution Control Act Amendments of 1972. That study confirmed tributary waters in the New York Harbor were negatively impacted by CSOs. In addition, occurrences of dry weather discharges– which DEP has since eliminated – were also confirmed. In 1984 a Citywide CSO abatement program was developed that initially focused on establishing planning areas and defining how facility planning should be accomplished. As part of that plan, the City was divided into eight individual project areas that together encompass the entirety of the New York Harbor. Four open water project areas (East River, Jamaica Bay, Inner Harbor and Outer Harbor), and four tributary project areas (Flushing Bay, Paerdegat Basin, Newtown Creek, and Jamaica Tributaries) were defined. For each project area, water-quality CSO Facility Plans were developed as required under the State Pollutant Discharge Elimination System (SPDES) permits for each WWTP. The SPDES permits for each WWTP, administered by the New York State Department of Environmental Conservation (DEC), apply to CSO outfalls as well as plant discharges and contain conditions for compliance with applicable federal and New York State requirements for CSOs.

In 1992, DEP entered into an Administrative Consent Order with DEC which incorporated into the SPDES permits a provision stating that the consent order governs DEP's obligations for its CSO program. The 1992 Order was modified in 1996 to add a catch basin cleaning, construction, and repair program. A new Consent Order became effective in 2005 that superseded the 1992 Consent Order and its 1996 modifications with the intent to bring all CSO-related matters into compliance with the provisions of the Federal Clean Water Act (CWA) and New York State Environmental Conservation Law. The new Order contains requirements to evaluate and implement CSO abatement strategies on an enforceable timetable for 18 waterbodies and, ultimately, for Citywide long-term CSO control. DEP and DEC also entered into a separate Memorandum of Understanding (MOU) to facilitate water quality standards

(WQS) reviews in accordance with the federal CSO control policy. The 2005 Order was subsequently modified in 2008 and 2009.

This Flushing Bay WB/WS Facility Plan Report is explicitly required by item IX.B.a, Appendix A of the 2005 Consent Order, and is intended to be consistent with the United States Environmental Protection Agency's (USEPA) CSO Control Policy promulgated in 1994. The policy requires municipalities to develop a long term plan for controlling CSOs (i.e. a Long Term Control Plan or LTCP). The CSO policy became law in December 2000 with the passage of the Wet Weather Water Quality Act. The approach to developing the LTCP is specified in USEPA's CSO Control Policy and Guidance Documents, and involves the following nine minimum elements:

1. System Characterization, Monitoring and Modeling
2. Public Participation
3. Consideration of Sensitive Areas
4. Evaluation of Alternatives
5. Cost/Performance Consideration
6. Operational Plan
7. Maximizing Treatment at the Treatment Plant
8. Implementation Schedule; and
9. Post Construction Compliance Monitoring Program

Subsequent sections of this WB/WS Facility Plan report will discuss each of these elements in more depth, along with the simultaneous coordination with State Water Quality Standard (WQS) review and revision as appropriate.

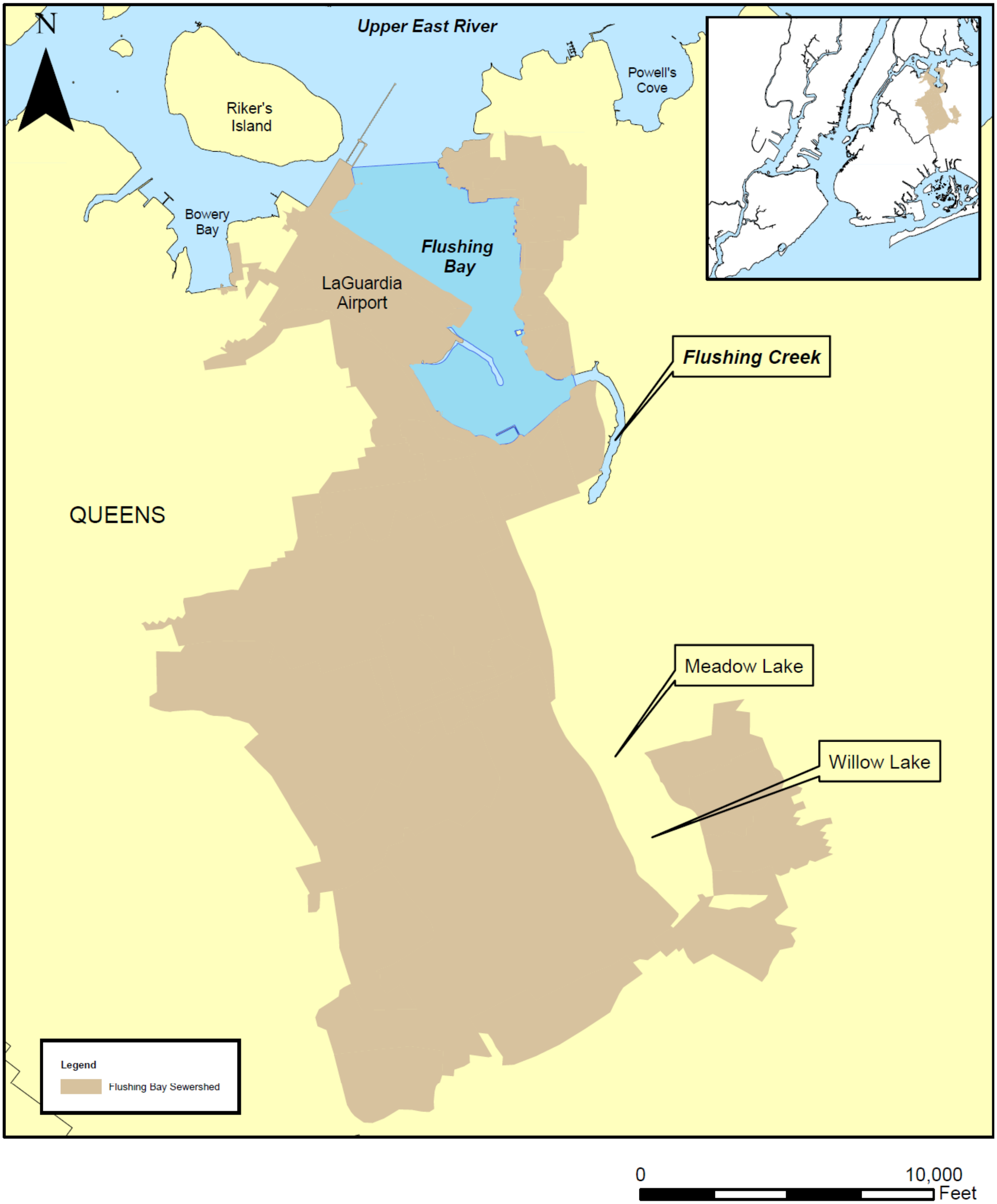
1.1 WATERBODY/WATERSHED ASSESSMENT AREA

The waterbody portion of the Flushing Bay WB/WS Facility Plan assessment area follows the DEC designation of Flushing Bay in its Codes, Rules and Regulations. The specific area of Flushing Bay is identified on Figure 1-2. Flushing Bay is bounded by the East River to the north between LaGuardia Airport and the community of College Point. The bay is designated as all the water south of this point to the mouth of Flushing Creek.

The Flushing Bay assessment area is composed of 6,423 acres of land in Queens, NY. Combined sewers serve most of this area and discharge to 10 CSOs, 7 in the Tallman Island service area and 3 in the Bowery Bay service area. Approximately 72 stormwater and/or other discharge points drain into Flushing Bay. Generally, sewage generated in the area east of Flushing Bay is treated at the Tallman Island WWTP and sewage generated in the area west of the bay is treated at the Bowery Bay WWTP.

LTCP Project Waterbody/Watershed Assessment Area

FIGURE 1-1



Environmental Protection

Flushing Bay Waterbody/Watershed Assessment Area

FIGURE 1-2

The Flushing Bay study area is surrounded by large tracts of land, including the 440-acre Rikers Island Correctional Facility to the northwest, the 650-acre LaGuardia Airport, a 1.4-mile long World's Fair Marina public promenade, Citi Field and Arthur Ashe Stadium and several smaller marinas. Flushing Meadows-Corona Park is located to the south of the bay and to the west of Flushing Creek. Areas to the east are mainly occupied by industrial and vacant uses, with a residential area inland. Heavy industrial uses in the Flushing Bay sewershed are concentrated on the eastern shore of the bay (e.g., North Shore Marine Transfer Station, two asphalt plants and miscellaneous other plants). The nearest residential areas are located near the northeastern shore of the bay (College Point) and near the southwestern shore of the bay upland of the Grand Central Parkway (East Elmhurst). The watershed is included primarily in the Queens Community Districts 3, 4, and 6.

1.2 REGULATORY CONSIDERATIONS

The waters of the City of New York are primarily subject to New York State regulation, but must also comply with the policies of the United States Environmental Protection Agency (USEPA), as well as water quality standards established by the Interstate Environmental Commission (IEC). The following sections detail the regulatory issues relevant to long-term CSO planning.

1.2.1 Clean Water Act

Although federal laws protecting water quality were passed as early as 1948, the most comprehensive approach to clean water protection was enacted in 1972, with the adoption of the Federal Water Pollution Control Act Amendments commonly known as the Clean Water Act (CWA) including the amendments adopted in 1977. The CWA established the regulatory framework to control surface water pollution, and gave the USEPA the authority to implement pollution control programs. Among the key elements of the CWA was the establishment of the National Pollutant Discharge Elimination System (NPDES) permit program, which regulates point sources that discharge pollutants into waters of the United States. CSOs and municipal separate storm sewer systems (MS4) are also subject to regulatory control under the NPDES program. In New York State, the NPDES permit program is administered by DEC, through its SPDES program. New York State has had an approved SPDES program since 1975.

The CWA requires that discharge permit limits be based on receiving Water Quality Standards (WQS) established by the State of New York. These standards should "wherever attainable, provide water quality for the protection and propagation of fish, shellfish and wildlife and for recreation in and on the water and take into consideration their use and value of public water supplies, propagation of fish, shellfish, and wildlife, recreation in and on the water, and agricultural, industrial, and other purposes including navigation" (40 CFR 131.2). The standards must also include an antidegradation policy for maintaining water quality at acceptable levels, and a strategy for meeting those standards must be developed for those waters not achieving WQS. The most common type of strategy is the development of a Total Maximum Daily Load (TMDL). TMDLs determine what level of pollutant load would be consistent with meeting WQS. TMDLs also allocate acceptable loads among the various sources of the relevant pollutants which discharge to the waterbody.

Section 305(b) of the CWA requires states to periodically report the water quality of waterbodies under their respective jurisdictions, and Section 303(d) requires states to identify impaired waters where specific designated uses are not fully supported. The DEC Division of Water addresses these requirements by following its Consolidated Assessment and Listing Methodology (CALM). The CALM includes monitoring and assessment components that determine water quality standards attainment and designated use support for all waters of New York State. Waterbodies are monitored and evaluated on a five-year cycle. Information developed during monitoring and assessment is inventoried in the Waterbody Inventory/Priority Waterbody List (WI/PWL). The WI/PWL incorporates monitoring data, information from state and other agencies, and public participation. The Waterbody Inventory refers to the listing of all waters, identified as specific individual waterbodies, within the state that are assessed. The Priority Waterbodies List is the subset of waters in the Waterbody Inventory that have documented water quality impacts, impairments or threats. The Priority Waterbodies List provides the candidate list of waters to be considered for inclusion on the Section 303(d) List.

Due to low dissolved oxygen (DO) levels and the presence of oxygen demanding substances, Flushing Bay is included in the New York State 303d list, where it can be found under Part 3c – Waterbodies for which TMDL Development may be Deferred Pending Implementation/Evaluation of Other Restoration Measures. A TMDL may not be required and may in fact delay the ability to meet the DO requirements as compared to the various control measures currently being developed and implemented which include this WB/WS Facility Plan. If after implementation of this WB/WS Facility Plan, Flushing Bay achieves the D.O. requirements of a Class I waterbody, it can then be delisted.

Another important component of the CWA is the protection of uses. USEPA regulations state that a designated use for a waterbody may be refined under limited circumstances through a Use Attainability Analysis (UAA) which is defined as "*a structured scientific assessment of the chemical, biological, and economic condition in a waterway*" (USEPA, 2000). In the UAA, the DEC would demonstrate that one or more of a limited set of circumstances exists to make such a modification. It could be shown that the current designated use cannot be achieved through implementation of applicable technology-based limits on point sources, or cost-effective and reasonable best management practice for non-point sources. Additionally, a determination could be made that the cause of non-attainment is due to natural background conditions or irreversible human-caused conditions. Another circumstance might be to establish that attaining the designated use would cause substantial environmental damage or substantial and widespread social and economic hardship. If the findings of a UAA suggest authorizing the revision of a use or modification of a WQS is appropriate, the analysis and the accompanying proposal for such a modification must go through the public review and participation process and the USEPA approval process.

1.2.2 Federal CSO Policy

The first national CSO Control Strategy was published by USEPA in the Federal Register on September 8, 1989 (54 FR 37370). The goals of that strategy were to minimize impacts to water quality, aquatic biota, and human health from CSOs by ensuring that CSO discharges comply with the technology and water quality based requirements of the CWA. On April 19, 1994, USEPA officially noticed the CSO Control Policy (59 FR 18688), which established a consistent national approach for controlling discharges from all CSOs to the waters of the United

States. The CSO Control Policy provides guidance to permittees and NPDES permitting authorities such as DEC on the development and implementation of a LTCP in accordance with the provisions of the CWA to attain water quality standards in accordance with the CWA. On December 15, 2000, amendments to Section 402 of the CWA (known as the Wet Weather Water Quality Act of 2000) were enacted incorporating the CSO Control Policy by reference.

USEPA has stated that its CSO Control Policy represents a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities and the public engage in a comprehensive and coordinated planning effort to achieve cost-effective CSO controls that ultimately meet appropriate health and environmental objectives and requirements (USEPA, 1995a). Four key principles of the CSO Control Policy ensure that CSO controls are cost effective and meet the objectives of the CWA:

1. Clear levels of control are provided that would be presumed to meet appropriate health and environmental objectives;

2. Sufficient flexibility is allowed to municipalities to consider the site-specific nature of CSOs and to determine the most cost effective means of reducing pollutants and meeting CWA objectives and requirements;

3. A phased approach to implementation of CSO controls is acceptable; and

4. Water quality standards and their implementation procedures may be reviewed and revised, as appropriate, when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs.

In addition, the CSO Control Policy clearly defines expectations for permittees, WQS authorities, and NPDES permitting and enforcement authorities. Permittees were expected to have implemented USEPA's Nine Minimum Controls (NMCs) by 1997, after which LTCPs should be developed. The NMCs are embodied in the 14 Best Management Practices (BMPs) required by DEC as discussed in Section 5.3, and include:

1. Proper operations and maintenance of combined sewer systems and combined sewer overflow outfalls;

2. Maximum use of the collection system for storage;

3. Review and modification of pretreatment requirements to determine whether non-domestic sources are contributing to CSO impacts;

4. Maximizing flow to the Publicly Owned Treatment Works (POTWs);

5. Elimination of CSOs during dry weather;

6. Control of solid and floatable material in CSOs;

7. Pollution prevention programs to reduce contaminants in CSOs;

8. Public notification; and

9. Monitoring to characterize CSO impacts and the efficacy of CSO controls.

WQS authorities should review and revise, as appropriate, State WQS during the CSO long-term planning process. NPDES permitting authorities should consider the financial capability of permittees when reviewing CSO control plans.

In July 2001, USEPA published *Coordinating CSO Long-Term Planning with Water Quality Standards Reviews*, additional guidance to address questions and describe the process of integrating development of CSO LTCPs with WQS reviews (USEPA, 2001d). The guidance acknowledges that the successful implementation of an LTCP requires coordination and cooperation among CSO communities, constituency groups, states and USEPA using a watershed approach. As part of the LTCP development, USEPA recommends that WQS authorities review the LTCP to evaluate the attainability of applicable water quality standards. The data collected, analyses and planning performed by all parties may be sufficient to justify a water quality standards revision if a higher level of designated uses is attainable or if existing designated uses are not reasonably attainable. If the latter is true, then the USEPA allows the State WQS authorities to consider several options:

- Apply site-specific criteria;

- Apply criteria at the point of contact rather than at the end-of-pipe through the establishment of a mixing zone, waterbody segmentation, or similar;

- Apply less stringent criteria when it is unlikely that recreational uses will occur or when water is unlikely to be ingested;

- Consider subcategories of uses, such as precluding swimming during or immediately following a CSO event or developing a CSO subcategory of recreational uses; and

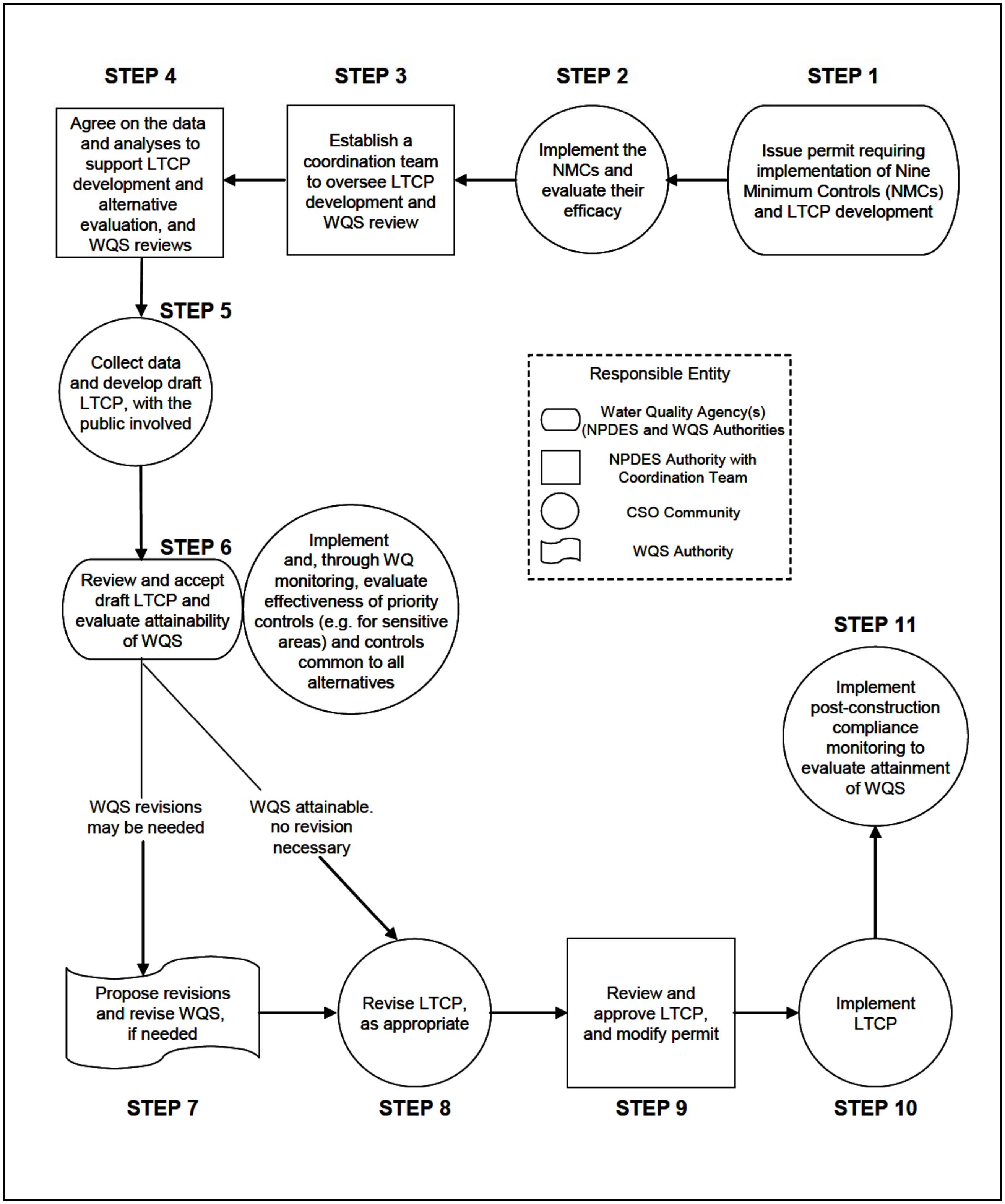
- Consider a tiered aquatic life system with subcategories for urban systems.

If the waterbody supports a use with more stringent water quality requirements than the designated use, USEPA requires the State to revise the designated use to reflect the higher use being supported. Conversely, USEPA requires that a UAA be performed whenever the state proposes to reduce the level of protection for the waterbody. States are not required to conduct UAAs when adopting more stringent criteria for a waterbody. Once water quality standards are revised, the CSO Control Policy requires post-implementation compliance monitoring to evaluate the attainment of designated uses and water quality standards and to determine if further water quality revisions and/or additional long-term control planning is necessary. USEPA provides a schematic chart (Figure 1-3) in its guidance for describing the coordination of LTCP development and water quality standards review and revision.

It is important to note that New York City's CSO abatement efforts were prominently displayed as model case studies by USEPA during a series of seminars held across the United States in 1994 to discuss the CSO Control Policy with permittees, WQS authorities, and NPDES permitting authorities (USEPA, 1994). New York City's field investigations, watershed and receiving water modeling, and facility planning conducted during the Paerdegat Basin Water Quality Facility Planning Project were specifically described as a case study during the seminars. Additional City efforts in combined sewer system characterization, mathematical modeling, water quality monitoring, floatables source and impact assessments, and use attainment were also displayed as model approaches to these elements of long-term CSO planning.

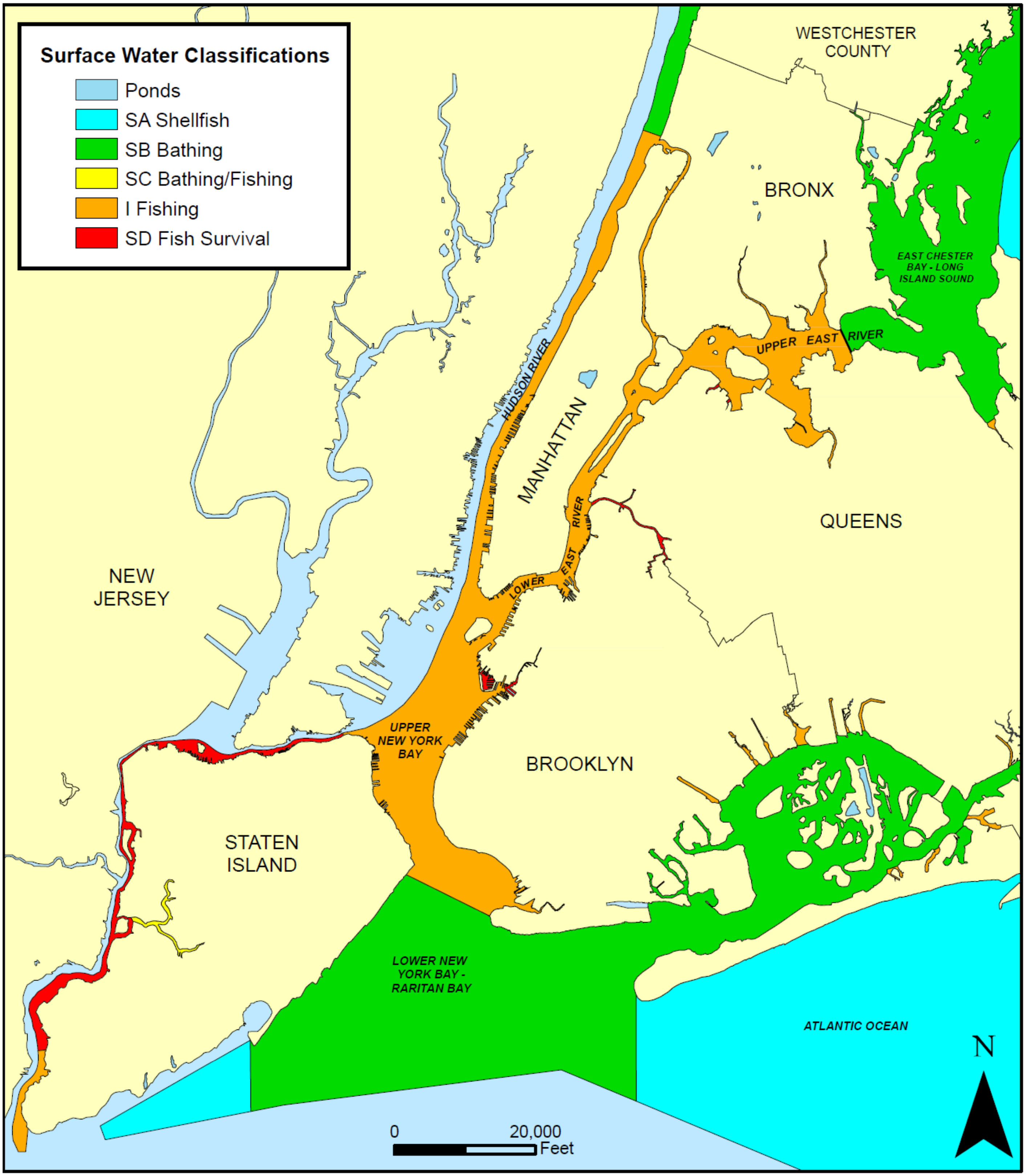
1.2.3 New York State Policies and Regulations

In accordance with the provisions of the Clean Water Act, the State of New York has promulgated water quality standards for all waters within its jurisdiction. The State has developed a system of waterbody classifications based on designated uses that includes five marine classifications, as shown in Table 1-1. New York State Water Quality classifications for the assessment area are shown in Figure 1-4.



Long Term CSO Planning Procedure

FIGURE 1-3



NYC Environmental Protection

Best Use Water Classification

FIGURE 1-4

Table 1-1. New York State Numeric Surface Water Quality Standards (Saline)

Classes	Usage	DO (mg/L)	Total Coliform(1,3) (per 100 mL)	Fecal Coliform(2,3) (per 100 mL)
SA	Shellfishing for market purposes, primary and secondary contact recreation, fishing. Suitable for fish propagation and survival.	≥ 4.8(1) ≥3.0(2)	70 (3)	N/A
SB	Primary and secondary contact recreation, fishing. Suitable for fish propagation and survival.	≥ 4.8(1) ≥3.0(2)	2,400 (4) 5,000 (5)	≤ 200 (6)
SC	Limited primary and secondary contact recreation, fishing. Suitable for fish propagation and survival.	≥ 4.8(1) ≥3.0(2)	2,400 (4) 5,000 (5)	≤ 200 (6)
I	Secondary contact recreation, fishing. Suitable for fish propagation and survival.	≥ 4.0	10,000 (6)	≤ 2,000 (6)
SD	Fishing. Suitable for fish survival. Waters with natural or man-made conditions limiting attainment of higher standards.	≥ 3.0	N/A	N/A

Notes:

(1) Chronic standard based on daily average. The DO concentration may fall below 4.8 mg/L for a limited number of days, as defined by:

$$DO_i = \frac{13.0}{2.80 + 1.84e^{-0.1t_i}}$$

Where DO_i = DO concentration in mg/L between 3.0-4.8 mg/L and t_i = time in days. This equation is applied by dividing the DO range of 3.0-4.8 mg/L into a number of equal intervals. DO_i is the lower bound of each interval (i) and t_i is the allowable number of days that the DO concentration can be within that interval. The actual number of days that the measured DO concentration falls within each interval (i) is divided by the allowable number of days that the DO can fall within interval (T_i). The sum of the quotients of all intervals (I …. N) cannot exceed 1.0: i.e.,

$$\sum_{i=1}^{n} \frac{t_i\ (actual)}{t_i\ (allowed)} < 1.0$$

(2) Acute standard (never less than 3.0 mg/L)

(3) Median most probable number (MPN) value in any series of representative samples(4) Monthly median value of five or more samples

(5) Monthly 80^{th} percentile of five or more samples

(6) Monthly geometric mean of five or more samples

DEC considers the SA and SB classifications to fulfill the Clean Water Act goals of fully supporting aquatic life and recreation. Class SC supports aquatic life and recreation but the recreational use of the waterbody is limited due to other factors. Class I supports the Clean Water Act goal of aquatic life protection and supports secondary contact recreation. SD waters shall be suitable for fish survival only because natural or manmade conditions limit the attainment of higher standards. DEC has classified Flushing Bay as a Class I waterbody.

Dissolved Oxygen

DO is the water quality parameter that DEC uses to establish whether a waterbody supports aquatic life uses. The numerical DO standard for Flushing Bay (Class I) requires that DO concentrations are at or above 4.0 mg/L at all times at all locations within the waterbody.

Bacteria

Total and fecal coliform bacteria concentrations are the numerical standards used by DEC to establish whether a waterbody supports recreational uses. The numerical bacteria standards for Flushing Bay (Class I) require that total coliform bacteria must have a monthly geometric mean of less than 10,000 per 100 milliliters (mL) from a minimum of five examinations. Fecal coliform (Class I) must have a monthly geometric mean of less than 2,000 per 100 mL from a minimum of five examinations.

An additional DEC standard for primary contact recreational waters (not applicable to Flushing Bay or any other Class I waters) is a maximum allowable enterococci concentration of a geometric mean of 35 per 100 mL for a representative number of samples. This standard, although not promulgated, is now an enforceable standard in New York State since the USEPA established January 1, 2005 as the date upon which the criteria must be adopted for all coastal recreational waters.

For areas of primary contact recreation that are used infrequently and are not designated as bathing beaches, the USEPA criteria suggest that a reference level indicative of pollution events be considered to be a single sample maxima enterococci concentration of 501 per 100 mL. These reference levels, in accordance with the USEPA documents are not standards but are to be used as determined by the state agencies in making decisions related to recreational uses and pollution control needs. For bathing beaches, these reference levels (104 per 100 mL single sample maxima enterococci concentration) are to be used for announcing bathing advisories or beach closings in response to pollution events. In this WB/WS Facility Plan, the reference level of 501 per 100 mL is considered in the assessment of the potential for bathing in Flushing Bay, since there are no bathing beaches in the waterbody. In anticipation of the new bacteria standards, DEP has started measuring enterococci in its Harbor Survey program and at WWTP influents and effluents and the New York City Department of Health and Mental Hygiene has started to monitor enterococci concentrations at designated bathing beaches.

Narrative Standards

In addition to numerical standards, New York State also has narrative criteria to protect aesthetics in all waters within its jurisdiction, regardless of classification. These standards also serve as limits on discharges to receiving waters within the State. Unlike the numeric standards, which provide an acceptable concentration, narrative criteria generally prohibit quantities that would impair the designated use or have a substantial deleterious effect on aesthetics. Important exceptions include garbage, cinders, ashes, oils, sludge and other refuse, which are prohibited in any amounts. The term "other refuse" has been interpreted to include floatable materials such as street litter that finds its way into receiving waters via uncontrolled CSO discharges. It should be noted that in August 2004, USEPA Region II recommended that DEC "revise the narrative criteria for aesthetics to clarify that these criteria are meant to protect the best use(s) of the water, and not literally required 'none' in any amount, or provide a written clarification to this end" (Mugdan, 2004). Table 1-2 summarizes the narrative water quality standards.

Table 1-2. New York State Narrative Water Quality Standards

Parameters	Classes	Standard
Taste, color, and odor producing toxic and other deleterious substances	SA, SB, SC, I, SD A, B, C, D	None in amounts that will adversely affect the taste, color or odor thereof, or impair the waters for their best usages.
Turbidity	SA, SB, SC, I, SD A, B, C, D	No increase that will cause a substantial visible contrast to natural conditions.
Suspended, colloidal and settleable solids	SA, SB, SC, I, SD A, B, C, D	None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.
Oil and floating substances	SA, SB, SC, I, SD A, B, C, D	No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.
Garbage, cinders, ashes, oils, sludge and other refuse	SA, SB, SC, I, SD A, B, C, D	None in any amounts.
Phosphorus and nitrogen	SA, SB, SC, I, SD A, B, C, D	None in any amounts that will result in growth of algae, weeds and slimes that will impair the waters for their best usages.

1.2.4 Interstate Environmental Commission (IEC)

The states of New York, New Jersey, and Connecticut are signatory to the Tri-State Compact that designated the Interstate Environmental District and created the IEC. The Interstate Environmental District includes all tidal waters of greater New York City. Originally established as the Interstate Sanitation Commission, the IEC may develop and enforce waterbody classifications and effluent standards to protect waterbody uses within the Interstate Environmental District. The applied classifications and effluent standards are intended to be consistent with those applied by the signatory states. There are three waterbody classifications defined by the IEC, as shown in Table 1-3.

Table 1-3. Interstate Environmental Commission Numeric Water Quality Standards

Class	Usage	DO (mg/L)	Waterbodies
A	All forms of primary and secondary contact recreation, fish propagation, and shellfish harvesting in designated areas	$\geq$ 5.0	East R. east of the Whitestone Br.; Hudson R. north of confluence with the Harlem R; Raritan R. east of the Victory Br. into Raritan Bay; Sandy Hook Bay; lower New York Bay; Atlantic Ocean
B-1	Fishing and secondary contact recreation, growth and maintenance of fish and other forms of marine life naturally occurring therein, but may not be suitable for fish propagation.	$\geq$ 4.0	Hudson R. south of confluence with Harlem R.; upper New York Harbor; East R. from the Battery to the Whitestone Bridge; Harlem R.; Arthur Kill between Raritan Bay and Outerbridge Crossing.
B-2	Passage of anadromous fish, maintenance of fish life	$\geq$ 3.0	Arthur Kill north of Outerbridge Crossing; Newark Bay; Kill Van Kull

In general, IEC water quality regulations require that all waters of the Interstate Environmental District are free from floating and settleable solids, oil, grease, sludge deposits, and unnatural color or turbidity to the extent necessary to avoid unpleasant aesthetics, detrimental impacts to the natural biota, or use impacts. The regulations also prohibit the presence of toxic or deleterious substances that would be detrimental to fish, offensive to humans, or unhealthful in biota used for human consumption. The IEC also restricts CSO discharges to within 24 hours of a precipitation event, consistent with the DEC definition of a prohibited dry weather discharge. Beyond that restriction, however, IEC effluent quality regulations do not apply to CSOs if the combined sewer system is being operated with reasonable care, maintenance, and efficiency.

Although IEC regulations are intended to be consistent with State water quality standards, the three-tiered IEC system and the five New York State marine classifications in New York Harbor do not overlap exactly; for example, the Class A DO numeric criterion (5 mg/L) differs from New York State's Class I criterion (4 mg/L). Primary contact recreation is defined in the IEC regulations as recreational activity that involves significant ingestion risk, including but not limited to wading, swimming, diving, surfing, and waterskiing. It defines secondary contact recreation as activities in which the probability of significant contact with the water or water ingestion is minimal including but not limited to boating, fishing and shoreline recreational activities involving limited contact with surface waters.

The IEC classifies Flushing Bay as a B-1 waterbody. Uses for this classification include fishing and secondary contact recreation with a minimum DO concentration of 4.0 mg/L to protect the growth and maintenance – though not necessarily the propagation – of fish and other marine life.

1.2.5 Administrative Consent Order

New York City’s 14 WWTP SPDES permits include conditions which require compliance with Federal and State CSO requirements. DEP was unable to comply with deadlines included within their 1988 SPDES permits for completion of CSO abatement projects initiated in the early 1980s. As a result, DEP entered into an Administrative Consent Order with DEC on June 26, 1992 which was incorporated into the SPDES permits with a provision stating that the Consent Order governs DEP’s obligations for its CSO program. It also required that DEP implement CSO abatement projects within nine facility planning areas in two tracks: those areas where DO and coliform standards were being contravened (Track One), and those areas where floatables control was necessary (Track Two). The 1992 Order was modified on September 19, 1996 to add catch basin cleaning, construction, and repair programs.

DEP and DEC negotiated a new Consent Order, signed January 14, 2005, that supersedes the 1992 Order and its 1996 Modifications, with the intent to bring all DEP CSO-related matters into compliance with the provisions of the Clean Water Act and Environmental Conservation Law. The new Order contains requirements to evaluate and implement CSO abatement strategies on an enforceable timetable for 18 waterbodies and, ultimately, for Citywide long-term CSO control in accordance with USEPA CSO Control Policy. This Order was recently modified and signed on April 14, 2008 and again on September 3, 2009. DEP and DEC also entered into a separate MOU to facilitate water quality standards reviews in accordance with the CSO Control Policy.

1.3 CITY POLICIES AND OTHER LOCAL CONSIDERATIONS

New York City's waterfront is approximately 578 miles long, encompassing 17 percent of the total shoreline of the State. This resource is managed through multiple tiers of zoning, regulation, public policy, and investment incentives to accommodate the diverse interests of the waterfront communities and encourage environmental stewardship. The local regulatory considerations are primarily applicable to proposed projects and do not preclude the existence of non-conforming waterfront uses. However, evaluation of existing conditions within the context of these land use controls and public policy anticipate the nature of long-term growth in the watershed.

1.3.1 New York City Waterfront Revitalization Program

The New York City Waterfront Revitalization Program (WRP) is the City's principal coastal zone management tool and is implemented by the New York City Department of City Planning (NYCDCP). The WRP establishes the City's policies for development and use of the waterfront and provides a framework for evaluating the consistency of all discretionary actions in the coastal zone with City coastal management policies. Projects subject to consistency review include any project located within the coastal zone requiring a local, state, or federal discretionary action, such as a Uniform Land Use Review Procedure (ULURP) or a City Environmental Quality Review (CEQR). An action is determined to be consistent with the WRP if it would not substantially hinder and, where practicable, would advance one or more of the 10 WRP policies. The New York City WRP is authorized under the New York State Waterfront Revitalization and Coastal Resource Act of 1981 which, in turn, stems from the Federal Coastal Zone Management Act of 1972. The original WRP was adopted in 1982 as a local plan in accordance with Section 197-a of the City Charter, and incorporated the 44 state policies, added 12 local policies, and delineated a coastal zone to which the policies would apply. The program was revised in 1999, and the new WRP policies were issued in September 2002. The revised WRP condensed the 12 original policies into 10 policies: (1) residential and commercial redevelopment; (2) water-dependent and industrial uses; (3) commercial and recreational boating; (4) coastal ecological systems; (5) water quality; (6) flooding and erosion; (7) solid waste and hazardous substances; (8) public access; (9) scenic resources; and (10) historical and cultural resources.

1.3.2 New York City Comprehensive Waterfront Plan

The City's long-range goals are contained in the Comprehensive Waterfront Plan (CWP). The CWP identifies four principal waterfront functional areas (natural, public, working, and redeveloping) and promotes use, protection, and redevelopment in appropriate waterfront areas. The companion Borough Waterfront Plans (1993-1994) assess local conditions and propose strategies to guide land use change, planning and coordination, and public investment for each of the waterfront functional areas. The CWP has been incorporated into local law through land use changes, zoning text amendments, public investment strategies, and regulatory revisions, which provide geographic specificity to the WRP and acknowledge that certain policies are more relevant than others in particular portions of the waterfront.

1.3.3 Department of City Planning Actions

The NYCDCP was contacted to identify any projects either under consideration or in the planning stages that could substantially alter the land use in the vicinity of Flushing Bay. NYCDCP reviews any proposal that would result in a fundamental alteration in land use, such as zoning map and text amendments, special permits under the Zoning Resolution, changes in the City Map, the disposition of City-owned property, and the siting of public facilities. In addition, NYCDCP maintains a library of Citywide plans, assessments of infrastructure, community needs evaluations, and land use impact studies. These records were reviewed and evaluated for their potential impacts to waterbody use and runoff characteristics, and the NYCDCP community district liaison for the Community District was contacted to determine whether any proposals in process that required NYCDCP review might impact the WB/WS Plan.

1.3.4 New York City Economic Development Corporation

The New York City Economic Development Corporation (NYCEDC) was contacted to identify any projects either under consideration or in the planning stages that could substantially alter the land use in the vicinity of Flushing Bay. The NYCEDC is charged with dispensing City-owned property to businesses as a means of stimulating economic growth, employment, and tax revenue in the City of New York while simultaneously encouraging specific types of land use in targeted neighborhoods. As such, NYCEDC has the potential to alter land use on a large scale.

Additionally, the NYCEDC serves as a policy instrument for the Mayor’s Office, and recently issued a white paper on industrial zoning (Office of the Mayor, 2005) intended to create and protect industrial land uses throughout the City. The policy directs the replacement of the current In-Place Industrial Parks (IPIPs) with Industrial Business Zones (IBZs) that more accurately reflect the City’s industrial areas. Policies of this nature can have implications on future uses of a waterbody as well as impacts to collection systems. Accordingly, a thorough review of NYCEDC policy and future projects was performed to determine the extent to which they may impact the WB/WS Plan. La Guardia airport is included in the Steinway Industrial Business Zone.

1.3.5 Local Law

Local law is a form of municipal legislation that has the same status as an act of the State Legislature. The power to enact local laws is granted by the New York State Constitution, with the scope and procedures for implementation established in the Municipal Home Rule Law. In New York City, local laws pertaining to the use of the City waterways and initiatives associated with aquatic health have been adopted beyond the requirements of New York State. Recent adoptions include Local Law 71 of 2005, which required the development of the Jamaica Bay Watershed Protection Plan (JBWPP) and Local Law 5 of 2008 which requires City-owned buildings or City-funded construction to include certain sustainable practices, as well as requiring the City to draft a sustainable stormwater management plan by October 1, 2008. These initiatives are discussed in Section 5 in detail.

1.3.6 Bathing Beaches

Bathing beaches in New York City are regulated, monitored and permitted by the City and State under Article 167 of the New York City Health Code and Section 6-2.19 of the New York City Sanitary Code. Siting requirements imposed by State and City codes must be considered to evaluate the potential use of a waterbody for primary contact recreation. These requirements include minimum distances from certain types of regulated discharges (such as CSO outfalls), maximum bottom slopes, acceptable bottom materials, minimum water quality levels, and physical conditions that ensure the highest level of safety for bathers.

1.4 REPORT ORGANIZATION

This report has been organized to clearly describe the proposed WB/WS Facility Plan that supports a Long-Term CSO Control Planning process and the environmental factors and engineering considerations that were evaluated in its development. The nine elements of long-term CSO control planning are listed in Table 1-4 along with relevant sections within this document for cross-referencing.

Section 1 describes general planning information and the regulatory considerations in order to describe the setting and genesis of the LTCP and the CSO Control Policy. Sections 2, 3, and 4 describe the existing watershed, collection system, and waterbody characteristics, respectively. Section 5 describes related waterbody improvement projects within the waterbody and the greater New York Harbor. Section 6 describes the public participation and agency interaction that went into the development of this WB/WS Facility Plan, as well as an overview of DEP's public outreach program. Sections 7 and 8 describe the development of the plan for the waterbody. Section 9 discusses the review and revision of water quality standards. The report concludes with references in Section 10 and a glossary of terms and abbreviations is included in Section 11. Attached for reference are the Wet Weather Operating Plans for the Tallman Island and Bowery Bay WWTPs.

Table 1-4. Locations of the Nine Minimum Elements of Long-Term Control Planning

No.	Element	Section(s) Within Report
1	Characterization of the Combined Sewer System	3.0
2	Public Participation	6.0
3	Consideration of Sensitive Areas	4.7
4	Evaluation of Alternative	7.0
5	Cost/Performance Considerations	7.0
6	Operational Plan	8.0
7	Maximizing Treatment at the Existing WWTP	7.0 & 8.0
8	Implementation Schedule	8.0
9	Post-Construction Compliance Monitoring	8.0

2.0 Watershed Characteristics

2.1 HISTORICAL CONTEXT OF WATERSHED URBANIZATION

Flushing Bay watershed has been heavily modified by urban development actions since the area was settled by European colonists. These modifications have led to the paving over of large portions of the drainage area resulting in increased runoff volumes and a decrease in wetland areas capable of absorbing and filtering runoff. The most substantial changes have occurred in the last hundred years. Visual comparison between the current conditions, as shown in the aerial photograph depicted in Figure 2-1 and a circa 1900 survey shown in Figure 2-2, depict how the change in concentration of residential, commercial and industrial development has affected the waterbody. In addition, a key map showing the locations of various photos of the watershed to be referenced in the sections below is shown in Figure 2-3. The notable changes are listed below.

The prominent land area of LaGuardia Airport extrudes into the northwest corner of Flushing Bay. The original North Beach Airport (also known as the Glenn-Curtis Airport) was built on the site in 1929 and occupies 105 acres, 50 of which were landfill. The City purchased this airport in 1935, and expanded the facility to 558 acres, 357 of which were reclaimed by filling wetlands. The airport was subsequently renamed LaGuardia Airport. In 1967 the airport's two runways were extended over Bowery Bay to increase their length to 7,000 feet, for an aerial coverage of 650 acres (PANYNJ, 1992). In 1995 Runway 13/31 at the airport was extended further southwest into Flushing Bay to provide a safety overrun complying with Federal Aviation Administration safety design standards. The project included wetlands mitigation elements in the construction. The overall dimensions of the runway overrun are approximately 690 feet long by 1,200 feet wide, occupying approximately 20 acres.

Along the southern edge of Flushing Bay is the World's Fair Marina, a set of docks for mooring recreational vessels and an associated esplanade promenade developed in conjunction with the 1939 World's Fair. The esplanade extends south from LaGuardia Airport to Harper Street, at the mouth of Flushing Creek. The marina, esplanade and adjacent parkland have been the subject of recent renovation by the NYC Parks Department (NYC Department of Planning, 1993). Photographs of the World's Fair marina and the promenade are shown in Figure 2-4.

Another prominent feature in Flushing Bay is the earthen breakwater that extends from the southwestern end of the LaGuardia Airport runway, constructed as a protective measure for the 500 slip World's Fair Marina during storm events. The breakwater, shown on Figure 2-1, was constructed under a permit issued in 1963 by the Department of the Army to the New York City Department of Parks and the New York World's Fair Corporation. The 2,800 foot, stone-faced breakwater was completed in 1964. The 1963 permit included a discretionary provision for the District Engineer to require the permittees to cut a channel 75 feet through the breakwater at a future date, if it was found to impede circulation in the inner (or back) bay. This 75-foot channel has not been constructed as it has not been deemed necessary. In 1967 the Corps of

Engineers accepted maintenance and operations of the outermost 1,400 feet of the breakwater from the City of New York, in lieu of a federally authorized 1,400 foot steel sheetpile breakwater; however, in 1992 Congress deauthorized further federal maintenance responsibility for the breakwater. In 1995, in conjunction with the LaGuardia runway extension, the Port Authority removed approximately 90,000 cubic yards from the breakwater to reduce its elevation to approximately 3.2 feet above Mean Low Water datum. The purpose of this was to mitigate wetlands loss associated with the runway extension by creating about 6.2 acres of non-vegetated wetlands at the top of the breakwater (USACE, 1996; PANYNJ, 1992).

Federal navigation improvement projects have also altered the bay since the original Congressional authorization in 1878. Initially this program consisted of a six-foot deep navigation channel extending from the deep water in the East River inland to the Whitestone Expressway Bridge crossing Flushing Creek (see Figure 2-5). These operations were designed to support and encourage existing and projected needs for industrial, commercial and recreational activities in the bay and creek. The practice in the early navigation channel dredging projects was to have the dredged material "placed directly on adjacent shores," which was done to create dry land for development. As authorized by Congress in 1962 the navigation improvement project included the following elements:

> *"The U.S. Army Corps of Engineers maintains a 2.9 mile navigation channel extending through Flushing Bay from College Point (at the mouth of Flushing Bay) up to Flushing Creek to a point approximately 50 feet downstream from the Roosevelt Avenue Bridge. The channel is maintained to a depth of 15 feet and width of 300 feet from deep water in the East River to the maneuvering area, a distance of 1.8 miles. The 1.1 mile creek channel is maintained at a depth of 15 feet and a width of 200 feet to Northern Boulevard Bridge, from which point the width decreases uniformly to 170 feet to just downstream of the Roosevelt Avenue Bridge. A branch channel with a depth of 15 feet and width of 200 feet from the main channel to the maneuvering area (a distance of about 0.1 mile). An irregularly shaped maneuvering area (15 feet deep except the approach to the west site of the municipal boat basin which remains at 12 feet), and an anchorage basin (about 100 feet by 1,800 feet or 84 acres, with a depth of 6 feet) are located in Flushing Bay." (USACE, 2003)*

The last maintenance dredging for the bay occurred in 1997, with removal of approximately 84,000 cubic yards of material. As of September 2008, the USACE is considering additional dredging in the bay but funding has not yet been established for any projects (USACE, 2008).

2.2 LAND USE CHARACTERIZATION

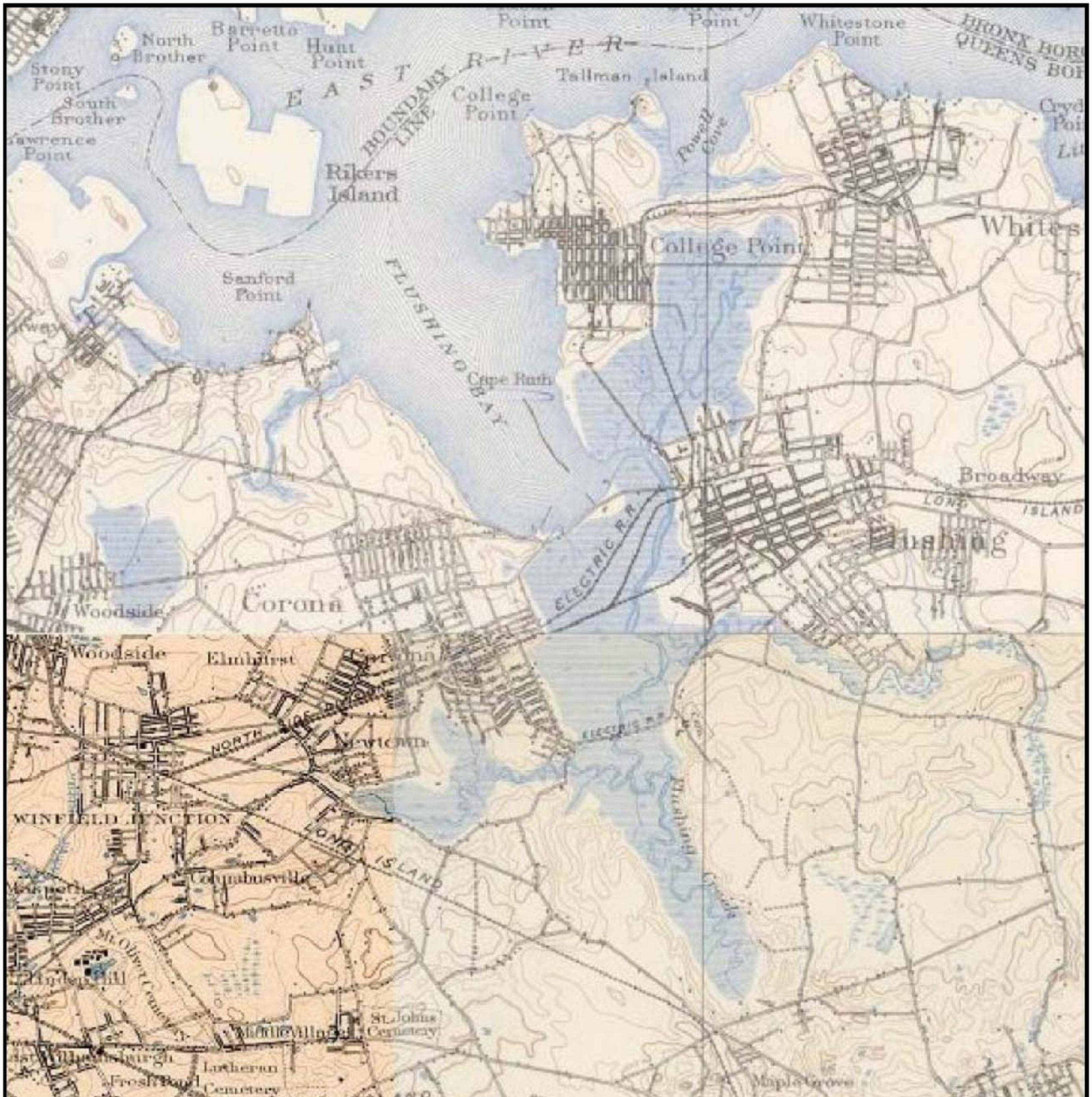
The Flushing Bay watershed is highly urbanized. With the exception of city parks, cemeteries and the World's Fair Marina, the watershed is a dense mixture of residential, transportation, commercial, industrial and institutional development. Flushing Bay eventually feeds into the East River. Flushing Creek discharges into the bay at its southeastern corner. The neighborhoods of East Elmhurst, Corona, College Point and Flushing surround the bay. The

Environmental
Protection

Present Day Flushing Bay (Detailed View)

Flushing Bay Waterbody/Watershed Facility Plan

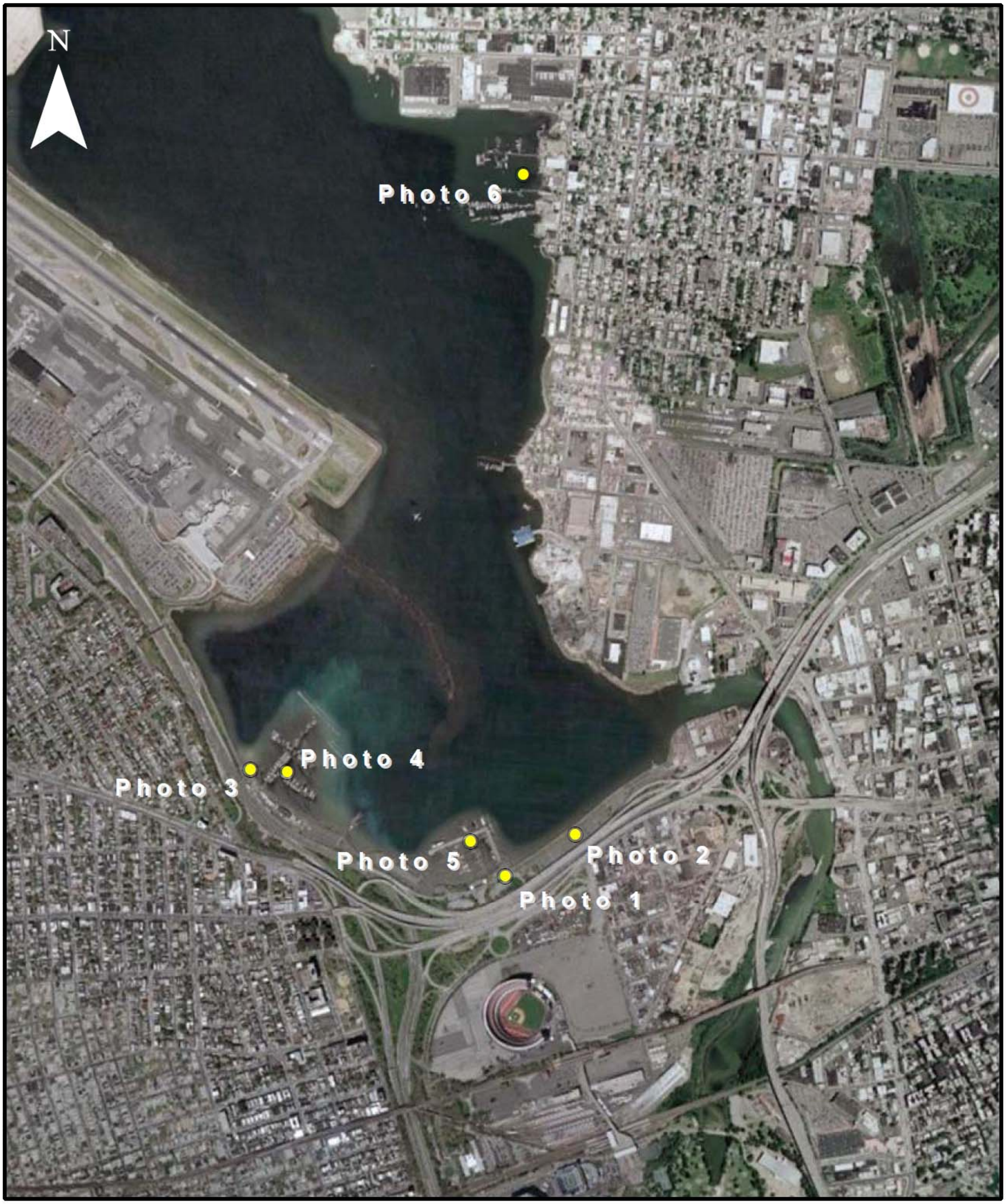
FIGURE 2-1



Environmental Protection

Flushing Bay (Circa 1900)

FIGURE 2-2



Environmental Protection

Flushing Bay (Photo Key)

FIGURE 2-3

Photo 1: Promenade

Photo 2: Promenade Looking Over Flushing Bay

Photo 3: World's Fair Marina

Environmental Protection

Flushing Bay
Promenade and Marina

FIGURE 2-4

Environmental Protection

Flushing Bay
Navigational Channel

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE 2-5

dominant land uses on the eastern shore include industrial and residential uses. The southern shore is mostly parkland, while the west is mostly transportation related.

The watershed includes approximately 5,203 acres (81 percent) of high density residential, commercial, industrial and institutional lands, as well as streets, highways, railroads, and other transportation service areas. Approximately 1,220 acres (19 percent) of the watershed consists of parks, open water, and major cemeteries. The portion of Flushing Meadows-Corona Park complex in the Flushing Bay watershed includes a mixture of pervious and impervious areas (parking lots, roads, Citi Field, open space, etc.). Other relatively open space developments representing pervious developed lands include:

- 1,093 acres of major parks (Cunningham, Forest, and College Point Shorefront Parks)
- 126 acres of major cemeteries
- several large school campuses

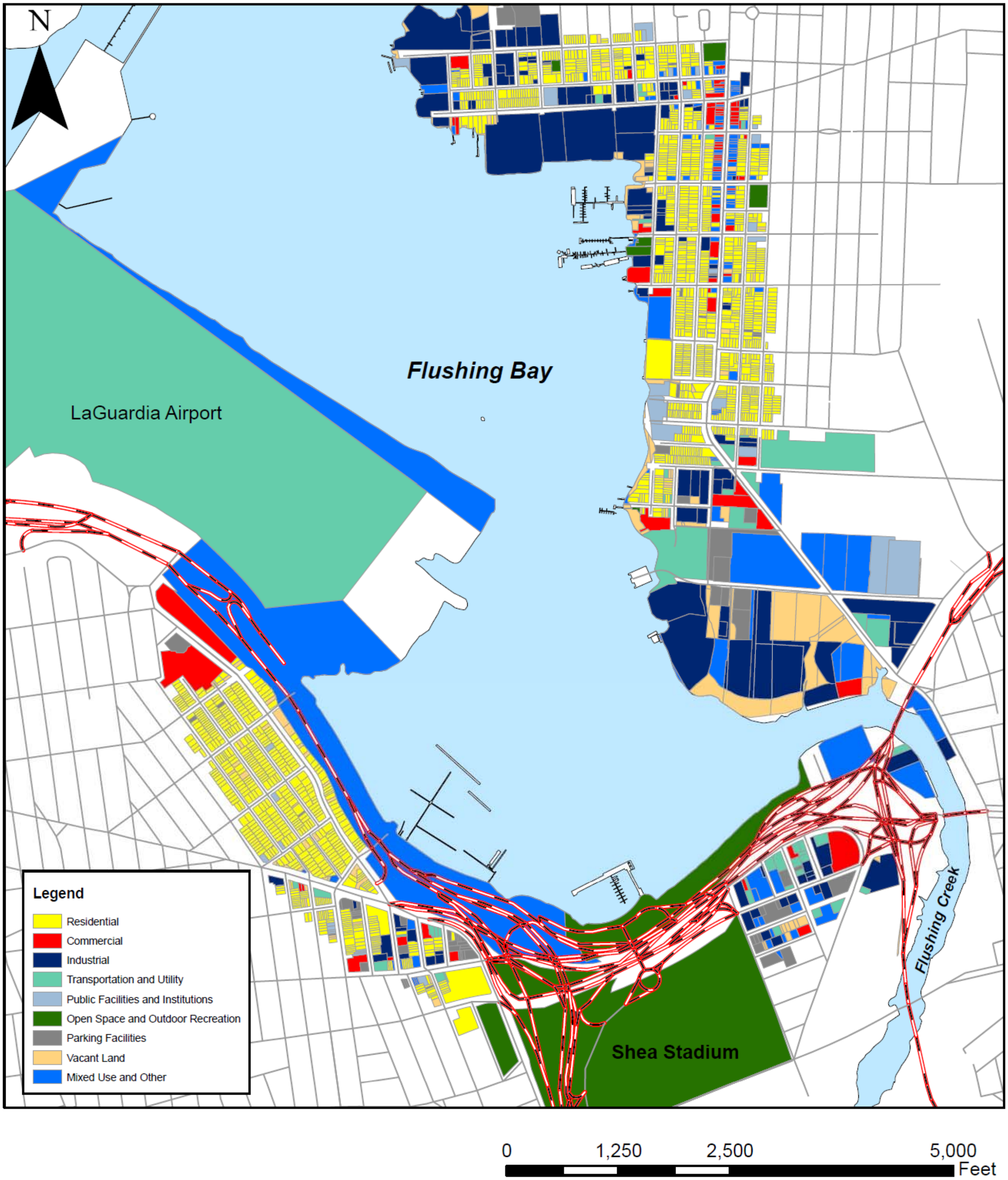
2.2.1 Existing Land Use

The existing land uses within a quarter mile radius of Flushing Bay are shown in Figure 2-6. The existing land uses along Flushing Bay follow a four-part division:

- mixed use (industrial, commercial, residential) College Point area, on the northeast side of the bay,
- predominant parkland on the southern side of the bay,
- mixed residential and shoreline park on the southwestern side of the bay, and
- La Guardia Airport on the northwest side of the bay.

The College Point area (on the northeast side of the bay) is mostly residential and industrial, with a few commercial and institutional uses mixed in. The industrial areas of College Point are mostly located along the waterfront and adjacent to residential areas. There is a large mass of industry located in the area due to historic use and development patterns. College Point experienced significant industrial development in its early years. It is now comprised mostly of manufacturing and construction areas. Several marinas and yacht clubs are located along the eastern shore of College Point. Aerial photographs of the World's Fair Marina and College Point Marina are shown in Figure 2-7.

The Flushing Bay Promenade runs for 1.4 miles along the southern shore of the bay, from approximately 126th Street to 27th Avenue. Inland of the promenade, on the western shore of the bay, is a large residential area made up of small apartment buildings, three-story rowhouses and garden apartments. A commercial center dominates the northern terminus. Citi Field (home of the New York Mets professional baseball team) is located directly south of Flushing Bay on the eastern side of Grand Central Parkway. La Guardia Airport lies on the northwest edge of Flushing Bay. A portion of Riker's Island lies within the quarter-mile cut-off of Flushing Bay, but is in East River waters. It houses a New York City correctional facility.



NYC Environmental Protection

Flushing Bay Generalized Land Use Map (1/4 mile radius)

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE 2-6

Photo 4: World's Fair Marina (1 of 2)

Photo 5: World's Fair Marina (2 of 2)

Photo 6: College Point Marina

Environmental Protection

Marinas in Flushing Bay

2.2.2 Zoning

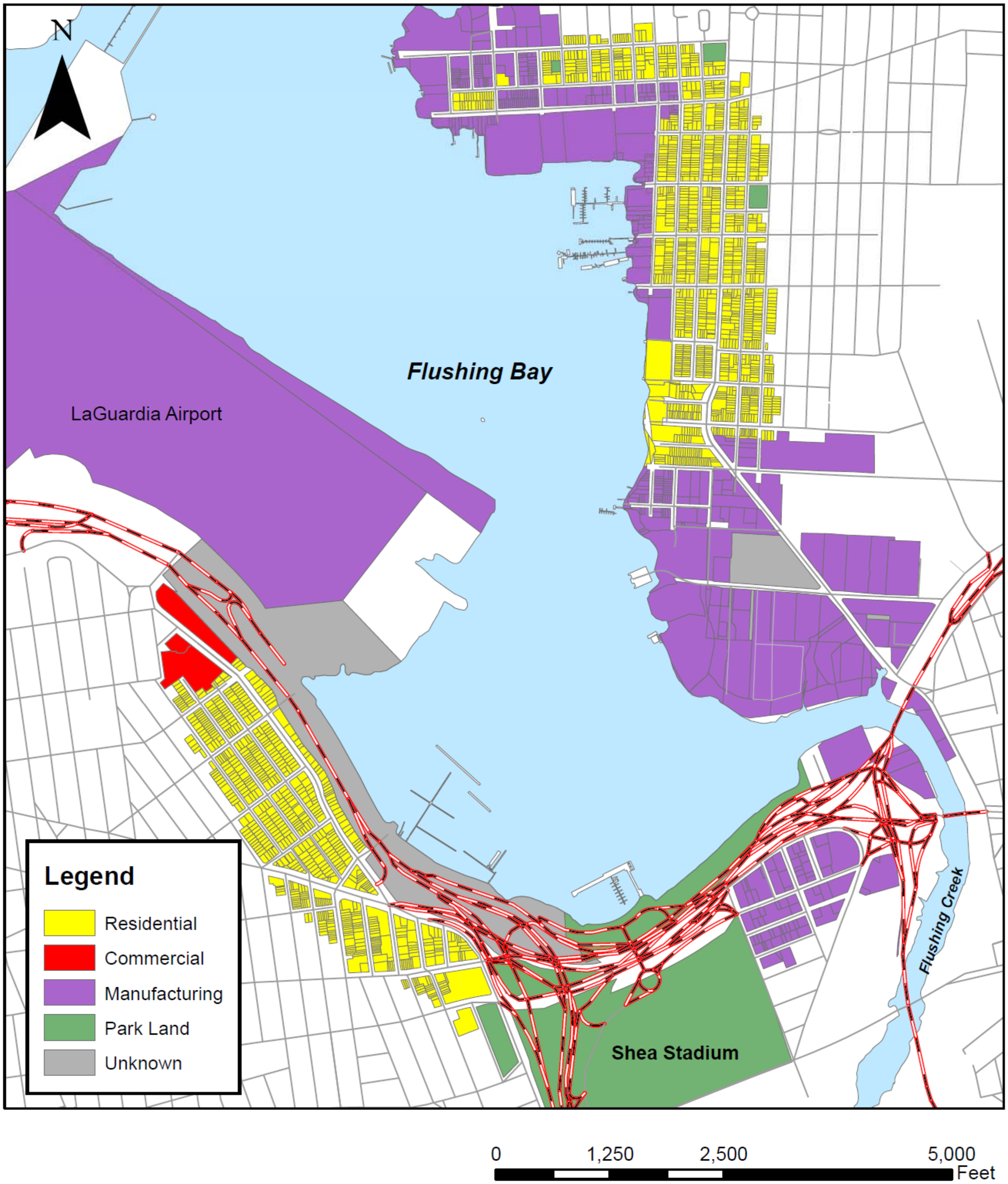
The zoning classifications within the riparian area comprised of blocks wholly or partially within a quarter mile radius of Flushing Bay are shown in Figure 2-8. The zoning in the inland College Point areas is residential, R3A, R4 and R4-1. There is a small C3 commercial zone immediately south of Herman MacNeil Park. The remainder of the College Point shoreline is predominantly industrial and zoned M1-1, M2-1 and M3-1. A segment of the shoreline between 23rd and 25th streets, extending to 120th Street, was rezoned to C3, to promote such uses as marina, restaurant and residential development.

Citi Field and the Flushing Bay Promenade are designated parkland. The railroad corridor is M1-1 zoned, while the industrial area to the northeast of it is zoned M3-1. The residential area south of La Guardia Airport is R3-2 and R5, while the airport is zoned M1-1.

2.2.3 Neighborhood and Community Character

Neighborhood and community character in the immediate vicinity of Flushing Bay is a mixture of industrial, vacant, residential, transportation and parkland uses. The shoreline of College Point is industrial, with older brick factory buildings. The southern part of College Point is more industrial in nature, due to the College Point Corporate Park. Several marinas also line the waterfront, including (from north-to-south) T&W Marine Service, Frank Tiborsky Marine, Inc. (moorings), Arrow Yacht Club and Skyline Marina. Vacant lands are interspersed with the industrial uses along the waterfront. Inland are the residential areas, which are made up of garden apartments, rowhouses and single- and two-family detached and semi-detached houses, often with deep front yards.

The residential areas to the west of the Flushing Bay Promenade are mostly garden apartments, rowhouses, small apartment buildings and three-to-twelve story apartment buildings. La Guardia Airport lies north of these residential areas. The airport also has a water shuttle that operates between its Marine Terminal and locations in Downtown and Midtown Manhattan.



Environmental Protection

Flushing Bay Generalized Zoning Map (1/4 mile radius)

FIGURE 2-8

2.2.4 Proposed Land Uses

New York City Department of City Planning has proposed a rezoning in the North Corona neighborhood. The rezoning project affects 100 blocks of primarily residential area on the southwestern shore of Flushing Bay. 68 blocks would be rezoned from R5 and R6B zones to a lower density classification of R5 or R5A zone. 34 blocks located along portions of Astoria and Northern Boulevard will be rezoned to establish a fixed maximum building height and allow medium density residential development. The formal public review process has begun for this project. It should be noted that these changes to zoning classification may not directly impact water quality.

2.2.5 Consistency with the Waterfront Revitalization Program and Comprehensive Waterfront Plan

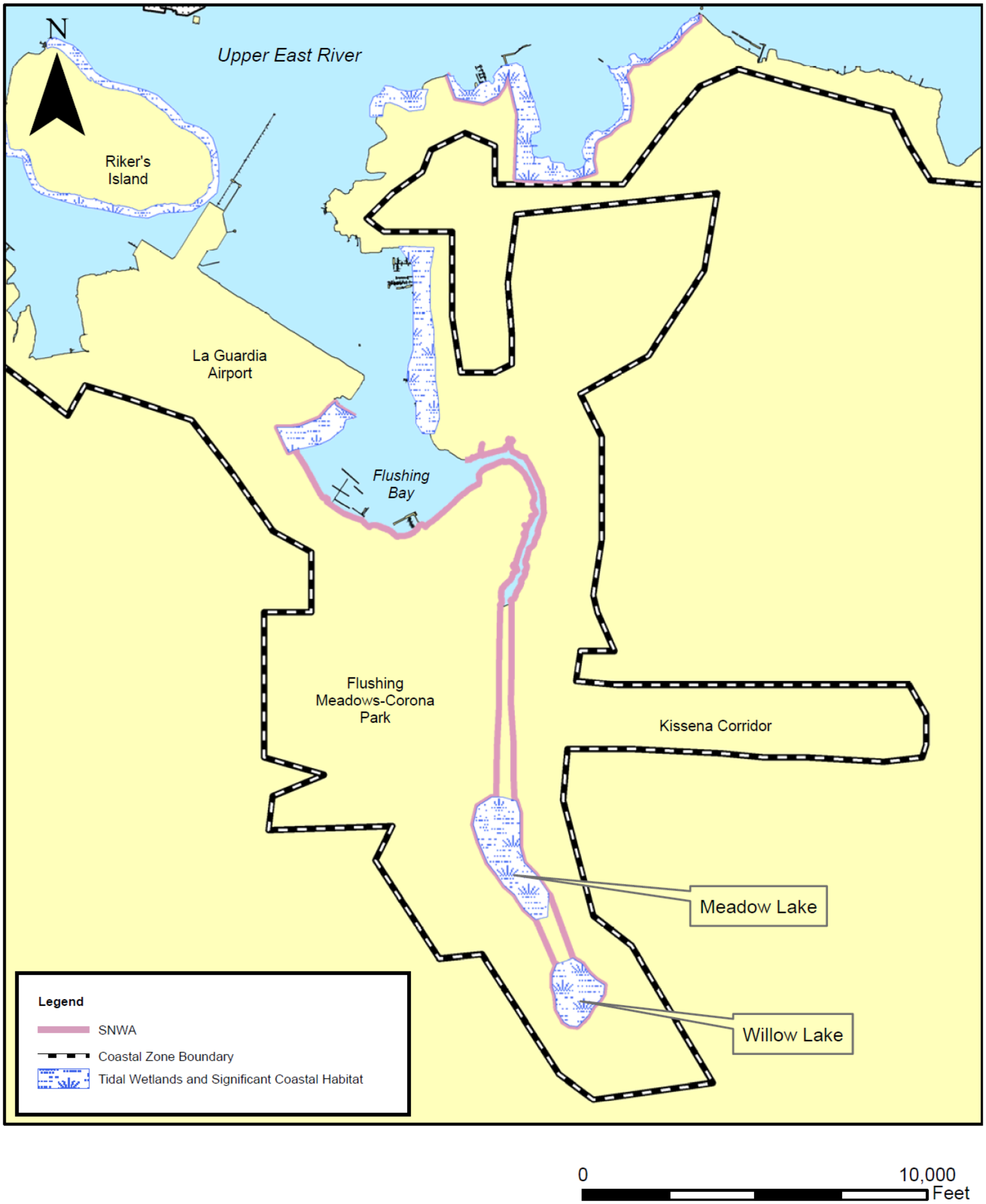
The WRP has designated the southwestern shoreline of Flushing Bay and all of Flushing Creek as Special Natural Waterfront Areas (SNWA) (See Figure 2-9). The designated area runs from just south of La Guardia Airport, southeast along the bay, around Flushing Creek and up the eastern shore to about 125th Street. Pockets of tidal wetlands exist throughout the bay including a strip of wetlands along College Point's western shore, while another pocket is located south of La Guardia Airport along much of the Flushing Bay Promenade. The existing and proposed future land uses for Flushing Bay are generally consistent with the intent and goals of the WRP and the recommendations made in the Plan for the Queens Waterfront and the New York City CWP.

2.3 REGULATED SHORELINE ACTIVITIES

An investigation of selected existing federal and state databases was performed to gather information on potential land-side sites and/or activities that have the potential to affect water quality in Flushing Bay. The extent of the study area was limited to the areas immediately adjacent to the mapped streets along Flushing Bay. For the purposes of this assessment, potential sites and activities included the existence of Underground Storage Tanks (UST), Major Oil Storage Facilities (MOSF), known contaminant spills, the existence of state or federal Superfund sites, the presence of SPDES permitted discharges to these waterbodies and other locations or activities that may have the potential to affect surface water quality.

2.3.1 USEPA and DEC Database Search Results

The USEPA Superfund Information System, which contains several databases with information on existing superfund sites, was accessed. These databases included: the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), the National Priorities List (NPL), Resource Conservation and Recovery Act Information (RCRAinfo) and the Brownfields Management System. In addition to these federal databases, several DEC databases were also reviewed. The DEC Spill Incident Database and the Environmental Site Remediation Database, which allows searches of the DEC Brownfield cleanup, state superfund (inactive hazardous waste disposal sites), environmental restoration and



NYC Environmental Protection

Flushing Bay
Special Natural Waterfront Areas

FIGURE 2-9

Voluntary Cleanup Programs (VCP) were also reviewed. In addition, an Environmental Data Records (EDR) DataMap Area Study report was performed for the study area. The EDR report was primarily reviewed to provide additional information with regard to UST, Leaking Storage Tanks (LTANKS) and MOSFs, which were not readily accessible within the aforementioned databases.

A review of the USEPA Superfund Information System indicated that there are no Superfund sites located in proximity to Flushing Bay. A review of the DEC State Superfund Program indicated that there is an inactive hazardous waste disposal site located south of 31st Avenue between 123rd and 124th Streets, approximately 1,000 feet east of Flushing Bay. The site is the former College Point Oil Lagoon that contained polychlorinated biphenyls (PCBs) contaminated oil, and water and sludge contaminated with oil and PCBs. A removal action was completed in 1980 and samples collected in 1989 confirmed that no hazardous wastes remain at the site and the site did not pose a significant threat to human health.

A review of the RCRA database indicated that there are three large quantity generators, 16 small quantity generators, seven conditionally exempt small quantity generators and seven unspecified sites located in close proximity to Flushing Bay. Under RCRA, a large quantity generator produces over 1,000 kilograms of hazardous waste or greater than one kilogram of acutely hazardous waste per month, while small quantity generators produce between 100 and 1,000 kilograms of waste per month. Conditionally exempt small quantity generators produce 100 kilograms or less per month of hazardous waste, or one kilogram or less per month of acutely hazardous waste. RCRA sites in proximity to Flushing Bay are listed in Table 2-1.

Table 2-1. RCRA Sites Located Near Flushing Bay (January 2006)

Large Quantity Generators	
Site Name	**Address**
Coastal Oil	31-70 College Point Boulevard
EDO Corporation	111-01 14th Avenue
La Guardia Airport	Flushing, NY
Small Quantity Generators	
Site Name	**Address**
Porex New York	109-15 14th Avenue
Pepsi Cola Bottling Company	117-02 15th Avenue
7Q86	116-11 15th Avenue
Queensboro Transformer Technology	115-25 15th Avenue
Traulsen & Company Incorporate	114-02 15th Street
Canada Dry Bottling Company	112-02 15th Avenue
Giles Varnish Company	109-09 15th Avenue
Sesco Industries Incorporated	110-19 15th Avenue
Queens Surface Corporation	122-16 31st Avenue
Queens North 7 Sanitation	120-15 31st Avenue
Queens County Asphalt	120-01 31st Avenue

Table 2-1. RCRA Sites Located Near Flushing Bay
(January 2006)

Mobil Oil Corp SS GP5	10702 Grand Central Parkway
Mobil Oil Corporation SS GQB	10801 Grand Central Parkway
Empire State Auto Corporation	127-04 Northern Boulevard
The Home Depot	124-04 31st Avenue
Continental Airlines	La Guardia Airport
Conditionally Exempt Small Quantity Generators	
Site Name	**Address**
Allegheny Airlines Incorporated	La Guardia Airport
American Airlines	La Guardia Airport
American Eagle Airlines	La Guardia Airport
Delta Airlines	La Guardia Airport
TSA at La Guardia Airport	La Guardia Airport
United Airlines	La Guardia Airport
US Airways	La Guardia Airport
Unspecified RCRA Sites	
Site Name	**Address**
AFSO La Guardia Airport	Runway 31 13 La Guardia Airport
Allied Aviation Service	La Guardia Airport
Eastern Airlines	La Guardia Airport
Jackson's Amoco	La Guardia Airport
Midway Airlines, Inc.	La Guardia Airport
Ogden Aviation Service Company of New York, Incorporated	La Guardia Airport
Signature Flight Support	La Guardia Airport

The DEC Petroleum Bulk Storage database identified eight USTs in the immediate vicinity of Flushing Bay. These sites contain USTs that are either in-service or closed. The storage capacities of these USTs ranged between 500 and 10,000 gallons. These store unleaded or leaded gasoline, diesel, No. 1, 2 or 4 fuel oil, or kerosene. The UST sites and additional information concerning these are presented in Table 2-2.

Table 2-2. USTs Located Near Flushing Bay
(January 2002)

Facility	Address	Tank Capacity (Gallons)	Product Stored	Number of Active Tanks	Status
Edgewater, LLC	11-01 14th Avenue	4,000 4,000	Unleaded Gasoline Diesel	1 1	In Service In Service
Atlantic Wire & Cable Corporation	119-01 15th Avenue	2,000	No. 1, 2 or 4 Fuel Oil	0	Closed - Removed
Angonoa Incorporated	115-05 15th Avenue	4,000	No. 1, 2 or 4 Fuel Oil	0	Either Closed - In Place or Closed - Removed

Table 2-2. USTs Located Near Flushing Bay (January 2002)

Facility	Address	Tank Capacity (Gallons)	Product Stored	Number of Active Tanks	Status
Traulsen & Company Incorporated	114-02 15th Avenue	2,000 3,000	No. 1, 2 or 4 Fuel Oil	0	Either Closed - In Place or Closed - Removed
Chilton Paint Company	109-09 15th Avenue	1,500	No. 1, 2 or 4 Fuel Oil	0	Closed - Removed
No Felco Realty Company	122-10 31st Avenue	4,000	No. 1, 2 or 4 Fuel Oil	0	Closed - In Place
Durante Brothers Construction Corporation	31-40 123rd Street	550	Diesel	0	Closed - Removed
D.O.T Central Repair Facility	32-11 Harper Street	1,000 4,000 500	Diesel Unleaded Gasoline Unleaded Gasoline	1 3 0	In Service In Service Closed - Removed

In addition, the MOSF database indicated one in service above ground storage tank located in proximity to Flushing Bay. Skaggs-Walsh, Inc., is located at 119-02 23rd Avenue and is an active above ground MOSF that stores approximately 100,000 gallons of No. 1, 2 or 4 fuel oil. This facility is located within 500 feet of Flushing Bay.

In addition, the LTANKS database, which identifies leaking underground storage tanks (LUST) or leaking above ground storage tanks, was reviewed and 16 leaking tank sites in proximity to Flushing Bay were identified. The tanks were reported to leak a variety of petroleum products including No. 2 fuel oil, diesel or unknown petroleum. These leaks were caused by tank test failures or tank failures. Of the 16 reported leaks, only two DEC leak files remain open in Flushing Bay. Table 2-3 summarizes the leaks that are still being investigated by DEC.

Table 2-3. Open LUST Sites Located Near Flushing Bay (October 2005)

Location	Date	DEC Spill Number	Quantity Released	Material Spilled	Cause
Harper Street Repair Shop DOT-DDC 32-11 Harper Street	07/10/1990	9003967	Not Specified	Diesel	Tank Test Failure
	10/08/2004	0407607	Not Specified	Diesel	Tank Test Failure

Review of the DEC SPILL databases indicated that there were 216 spills that have occurred within close proximity to Flushing Bay over the past 10 years. The majority of these spills affected soil. However, contamination of other media was also noted. In Flushing Bay, only 12 of these 216 spills remained open as of January 2006 and are listed in Table 2-4. The remaining open spill files resulted in the release of No. 2 or 4 fuel oil, jet fuel, auto waste fluids and/or gasoline into soil, ground waters or the municipal sewer system.

Table 2-4. DEC Open Spills in the Vicinity of Flushing Bay (January 2006)

Location	Date	Spill Number	Quantity (Gallons)	Material	Resource Affected	Spill Cause
Allied Aviation Services La Guardia Airport	12/16/1996	9611834	Not Reported	Jet Fuel	Groundwater	Equipment Failure
Manhole No. 2 31st Avenue, East of 120th Street	01/07/1999	9812442	2	Unknown Petroleum	Soil	Unknown
Durante Bros. Construction 31-40 123rd Street	09/13/1999	9907033	Not Reported	Diesel	Soil	Unknown
AA Auto Salvage 126-75 Willets Point Boulevard	09/27/2000	0007535	Not Reported	Other	Groundwater and Sewer	Other
Turbo Auto Sales, Inc. 127-18 Willets Point Boulevard	09/27/2000	0007569	Not Reported	Other	Soil	Unknown
18 Auto Parts, Inc. 127-40 Willet Point Boulevard	09/27/2000	0007542	Not Reported	Motor Oil	Soil	Unknown
Chepy Station, Inc. 127-61 Willets Point Boulevard	05/23/2000	0230007	Not Reported	Waste Oil/Used Oil	Soil	Deliberate
DSNY Queens 7 Garage 120-15 31st Avenue	11/27/2001	0108624	Not Reported	No. 2 Fuel Oil	Soil	Unknown
American Hangar 4 La Guardia Airport	11/25/2002	0208800	Not Reported	No. 4 Fuel Oil	Soil	Tank Test Failure
Post Office La Guardia Airport	06/24/2004	0403221	Not Reported	Unknown Petroleum	Soil	Unknown
Pepsi Cola Parking Lot 112-02 15th Avenue	01/03/2005	0410825	Not Reported	Unknown Petroleum	Soil	Unknown
Casey Stengel Depot 123-53 Willets Point Boulevard	08/02/2000	0005268	Not Reported	Motor Oil	Soil	Equipment Failure

According to the DEC Environmental Site Remediation database, there is one brownfield in the vicinity of Flushing Bay. Anchorage Marina, located at 20-08 119th Street is listed under the Brownfield Cleanup Program (BCP) for petroleum-based products that affected soil and groundwater resources. A Phase I Environmental Site Assessment and a Phase II investigation had been previously performed at the site. The EDO Corporation property, located at 111-01 14th Avenue, is listed under the VCP for cadmium and chromium present in soils and groundwater. Remediation of the site was completed and the source of the contamination was removed and replaced with clean backfill.

2.3.2 DEC Permitted Discharge

The results of a search of additional available environmental records indicated that there are two DEC SPDES permitted discharges located in Flushing Bay. The state permitted dischargers are Leffert's Oil Terminal, Inc. and La Guardia Airport. In addition, a review of the USEPA's Permit Compliance System (PCS) also identified Leffert's Oil Terminal, Inc. and La Guardia Airport as permitted discharges, as well as an additional regulated discharge, Tully Environmental, Inc.

2.3.3 Summary

A review of the available databases and the other information sources discussed above indicates that these potential sources of contamination may be associated with existing or previous combined sewer overflows.

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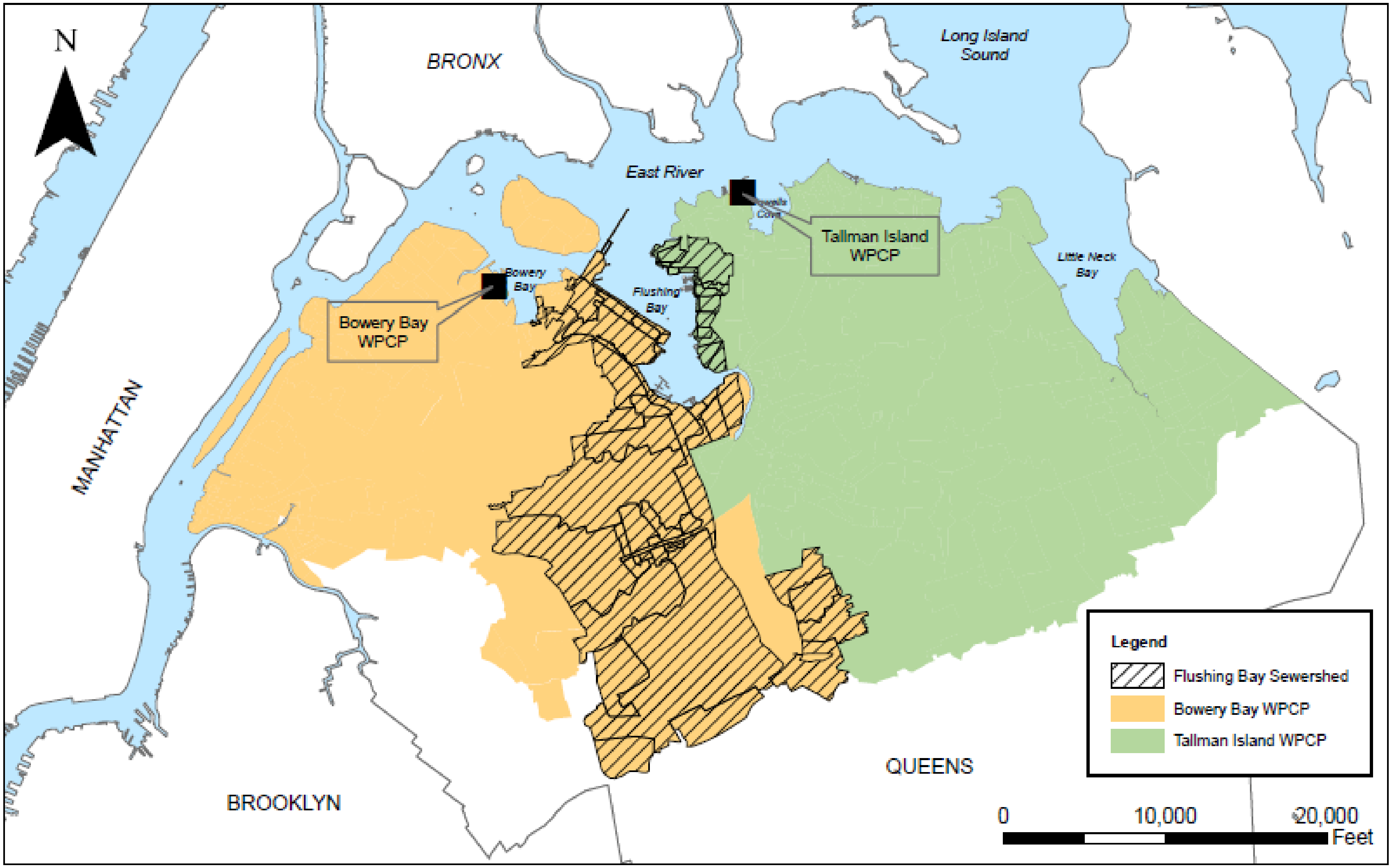
3.0 Existing Sewer System Facilities

Wastewater collection in the Flushing Bay watershed is accomplished by portions of two adjoining sewer service areas, one tributary to the Tallman Island WWTP on the east side of the bay, and the second tributary to the Bowery Bay WWTP on the west side of the bay. The location of these two wastewater treatment plants, and the respective sewershed boundaries, are depicted in Figure 3-1. The configuration of these two sewerage systems is described in the sections below.

3.1 TALLMAN ISLAND WWTP

The Tallman Island WWTP is permitted by the DEC under SPDES permit number NY-0026239. The facility is located at 127-01 134th Street, College Point, NY, 11356 in the College Point section of Queens, on a 31-acre site adjacent to Powells Cove, leading into the Upper East River, bounded by Powells Cove Boulevard. The Tallman Island WWTP serves an area of approximately 16,579 acres in the Northeast section of Queens, including the communities of Little Neck, Douglaston, Oakland Gardens, Bayside, Auburndale, Bay Terrace, Murray Hill, Fresh Meadows, Hillcrest, Utopia, Pomonok, Downtown Flushing, Malba, Beechhurst, Whitestone, College Point, and Queensboro Hill. The total sewer length, including sanitary, combined, and interceptor sewers, that feeds into the Tallman Island WWTP is 430 miles. The Tallman Island WWTP has been providing full secondary treatment since 1978. Processes include primary screening, raw sewage pumping, grit removal and primary settling, air activated sludge capable of operating in the step aeration mode, final settling, and chlorine disinfection. The Tallman Island WWTP has a design dry weather flow (DDWF) capacity of 80 million gallons per day (MGD), and is designed to receive a maximum flow of 160 MGD (2 times DDWF) with 120 MGD (1.5 times DDWF) receiving secondary treatment. Wet weather flows to the Tallman Island WWTP are limited to less than 2 times DDWF due to conveyance system limitations which are currently being addressed by DEP. The Tallman Island WWTP 2007 wet weather average sustained flow is 142 MGD. Flows over 120 MGD receive primary treatment and disinfection. The daily average flow during Fiscal Year 2008 was 58.3 MGD, with a dry weather flow average of 54.8 MGD (DEP, 2008). Table 3-1 summarizes the Tallman Island WWTP permit limits.



Environmental Protection

Flushing Bay Watershed and WWTP Service Areas

FIGURE 3-1

Table 3-1. Select Tallman Island WWTP SPDES Effluent Permit Limits

Parameter	Basis	Value	Units
Flow	DDWF Maximum secondary treatment Maximum primary treatment Actual average, FY2008	80 120 160 58.3	MGD
$CBOD_5$	Monthly average 7-day average	25 40	mg/L
TSS	Monthly average 7-day average	30 45	mg/L
Total Nitrogen[(1)]	12-month rolling average	101,075	lb/day

[(1)] Nitrogen limit for Combined East River Management zone, calculated as sum of discharges from four Upper East River WWTPs (Bowery Bay, Hunts Point, Wards Island, Tallman Island) and one quarter of discharges from 2 Lower East River WWTPs (Newtown Creek, Red Hook). This limit is effective through June 2010, then decreases stepwise until limit of 44,325 lb/day takes effect in 2017.

The original Tallman Island plant was designed in the early 1930s. The plant began operation to treat wastewater with a step aeration design capacity of 40 MGD in time for the 1939 World's Fair held at Flushing Meadows Park. The original plant was designed to serve an estimated 300,000 people. Several major expansions and upgrades were completed in 1964 (upgrade and expansion to 60 MGD) and 1979 (upgrade and expansion to 80 MGD). The Tallman Island WWTP is scheduled to undergo a construction upgrade program to address the facility's critical needs and to upgrade the aeration process to a basic step-feed BNR process. This includes the installation of baffles in each pass of the aeration tanks to create anoxic zones, submersible mixers in each anoxic zone to prevent solids settling, and froth-control chlorine spray hoods for filament suppression.

3.1.1 Tallman Island WWTP Process Information

Figure 3-2 shows the current layout of the Tallman Island WWTP. Wastewater from the Flushing Main Interceptor and Whitestone Interceptor discharges to a 7-foot by 7-foot combined sewer interceptor which conveys flow to the forebay of the Tallman Island WWTP. Upon entry to the screenings building, the flow passes through the four screening channels to the influent channel to the wet well. Each screening channel is provided with a hydraulically operated sluice gate used for channel isolation and throttling. There are four climber-type mechanical bar screens that are six feet wide with 1-inch openings. The screens are cleaned with a vertical climber rake and are designed to handle 53.3 MGD each providing for a capacity of 160 MGD with three channels open and three screens operating.

From the wet well, the plant design calls for main sewage pumps to transfer the flow into the discharge header. This part of the WWTP is currently undergoing major reconstruction and the configuration is now slightly different than originally designed. Influent pumps have temporarily been moved from the wet well and are now located downstream of the screens in the screening channels. The screening channels have also been reconfigured to provide for equalization of flow between the channels. There are now a total of eight submersible pumps in the four screening channels providing an influent pumping capacity of 120 MGD that are supplemented with an additional six pumps that provide an additional 60 MGD pumping capacity for wet weather. Upon completion of construction sometime around 2013, these temporary pumps will be removed and the five 60 MGD main sewage pumps will operate off the wet well level.

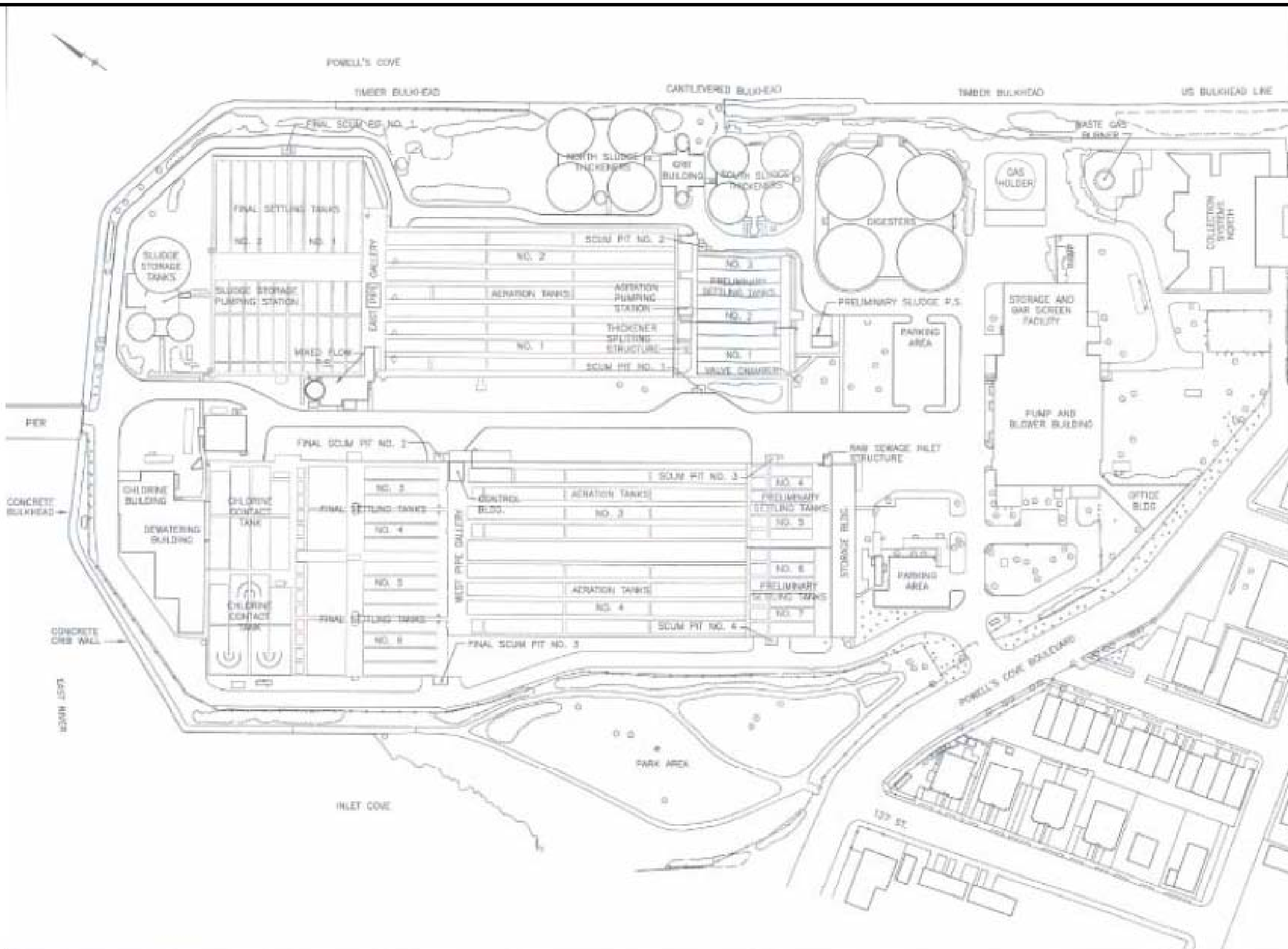
Two batteries of primary clarifiers are provided with three settling tanks in the east battery and four settling tanks in the west battery, giving seven primary settling tanks in total. Flow is distributed to the seven primary settling tanks through 24-inch by 24-inch sluice gates. Each settling tank has six sluice gates. Primary effluent flows over weirs at the end of each tank into the primary settling tanks effluent channel. Scum is removed from each tank by a manually operated rotating scum collector and is temporarily stored in four scum concentration pits prior to off-site disposal. Each rectangular clarifier includes three longitudinal chain and flight collectors and a chain flight cross collector to direct sludge to a sludge pit. The sludge is then pumped to the primary sludge degritters. The total volume of the primary settling tanks is 3.5 million gallons (MG) with a surface overflow rate of 2,073 gallons per day per square foot (gpd/sf) at average design flow.

From the primary settling tanks, primary effluent flows by gravity to the four aeration tanks for biological treatment; Tanks 1 and 2 in the east battery and Tanks 3 and 4 in the west battery. The total aeration tank volume is 14.8 MG and five engine-driven blowers at 20,100 standard cubic feet per minute (scfm) provide air to the aeration tanks through ceramic tube diffusers.

Aeration tank effluent is conveyed to the final settling tanks. The plant has a total of six final settling tanks. The east plant final settling tanks receive flow directly from the aeration tank effluent channel and are comprised of two rectangular tanks with five bays. Each bay has a chain and flight mechanism that directs sludge to a cross-collector channel. Cross-collectors direct the sludge to an airlift pump chamber. Return activated sludge (RAS) is conveyed back to the aeration tanks by four airlift pumps. Waste activated sludge (WAS) is drawn off from the airlift pump chamber to the mixed flow pumping station. Effluent from the east battery final settling tanks is directed to the chlorine contact tanks.

In the west plant, aeration tank effluent is discharged from the 48-inch diameter aeration tank effluent pipe. The west plant has two rectangular tanks, each with three bays, and two rectangular tanks, each with four bays. Each bay has a chain and flight mechanism that directs sludge to a cross-collector channel. Cross-collectors move the sludge to the airlift pit where RAS is pumped by four airlift pumps. WAS is removed by draw-off lines at waste sludge manholes. From the manholes, the WAS flows by gravity to the mixed flow pumping station. Effluent from the west battery final settling tanks is directed to the chlorine contact tanks.

The disinfection system consists of two 4-pass chlorine contact tanks, two sodium hypochlorite storage tanks, two metering pumps and an automated control system. Sodium hypochlorite solution is pumped to the influent through diffusers. The two tanks have a total volume of 2.16 MG and a detention time of 19.4 minutes at peak design flow. Chlorinated effluent is discharged to the East River. Primary sludge from both batteries is pumped through cyclone degritters to remove grit. The degritted sludge, along with WAS from the mixed flow pumping station, is discharged to the gravity thickeners. Grit flows to the grit classifiers/washers where the grit is washed and separated from liquid and stored in containers prior to off-site disposal.



Tallman Island WWTP
Site Layout
FIGURE 3-2

Environmental Protection

Two sets of four circular, conical-bottomed gravity thickeners are used for sludge thickening. The north gravity thickeners are 60 feet in diameter and the south gravity thickeners are 50 feet in diameter. Each thickener contains a picket-type stirring mechanism that aids thickening and directs sludge to the center pit where it is pumped to anaerobic digesters. For each thickener, two plunger pumps directly below the tank pump the sludge into the digester-heating loop.

Sludge is mixed within each digester by three draft tube mixers. To heat the digester contents, sludge is pumped from the digesters through external heat exchangers. Each digester has a dedicated heat exchanger. The main source of heat is the engine jacket cooling water system. Sludge is removed from each digester using four pipes at various depths and locations within the digester. The pipes are manifolded to four sludge transfer pumps. The pumps can either pump sludge to two of three storage tanks or return it to the digester for further digestion. Currently, the sludge is pumped from the storage tanks through two dedicated sludge pumps to two sludge centrifuges in the dewatering building. The dewatered sludge is then removed and trucked out of the plant. The centrate is returned to the head of the plant by gravity.

3.1.2 Tallman Island WWTP Wet Weather Operating Plan

DEP is required by its SPDES permit to maximize the treatment of combined sewage at the Tallman Island WWTP. The permit requires treatment of flows of up to 120 MGD through complete secondary treatment. Further, to maximize combined sewage treatment, the SPDES permit requires flows of up to 160 MGD to be processed through all elements of the WWTP except the aeration basins and the final settling clarifiers.

New York State requires the development of a Wet Weather Operating Plan (WWOP) as one of the 14 BMPs for collection systems that include combined sewers. The goal of the WWOP is to maximize flow to the WWTP, one of the nine elements of long-term CSO control planning. DEP has developed a WWOP for each of its 14 WWTPs. Table 3-2 summarizes the requirements for the Tallman Island WWTP, and notes that flows beyond the maximum capacity of the aeration basins and final clarifiers (i.e., over 120 MGD) would cause damage to the WWTP by creating washout of biological solids and clarifier flooding. The WWOP therefore suggests that the facility is operating at or near its maximum capacity as designed, configured and permitted by DEC. The WWOP for the Tallman Island WWTP dated July 2010 is attached as Appendix A.

Table 3-2. Wet Weather Operating Plan for Tallman Island WWTP

Unit Operation	General Protocols	Rationale
Influent Gates and Screens	Leave gate in automatic position until wet well capacity is hit, plant flow approaches 160 MGD, bar screens become overloaded, or conditions warrant going to manual (ex. high wet well levels could cause the gates to close under automatic operation). Maintain acceptable wet well level by throttling back on influent gates. Set additional screens into operation and set screen rakes to continuous operation in order to accommodate increased flow.	To protect the main sewage pumps from damage and allow the plant to pump the maximum flow through preliminary treatment without flooding bar screens, bar channels, screen room, and wet well.
Main Sewage Pumps	As wet well level rises, put off-line pumps in service and increase speed of pumps up to maximum capacity, leaving one pump out of service as standby.	Maximize flow to treatment plant and minimize need for flow storage in collection system and associated overflow from collection system into Long Island Sound.
Primary Settling Tanks	Check levels of primary tank influent channels and effluent weirs for flooding. Switch pumps in service as necessary.	Maximize the amount of flow that receives primary treatment, protect downstream processes from abnormal wear and solids overload/scum accumulation.
Bypass Channel	Visually monitor the bypass channel.	To relieve flow to the aeration system, avoid excessive loss of biological solids, relieve primary clarifier flooding, and prevent secondary system failure due to hydraulic overload.
Aeration Tanks	Keep all aeration tanks in operation using the step feed mode and adjust the airflow to maintain dissolved oxygen greater than 2 mg/L. Adjust wasting rates if necessary.	To maintain a desired solids inventory in the aerators.
Final Settling Tanks	In case of a longitudinal collection failure, maintain final tanks in service. Balance flows to the tanks to keep blanket levels even.	To prevent solids washout in the clarifiers.
Chlorination	Check, adjust, and raise the hypochlorite feed rates to maintain adequate residual.	Hypochlorite demand will increase as flow rises and secondary bypasses occur.
Sludge Handling	Proceed as normal.	Uninfluenced by wet weather.

3.1.3 Other Operational Constraints

DEC and DEP entered into a Nitrogen Control Consent Order that updated the New York City SPDES permits to reduce nitrogen discharges to the Long Island Sound and Jamaica Bay to reduce the occurrence of eutrophic conditions and improve attainment of dissolved oxygen numerical criteria. The Consent Order was partly a result of the Long Island Sound Study, which recommended a 58.5 percent load reduction of nitrogen discharge. The Consent Order specified process modifications at the four WWTPs that discharge into the Upper East River (Bowery Bay, Hunts Point, Tallman Island, Wards Island) and one of the WWTPs that discharge to Jamaica Bay (26th Ward) for nitrogen removal. "The Modified Phase I BNR Facility Plan for the Upper East River and the 26th Ward Water Pollution Control Plants" was prepared by DEP and submitted to DEC in 2005, and outlines the modifications necessary to upgrade these five

WWTPs. The critical BNR upgrade items for Phase I construction are as follows:

1. Aeration tank equipment modifications:
   - Baffles for the creation of anoxic/switch zones and pre-anoxic zones
   - Mixers in the anoxic zones

2. Process aeration system upgrades:
   - New blowers or retrofit of existing blowers
   - New diffusers (fine bubble)
   - Air distribution control equipment
   - Metering and dissolved oxygen (DO) monitoring and control

3. Return activated sludge (RAS) / Waste activated sludge (WAS) systems:
   - Expanded capacity or upgrade of existing RAS/WAS system, as applicable

4. Froth control system:
   - Implemented to prevent or control filamentous growth

5. Chemical addition facilities:
   - Sodium hypochlorite for froth control (RAS and surface chlorination)
   - Alkalinity addition for nitrification and pH buffering (except at Tallman Island)

DEP has agreed to perform interim measures during the Phase I construction period to make best efforts to reduce the levels of nitrogen being discharged into the East River. These measures include:

1. Wards Island Battery E additional upgrades:
   - Enhanced Flow Control in the Aeration Tanks
   - Supplemental carbon addition facilities
   - Additional baffles to enhance flow distribution and settling in final settling tanks

2. The SHARON Process will be constructed at Wards Island including:
   - Reactor tanks with both aerated and anoxic zones;
   - Influent centrate pumping station and controls;
   - Blowers and process air piping, distribution grid and diffusers;
   - Mixers for the denitrification zone;
   - Alkalinity storage and pumping station;
   - Supplemental carbon (methanol) storage and pumping station;
   - Recycle pumps;
   - Temperature control units; and
   - Electrical power substation.

3. Relocation of Bowery Bay and Tallman Island digested sludge and/or centrate via shipping with DEP marine vessels or contract services. The DEP can send this material to either a NYC facility or an out-of-city facility.

3.1.4 Upgrade of Tallman Island WWTP

The Tallman Island WWTP is scheduled to undergo a construction upgrade program to address the facility's critical needs and to upgrade the aeration process to a basic step-feed BNR process. This work is currently in progress and has a Consent Order completion date of December 31, 2010. DEP and the DEC are currently negotiating the Nitrogen Consent Judgment and the new proposed BNR construction completion date for TI is January 31, 2013

This section summarizes the major improvements to be implemented as part of the first phase of the Tallman Island WWTP Upgrade Program.

- Main Sewage Pumping Station – As noted above, the headworks of the WWTP is currently being reconstructed; existing main sewage pumps, suction, discharge piping and valves will be demolished and replaced with five new centrifugal-type pumps each capable of pumping 60 MGD. The facility will have the capability of pumping at least 160 MGD to the preliminary settling tanks during wet weather with three pumps in operation. During this work, a temporary pump around system has been installed in the influent channels following the primary screens. The temporary pumping system is capable of pumping a maximum flow of 120 MGD using the submersible pumps. The additional suction pumps located at the ends of the screening channels provide additional pumping capacity to bring the total flow to 160 MGD as needed. The existing conveyor system for the Main Influent Screens will be demolished and replaced in-kind. This work should no effect on the plant's ability to accept and treat wet weather flow.

  The Powell's Cove Pumping Station, located in the plant's Pump and Blower Building, will also be upgraded. The existing pumps and climber screen will be demolished and replaced with three new pumps each capable of pumping 4 MGD and a new climber screen. Temporary pumping units capable of handling the entire Powell's Cove Pumping Station flow will be provided during this phase of the work. As a result, this work will not impact the Plant's ability to accept and/or treat wet weather flow.

- Preliminary Tanks – The Preliminary Tanks at the Tallman Island WWTP will be provided with new flights and chains as part of this construction contract. During this work, only one preliminary tank at a time will be taken out-of-service. As a result, during this phase of the construction, the Tallman Island Preliminary Tanks should be able to process a maximum wet weather flow of 160 MGD without a reduction in permit performance.

- Aeration Tanks – The aeration tanks at the Tallman Island WWTP will be modified to provide basic step-feed BNR. Baffles will be added to allow for separation of anoxic and aerobic treatment zones. Mixers will be provided in the anoxic zones to maintain the suspension of biomass. A new aeration system including fine bubble diffusers will be provided along with new centrifugal process air blowers. The existing air header will be rehabilitated to reduce air losses and a new DO control system will be provided. The existing spray water system will be demolished and replaced with a new system capable of providing full tank coverage. New influent gates will be added to the aeration tanks to allow for uniform flow distribution to each pass. Automation will be provided to allow storm flow to be sent to Pass D of each aeration tank so as to prevent biomass washout. Two froth control hoods will be added in both Pass A and B of each aeration tank to limit the generation of filamentous froth. Surface wasting will also be provided to maintain the solids residence time (SRT) and prevent nocardia and foam accumulation. Centrate from the dewatering building will be conveyed to Pass A of the aeration tanks by gravity. As with the preliminary tank work, only one aeration tank will be taken out of service by the contractor at any time. As a result, the system should be capable of processing a wet-weather flow of 120 MGD for short durations without a significant effect on overall treatment performance.

- <u>RAS and WAS System</u> – New submersible RAS pumps will be added to the system with the capacity of 64 percent of design dry weather flow. RAS chlorination will be provided to prevent sludge bulking. Waste activated sludge (WAS) will be conveyed from Pass A to Pass B of the aeration tanks. Additional instrumentation will be provided to measure RAS flow and RAS total suspended solids (TSS) concentrations.

- <u>Gravity Thickeners</u> – The existing eight gravity thickeners will undergo complete rehabilitation. New mechanisms, drive units, over-flow piping and sludge pumps will be provided under this phase of the upgrade. Since six gravity thickeners are required by the plant at any time, the contractors will be allowed to upgrade two gravity thickeners at a time, without affecting the plant's ability to process wet weather flows.

- <u>Mixed Flow Pumping Station</u> – The existing pumps in the mixed flow pump station will be demolished and replaced. Due to the current space limitations, the pumps will be replaced in-kind with new pumps of the same capacity. As part of this upgrade, the spray water system will also be replaced. The capacity of the spray water system will be increased, but only to the extent possible within the existing footprint of the mixed flow pump station. Only one mixed flow pump will be taken out of service at any time. As a result, this work will not affect the plant's ability to treat wet weather flows.

- <u>Sludge Digestion and Storage</u> – The existing covers on the four digesters will be demolished and replaced. New gas piping will be provided from the digester tank covers to the gas compressor building. Gas compressors are required to mix the digester gas and boost the pressure for utilization in the engine drive units currently proposed to drive the main sewage pumps and process air blowers. New piping will be provided from the digester sludge transfer pumps to the existing sludge storage tanks located near the dewatering building.

- <u>Miscellaneous Upgrade Improvements</u> – Miscellaneous improvements included in this phase of the plant upgrade will include the rehabilitation of the existing boiler plant, the replacement of the existing grit cyclones and classifiers in kind and the addition of temporary personnel facilities including lockers, showers and administration area.

Concurrent with the BNR upgrades, the DEP will continue to perform upgrade work as part of the Plant Upgrade Program at the Upper East River WWTPs and the 26th Ward WWTP. Plant upgrades are required to stabilize or replace equipment that has reached its intended design life to ensure reliable plant performance that is in compliance with the existing SPDES permits for each WWTP.

3.2 BOWERY BAY WWTP

The Bowery Bay WWTP is permitted by the DEC under SPDES permit number NY-0026158. The facility is located at 43-01 Berrian Blvd., Astoria, NY, 11105 in the Astoria section of Queens, on a 34.6 acre site adjacent to the Rikers Island Channel, leading into the Upper East River, bounded by Berrian Blvd. and Steinway Street. The Bowery Bay WWTP serves an area of approximately 14,089 acres in the Northwest section of Queens, including the communities of Kew Garden Hills, Rego Park, Forest Hills, Forest Hills Gardens, North Corona, South Corona, Lefrak City, Elmhurst, East Elmhurst, Jackson Heights, Maspeth, Woodside, Sunnyside Gardens, Sunnyside, Hunters Point, Long Island City, Astoria, Astoria Heights, Steinway, Ravenswood, and Roosevelt Island. The total sewer length, including sanitary, combined, and interceptor sewers, that feeds into the Bowery Bay WWTP is 398 miles. The Bowery Bay WWTP has been providing full secondary treatment since 1978. Processes include primary screening, raw sewage pumping, grit removal and primary settling, air activated sludge capable of operating in the step aeration mode, final settling, and chlorine disinfection. The Bowery Bay WWTP has a DDWF capacity of 150 MGD, and is designed to receive a maximum flow of 300 MGD (2 times DDWF) with 225 MGD (1.5 times DDWF) receiving secondary treatment as required by the SPDES permit. Flows over 225 MGD receive primary treatment and disinfection. The daily average flow during Fiscal Year 2008 was 104.7 MGD, with a dry weather flow average of 94.9 MGD. Table 3-3 summarizes the Bowery Bay WWTP permit limits.

Table 3-3. Select Bowery Bay WWTP SPDES Effluent Permit Limits

Parameter	Basis	Value	Units
Flow	DDWF Maximum secondary treatment Maximum primary treatment Actual average, FY2008	150 225 300 105	MGD
$CBOD_5$	Monthly average 7-day average	25 40	mg/L
TSS	Monthly average 7-day average	30 45	mg/L
Total Nitrogen (1)	12-month rolling average	101,075	lb/day

(1) Nitrogen limit for the Combined East River Management zone, calculated as the sum of the discharges from the four Upper East River WWTPs (Bowery Bay, Hunts Point, Wards Island, Tallman Island) and one quarter of the discharges from the 2 Lower East River WWTPs (Newtown Creek, Red Hook). This limit is effective through June 2010, then decreases stepwise until the limit of 44,325 lb/day takes effect in 2017.

The Bowery Bay plant went into operation in 1939 as a 40 MGD primary treatment plant and has undergone a series of upgrades and expansions since that time. In 1940, secondary treatment was implemented using the step aeration process. In 1954, the plant's capacity was increased to 120 MGD and then again in 1971 to 150 MGD. In 1991, sludge dewatering facilities were added. In December 1999, construction was completed for the Basic Step Feed

BNR retrofit at Bowery Bay. This included the installation of baffles in each pass of the aeration tanks to create anoxic zones, submersible mixers in each anoxic zone to prevent solids settling, froth-control chlorine spray hoods for filament suppression, and fine bubble membrane diffusers to provide necessary oxygen transfer rates. Currently, Bowery Bay is undergoing upgrades to replace and refurbish aged and outdated facilities and provide additional biological nutrient removal capability.

3.2.1 Bowery Bay WWTP Process Information

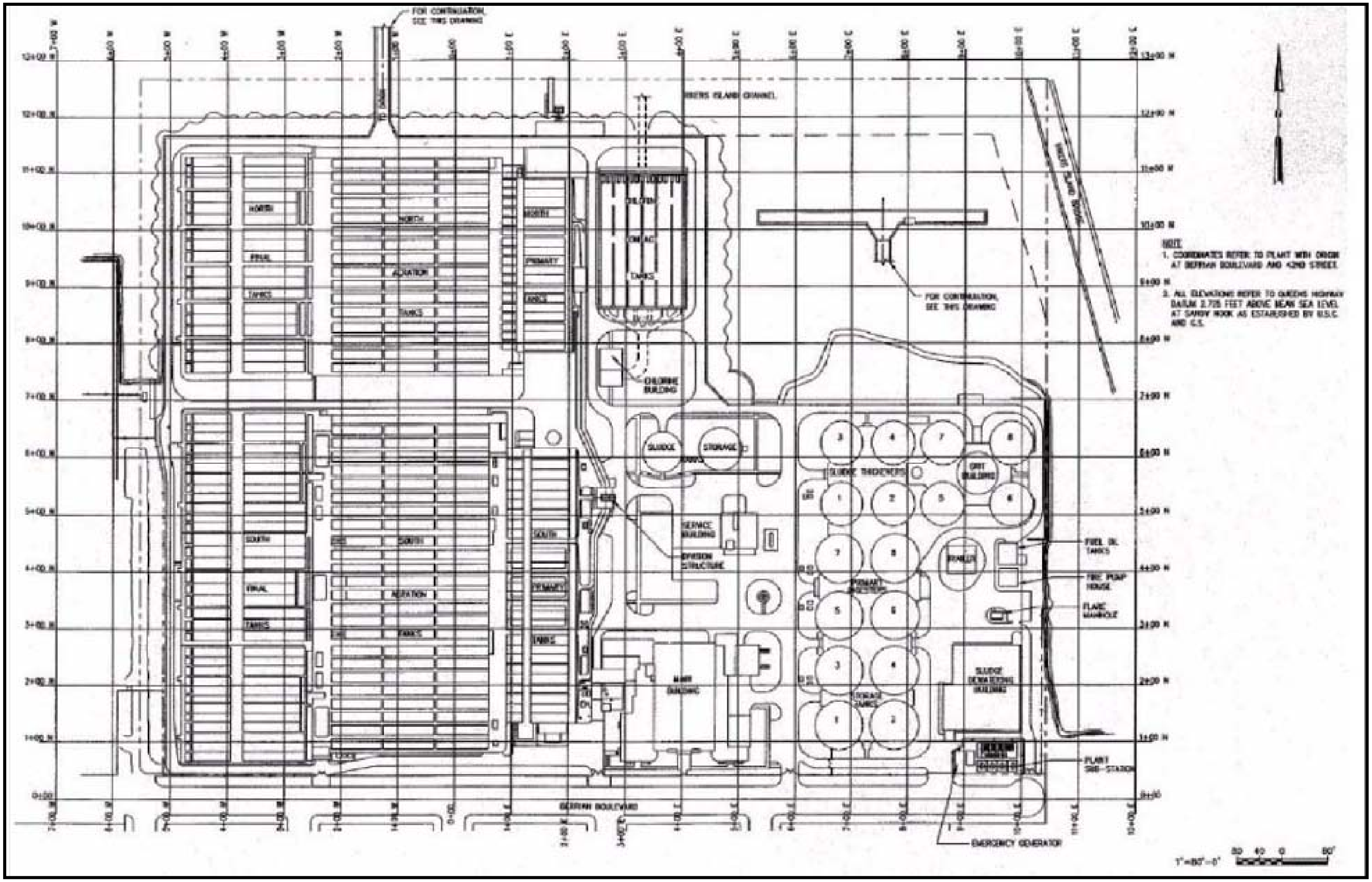
Figure 3-3 shows the current layout of the Bowery Bay WWTP. Two interceptors deliver flow to the Bowery Bay WWTP. The low level interceptor is a 96-inch sewer that enters the low level screening chamber. The high level interceptor is a 9-foot by 9-foot sewer that enters the high level screening chamber. There are three low level screens, each four feet wide with 1-inch openings, which are cleaned with a vertical climber rake. Each of the low level screens is designed to handle 47 MGD. There are also three high level screens, each seven feet wide with 1-inch openings, which are also cleaned with a vertical climber rake. Each of the high level screens is designed to handle 53 MGD.

After the interceptor flow enters the plant and passes through the screening channels, it proceeds to the high and low level wet wells. The low level pumps draw flow from the low level wet well via a 36-inch suction line. Discharge from each low level pump is via a 36-inch line that includes a cone check valve and gate valve. The low level pump system has four vertical, centrifugal, mixed-flow, bottom suction, flooded suction main sewage pumps, rated at 47 MGD each, at a total dynamic head of 62 feet. These pumps are in the process of being replaced by 75 MGD pumps with a total dynamic head of 72 feet.

The high level pumps draw flow from the high level wet well via a 36-inch suction line. Discharge from each high level pump is via a 36-inch line that includes a cone check valve and gate valve. The high level pump system has four vertical, centrifugal, mixed-flow, bottom suction, flooded suction main sewage pumps, rated at 53 MGD each, at a total dynamic head of 38 feet. These pumps are in the process of being replaced by 75 MGD pumps with a total dynamic head of 42 feet.

Each low and high-level pump discharges into a line connected to the low and high discharge headers which convey raw sewage to the primary settling tank distribution chamber. The primary settling tank distribution chamber splits into five distribution channels with each chamber having a secondary screen. The secondary screens are 5 feet wide with 1/2-inch openings. Each screen operates continuously and is cleaned on a timed cycle with a climber rake.

Flow is divided into two process chains, identified as the north battery and the south battery (See Figure 3-3). Secondary screen effluent is conveyed to the 15 primary settling tanks, nine of which are in the south battery and six in the north battery. All tanks are three-bay, end-collection, rectangular clarifiers. Sludge is directed along the tank bottom to the cross collector located at the influent end of the tank by chain and flight collectors. A single cross collector then conveys sludge to the draw off sump where it is withdrawn by pump suction to cyclone degritters. The total volume of the primary settling tanks is 8.1 MG with a surface overflow rate of 1,613 gpd/sf at average design flow.



Environmental Protection

Bowery Bay WWTP
Site Layout
FIGURE 3-3

Primary tank effluent is conveyed to the aeration tanks in a primary effluent channel. Ten 4-pass aeration tanks provide biological treatment; six in the south battery and four in the north battery. The total aeration tank volume is 25.2 MG. There are eight aeration blowers, four at 24,000 scfm and four at 22,000 scfm, providing air to the aeration tanks through membrane diffusers.

Aeration tank effluent is conveyed to the 17 final settling tanks, eleven in the south battery and six in the north battery. All tanks are three-bay, center-collection, rectangular clarifiers. Sludge is directed along the tank bottom to the cross collector located past midway of the tank from both the influent end and the effluent end by chain and flight collectors. A single cross collector then conveys sludge to the draw off sump where a hydrostatic lift conveys the sludge to a RAS well. Each final settling tank has a telescoping valve to control RAS rate located in the sludge well.

Final settling tank effluent is conveyed to the three chlorine contact tanks in the final settling tank effluent channel. The three chlorine contact tanks have a total volume of 3.27 MG and a detention time of 15.7 minutes at the peak design flow rate of 300 MGD. Chlorinated effluent is discharged through the Rikers Island Channel to the Upper East River. Primary sludge is degritted in cyclones and screened before entering the mixed sludge pump station. Waste activated sludge is withdrawn from the aeration tank overflow or from the final settling tank underflow and also enters the mixed sludge pump station. The combined mixed sludge is thickened in a set of eight gravity thickeners, with a total volume of 2.9 MG. The design overflow rate for the eight thickeners is 800 gpd/sf and the design solids loading rate is 7.7 lb/ft^2-day at average flow conditions.

Thickener overflow is returned to the division structure, upstream of the primary settling tanks and thickened sludge is stabilized in a set of six anaerobic digesters. Four digesters are used as primary digesters and two are designed to operate as secondary digesters. However, the two secondary digesters are currently being used as sludge storage tanks. The anaerobic digesters are heated and mixed. Digested sludge is stored in four sludge storage tanks. Digested sludge is dewatered by centrifuges and the dewatered sludge cake is hauled to heat dryers or landfills. Centrate produced from Bowery Bay's anaerobically digested sludge is transported via vessel to the North River WWTP until the completion of the BB-59 contract, expected January 2012.

3.2.2 Bowery Bay WWTP Wet Weather Operating Plan

DEP is required by its SPDES permit to maximize the treatment of combined sewage at the Bowery Bay WWTP. The permit requires treatment of flows of up to 225 MGD through complete secondary treatment. Further, to maximize combined sewage treatment, the SPDES permit requires flows of up to 300 MGD to be processed through all elements of the WWTP except the aeration basins and the final settling clarifiers.

New York State requires the development of a Wet Weather Operating Plan (WWOP) as one of the 14 BMPs for collection systems that include combined sewers. The goal of the WWOP is to maximize flow to the WWTP, one of the nine elements of long-term CSO control planning. DEP has developed a WWOP for each of its 14 WWTPs, and Table 3-4 summarizes the requirements for the Bowery Bay WWTP, and notes that flows beyond the maximum capacity of the aeration basins and final clarifiers (i.e., over 300 MGD) would cause damage to the WWTP by creating washout of biological solids and clarifier flooding. The WWOP therefore suggests that the facility is operating at or near its maximum capacity as designed, configured and permitted by the DEC. The WWOP for Bowery Bay was submitted to the DEC in March 2009 as required by the SPDES and is attached as Appendix B.

Table 3-4. Wet Weather Operating Plan for Bowery Bay WWTP

Unit Operation	General Protocols	Rationale
Influent Gates and Screens	Maintain wet well level and visually monitor screens for overflow. If screen blinding occurs, close the influent sluice gate until the screen clears.	To protect the main sewage pumps from damage and allow the plant to pump the maximum flow through primary treatment without flooding high/low level wet wells and the high level or bar screen channels.
Main Sewage Pumps	Maintain wet well level by adjusting/adding main sewage pumps and pump to maximum capacity.	To allow the plant to pump the maximum flow through primary treatment without flooding and to minimize the need for flow storage in the collection system and reduce the storm sewer overflows to the East River.
Primary Settling Tanks	Check levels of primary tank influent channel and effluent weirs for flooding. Reduce flow if necessary.	Maximize the amount of flow that receives primary treatment, protect downstream processes from abnormal wear due to grit abrasion, and prevent grit and grease accumulation in the aeration tanks.
Bypass Channel	When flow reaches 225 MGD, fully open the South Bypass Control Gate and bypass flow around aeration tanks into chlorination. The actual flow that can be bypassed may be lower in order to protect the nitrogen treatment biomass. If flow meter fails, use temporary measurement ruler installed on the wall and convert the inches of water into MGD based on the chart provided.	To maximize the flow that receives primary treatment, chlorination, and secondary treatment without causing nitrification failure, hydraulic failure, or violations.
Aeration Tanks	Adjust/shut off wasting rates and shut off froth hoods.	To maintain a desired solids inventory in the aerators. Also, spray hoods are not effective during wet weather events.
Final Settling Tanks	Check sludge collectors, effluent quality, RAS bell weirs, and RAS pump flow rate.	To prevent solids build-up and washout in the clarifiers.
Chlorination	Adjust chlorine dose as flow increases. When a sixth main sewage pump is started, increase the chlorine dose in anticipation of bypassed flow.	To meet the elevated chlorine residual demand from additional flow and from bypassed flow that has only received primary treatment.
Sludge Handling	No changes are currently made to the thickening operations during wet weather events.	To prevent flooding of the thickener overflow weirs.

3.2.3 Other Bowery Bay WWTP Operational Constraints

The DEC and the DEP entered into a Nitrogen Control Consent Order that updated the New York City SPDES permits to reduce their nitrogen discharge. The Consent Order was partly a result of the Long Island Sound Study, which determined that a 58.5 percent load reduction of nitrogen discharge would be needed to meet their water quality standards.

A Phase I Modified BNR Facility Plan, which outlines the DEP modified nitrogen program to upgrade five of its WWTPs that discharge into the Upper East River (Bowery Bay, Hunts Point, Tallman Island, Wards Island) and Jamaica Bay (26th Ward) for nitrogen removal, has agreed upon and was executed on February 1, 2006. The critical BNR upgrade items for Phase I construction at all five of the plants are as follows:

1. Aeration tank equipment modifications:
   - Baffles for the creation of anoxic/switch zones and pre-anoxic zones
   - Mixers in the anoxic zones

2. Process aeration system upgrades:
   - New blowers or retrofit of existing blowers
   - New diffusers (fine bubble)
   - Air distribution control equipment
   - Metering and DO monitoring and control

3. RAS/WAS systems:
   - Expanded capacity or upgrade of existing RAS/WAS system, as applicable

4. Froth control system:
   - Implemented to prevent or control filamentous growth

5. Chemical addition facilities:
   - Sodium hypochlorite for froth control (RAS and surface chlorination)
   - Alkalinity addition for nitrification and pH buffering (not at Tallman Island)

6. Final settling tanks (Upgrades implemented on a plant specific basis):
   - Maximize solids removal
   - Allow for increased RAS flow requirements
   - Handle higher solids loading from the aeration tanks

DEP is also required to perform interim measures during the Phase I construction period to reduce the levels of nitrogen being discharged into the East River. At the Bowery Bay and Tallman Island WWTPs these measures include transport of digested sludge and/or centrate for processing at another DEP WWTP or an out-of-city facility via shipping with DEP marine vessels or contract services. This requirement to transship is effective beginning July 1, 2009 through the end of Phase I BNR construction.

Phase II upgrades are also a part of the agreed-upon Nitrogen Facility Plan. The Phase II plan was submitted to DEC on December 31, 2009. A major component of Phase II upgrades is expected to be supplemental carbon addition facilities to promote denitrification and further reduce nitrogen discharges into the Upper East River. Phase II upgrades are projected to be online by January 1, 2016.

Concurrently with the BNR upgrades, the DEP will continue to perform upgrade work as part of the Plant Upgrade Program at the Upper East River WWTPs and the 26th Ward WWTP. Plant upgrades are required to stabilize or replace equipment that has reached its intended design life to ensure reliable plant performance that is in compliance with the existing SPDES permits for each WWTP.

3.3 TALLMAN ISLAND COLLECTION SYSTEM

The Tallman Island sewershed is comprised of both sanitary and combined sewersheds, as shown in Figure 3-4 and summarized below in Table 3-5.

Table 3-5. Tallman Island WWTP Drainage Area: Acreage Per Sewer Category

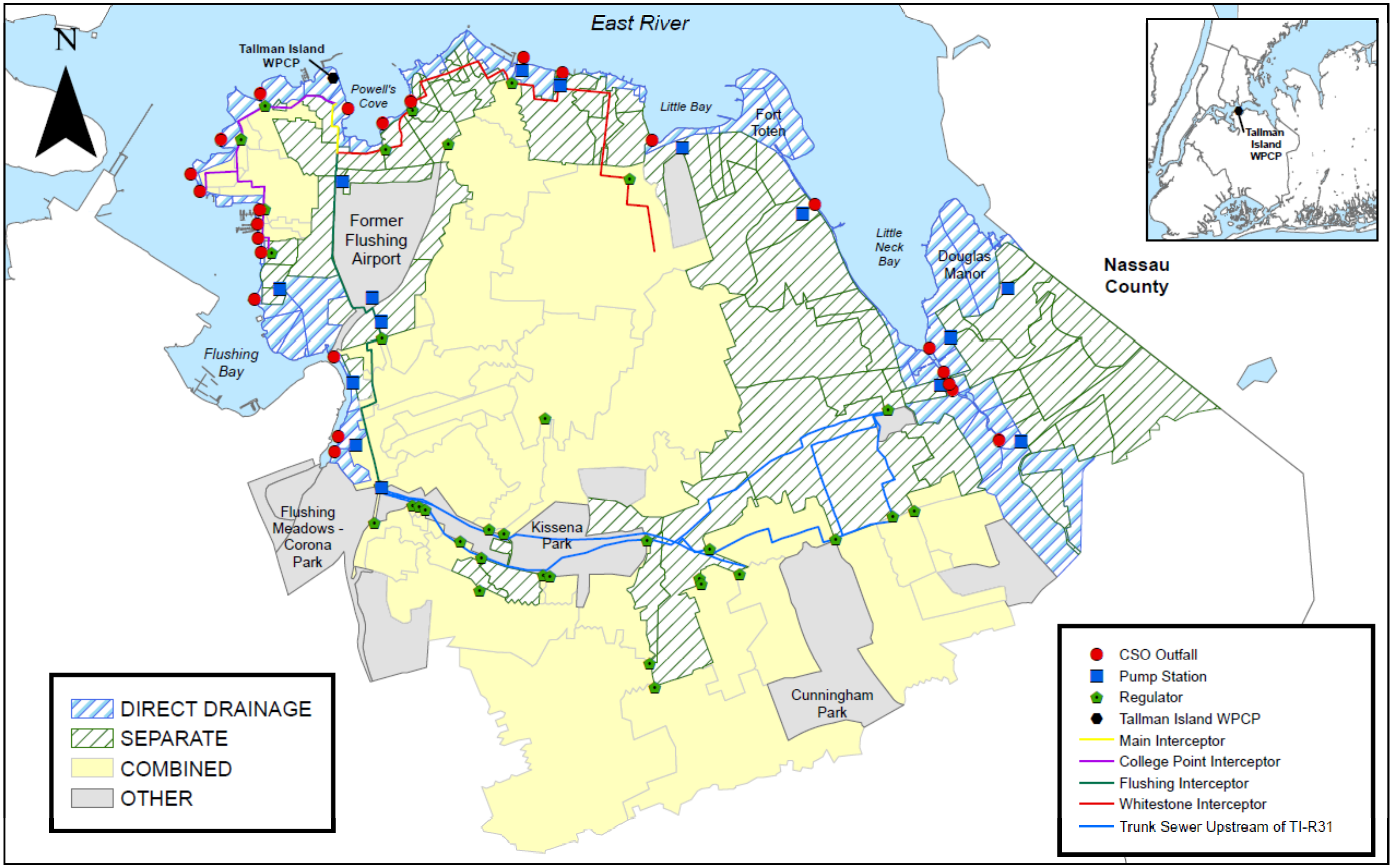
Sewer Area Description	Area (acres)
Combined	**8,032**
Separate Fully separated Watershed separately sewered, but with sanitary sewage subsequently flowing into a combined interceptor, and stormwater subsequently flowing into either a combined interceptor or a receiving water.	**4,893** (610 acres) (4,283 acres)
Other[1]	**2,171**
Total	**15,069**

[1] See Section 3.3.3 and Figure 3-4 for a description and the locations of "other" areas in the Tallman Island drainage area. Direct drainage areas (1,483 acres) are not included because they do not contribute stormwater to the Tallman Island WWTP. The direct drainage areas were, however, modeled to determine runoff values that can be used with typical pollutant loadings for estimating the effect of these land areas on water quality.

The Tallman Island WWTP collection system includes 430 miles of combined and sanitary sewers and interceptors varying in size from 10-inch diameter street laterals to 13-foot by 6-foot trunk and interceptor sewers. There are four principal interceptors in the collection system: the Main Interceptor, the College Point Interceptor, the Flushing Interceptor, and the Whitestone Interceptor.

- The Main Interceptor is directly tributary to the Tallman Island WWTP, and picks up flow from the other three interceptors.

- The College Point Interceptor, which carries flow from sewersheds to the west of the treatment plant, discharges into the Powells Cove Pump Station, which discharges into the Main Interceptor.



NYC Environmental Protection

Flushing Bay Waterbody/Watershed Facility Plan

Tallman Island Sewersheds

FIGURE 3-4

- The Whitestone Interceptor discharges to the Main Interceptor shortly upstream of College Point input, via gravity discharge. The Whitestone conveys flow from the area east of the treatment plant along the East River.

- The Flushing Interceptor can be considered an extension of the Main Interceptor south of the Whitestone connection and serves most of the areas to the south in the system. The Flushing Interceptor also picks up flow from the southeast areas of the system, along the Kissena Corridor (via trunk sewers upstream of the TI-R31 regulator) and from the Douglaston area east of Alley Creek.

These principal sewers are mapped in Figure 3-5 and depicted schematically in Figure 3-6. Summary statistics for the interceptor drainage areas are shown in Table 3-6. Other components of the system, also shown in Figures 3-5 and 3-6, include the following:

- Sixteen pumping stations, five serving combined system areas, as listed in Table 3-7

- Forty-nine combined sewer flow regulator structures (six of which discharge to outfalls in Flushing Bay), as listed in Table 3-8

- A total of 24 CSO discharge outfalls (two of which are permanently bulkheaded). Of these 24 outfalls, seven discharge to Flushing Bay, as listed in Table 3-9. The pump station bypasses are for emergency relief and do not activate under normal operating conditions.

The Powell's Cove Pump Station is a separate pump station at the Tallman Island WWTP which receives flow from approximately 375 acres in College Point. This flow is conveyed to the plant via the 36-inch College Point Interceptor sewer. The pump station consists of three vertical centrifuge pumps with a total capacity of 9.3 MGD with two pumps online and a single, manually cleaned bar screen. The Powell's Cove Pump Station discharges to the Flushing Main Interceptor which discharges to the headworks of the plant.

Table 3-6. Tallman Island WWTP Interceptor Drainage Areas

Interceptor	Length (feet)	Total Area (acres)	Combined (acres)	Separate (acres)
Main *(receives flow from Flushing and Whitestone interceptors)*	2,238	76	0	76
Flushing *(receives flow from areas downstream and upstream of TI-R31 and from Old Douglaston Pump Station)*	79,422	10,001	6,616	3,385
Flushing downstream of TI-R31	*15,507*	*1,387*	*974*	*413*
Trunk Sewers upstream Of TI-R31	*63,915*	*7,274*	*5,512*	*1,761*
Old Douglaston Pump Station (upstream of Trunk Sewers)	*N/A*	*1,340*	*130*	*1,210*
College Point	12,744	375	310	66
Whitestone	23,104	2,473	1,106	1,367
Interceptor Subtotal	117,508	12,925	8,032	4,893
Other[(1)]	N/A	2,171	0	0

Table 3-6. Tallman Island WWTP Interceptor Drainage Areas

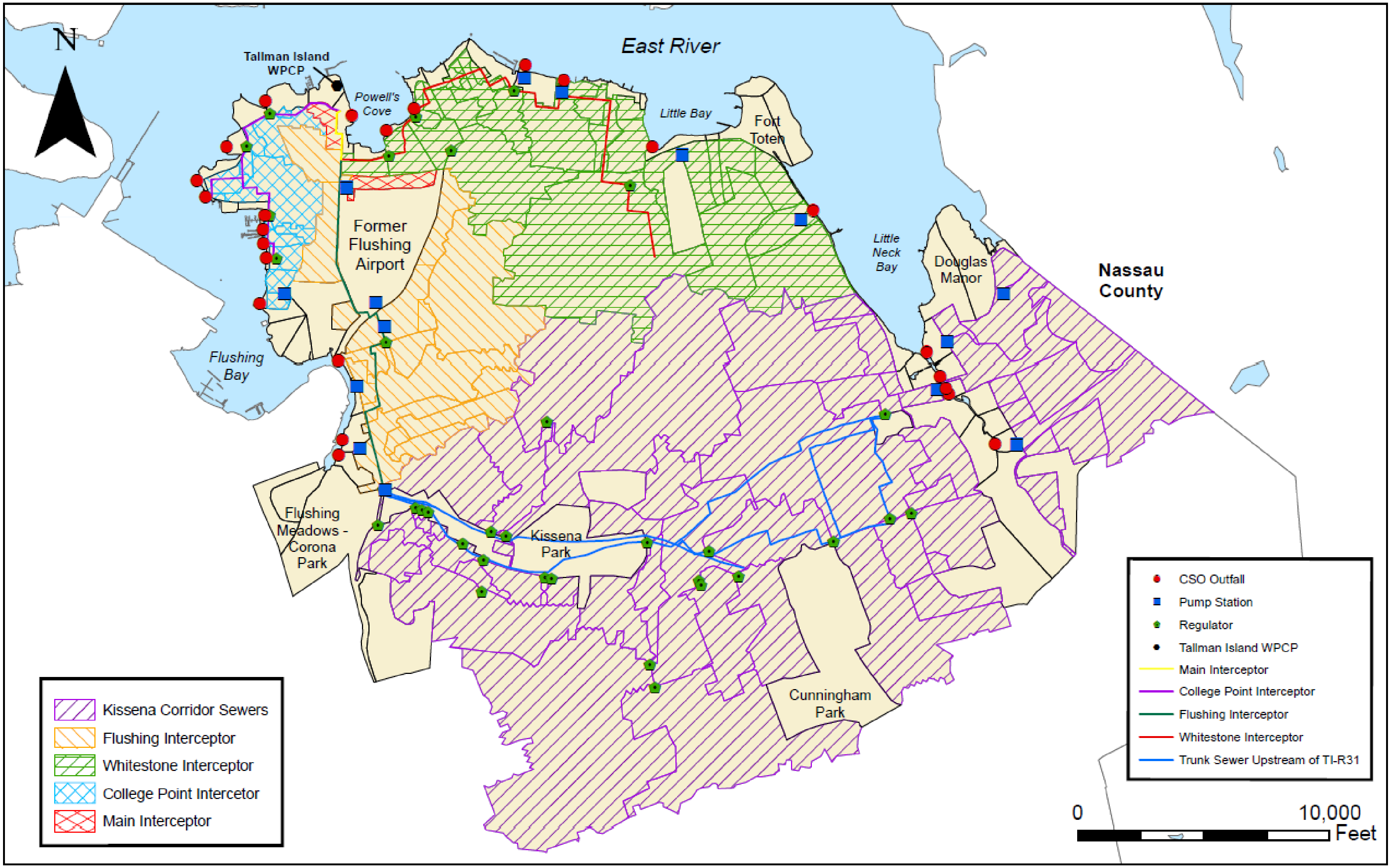
Interceptor	Length (feet)	Total Area (acres)	Combined (acres)	Separate (acres)
Total Tallman Island WWTP Drainage Area	**117,508**	**15,096**	**8,032**	**4,893**

(1) See Section 3.3.3 and Figure 3-4 for a description and the locations of "other" areas in the Tallman Island drainage area. Direct drainage areas (1,483 acres) are not included

Table 3-7. Tallman Island WWTP Collection System Pump Stations

Pump Station Name	Address	Type	Cap. (MGD)	DWF (MGD)	No. of Pumps	Bypass Outfall	Associated Interceptor
Lawrence & Peck	50-01 College Pt. Blvd.	Com.	14.00	7.10	3	None	Flushing
40th Road	40th Rd, West of College Pt. Blvd	San.	2.00	0.40	2	None	Flushing
Flushing Bridge	Lawrence St. & Northern Blvd.	San.	1.20	0.18	2	None	Flushing
Linden Place	Linden Pl/31st Rd.	Com.	5.00	1.89	3	None	Flushing
New York Times	Whitestone Exp. & Linden Place	San.	0.64		2	None	Flushing
122nd Street	122 St. & 28 Ave.	San.	1.50	0.31	2	TI-012; Flushing Creek	College Point
15th Avenue	15 Ave. & 131 St.	San.	2.90	0.22	2	None	Flushing
6th Road	6th Rd & 151 St.	San.	0.72	0.40	2	None	Whitestone
154th Street	Powells Cove Blvd. & 154 St.	Com.	2.30	0.61	3	None	Whitestone
Clearview	Willets Pt. Blvd, Cross-Isl. Pkwy	Com.	13.00	1.87	3	None	Whitestone
24th Avenue	24th Ave & 217th St.	San.	4.30	0.75	2	TI-006; Little Neck Bay	Whitestone
Little Neck	40th Ave. & 248th St	San.	1.40	0.26	2	None	Flushing (via Old Douglaston PS)
Douglaston Bay	41st Ave & 233rd St.	San.	1.00	0.07	2	TI-009; Alley Creek	Flushing (via Old Douglaston PS)
Old Douglaston	Parkland, Northern Blvd & 234 St.	San.[1]	6.50	2.00	3	TI-007; Alley Creek	Flushing
New Douglaston	Parkland, North of LI Expressway, Cross-Isl. Pkwy	San.	3.30	0.34	2	TI-024; Alley Creek	Flushing (via Old Douglaston PS)
Powells Cove	Influent PS at WWTP[2]	Com.	9.3	1.00	3	None	WWTP[(1)]

(1) Flow through the Old Douglaston Pump Station will be combined sewerage after the Alley Creek CSO Tank is operational.
(2) The Powells Cove Pump Station receives flow from the College Point Interceptor and pumps to the Main Interceptor. It is located on the WWTP site.

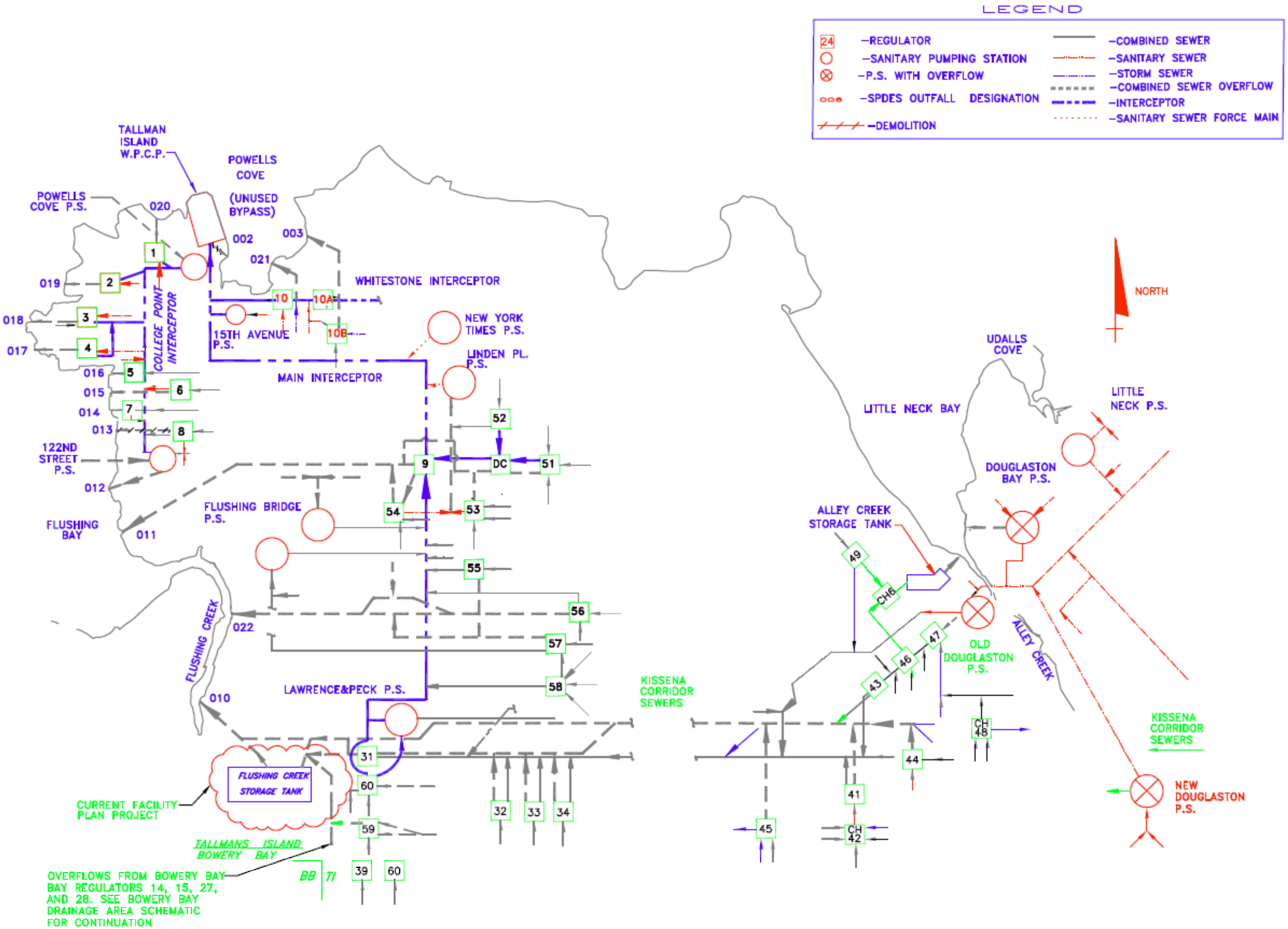


NYC Environmental Protection

Flushing Bay Waterbody/Watershed Facility Plan

Tallman Island Principal Sewers

FIGURE 3-5



Tallman Island Sewer System Schematic

FIGURE 3-6

Table 3-8. Tallman Island WWTP Collection System Regulators

	Reg. ID	Location	Outfall	Flow Compartment	Elev
College Point Interceptor					
	TI-R01	College Point & 5th Ave	020	10"x10"	+ 0.47
	TI-R02	115th St & 9th Ave (Former WWTP bypass to outfall TI-019, currently bulkheaded)			
	TI-R03	110th St & 14th Ave	018	Double 8"x 8"	- 0.75
	TI-R04	110th St & 15th Ave	017	Double 8"Dia	+ 0.35
	TI-R05	119th St & 20th Ave	016	12"x16"	- 2.20
	TI-R06	119th St & 22ndAve	015	Double 8"Dia	+ 5.18
	TI-R07	119th St & 23rd Ave	014	Double 8"Dia	+ 1.43
	TI-R08	119th St & 25th Ave	013	Double 8"Dia	+ 5.97
Whitestone Interceptor					
	TI-R10	138th St & 11th Ave (Bulkheaded; formerly 021)			
	TI-R10A	144th St & 7th Ave	003	12" Dia	+ 8.50
	TI-R10B	144th St E/O Malba Ave	003	18"x12"	+10.00
	TI-R11	151st St & 7th Ave	004	12"x12"	+17.50
	TI-R12	154th St & Powells Coge Ave	005		- 0.50
	TI-R13	15th Dr & Willets Point Blvd	023	24"x18"	+24.65
Flushing Interceptor					
	TI-R09	Linden Place & 32nd Ave	011	60"Dia.	+ 4.50
	TI-R51	Parsons Blvd & 32nd Ave	011	24"x24"	+16.35
	TI-R52	Union St & 32nd Ave	011	12"x12"	+ 8.00
	TI-R53	137th St & 32nd Ave	011	12"x12"	+ 2.75
	TI-R54	Downing St & 32nd Ave	011	12"x12"	+ 0.50
	TI-R55	College Pt Blvd & Roosevelt Ave	022	12"x12"	+10.80
	TI-R56	Main St & 40th Rd	022	24"x24"	+12.50
	TI-R57	41st Ave E/O Lawrence St	022	12"x12"	+ 8.72
	TI-R58	Sanford Ave & Frame St	022	15"x15"	+21.10
	TI-R59	58th Ave & Lawrence St	010	24"x36"	+14.68
	TI-R60	Booth Mem Pkwy & Lawrence St	010	Orifice	+13.00
Kissena Corridor Trunk Sewers Upstream of TI-R31					
	TI-R29	Oak Ave & Colden St	010	12"x12"	+ 5.50
	TI-R30	Quince Ave & Kissena Blvd	010	9"x 33"	+ 1.88
	TI-R31	Lawrence St & Blossom Ave	010	18"Dia	+12.00
	TI-R32	137th St & Peck Ave	010	8"Dia	+13.68
	TI-R33	138th St & Peck Ave	010	8"Dia	+13.68
	TI-R34	Main St S/O Peck Ave	010	8"Dia	+13.88
	TI-R35	56th Rd & 146th St	010	10"Dia	+21.25
	TI-R36	150th St & Booth Mem Pkwy	010	Orifice	
	TI-R37	150th St & 60th Ave	010	24"Dia	+16.40
	TI-R38	Parsons Blvd & Booth Mem Pkwy	010	8"Dia	+18.66
	TI-R39	159th St & Booth Mem Pkwy	010	18"Dia	+20.25

Table 3-8. Tallman Island WWTP Collection System Regulators (cont.)

	Reg. ID	Location	Outfall	Flow Compartment	Elev
Kissena Corridor Trunk Sewers Upstream of TI-R31 (cont).					
	TI-R40	Fresh Medal La & Peck Ave	010	36”x28”	+19.05
	TI-R40A	Gladwin Ave & Fresh Meadow La	010	12”x12”	+34.10
	TI-R41	188th St & LIE (N.S.)	010	27”Dia	+24.75
	TI-R42	188th St & LIE (S.S.)		Orifice	+27.08
	TI-R43	192nd St & 56th Ave	010	36”Dia	+25.90
	TI-R44	Peck Ave & LIE (S.S.)	010		+31.00
	TI-R45	73rd Ave & Utopia pkwy	010	Orifice	+25.00
	TI-R45A	69th Ave & Fresh Meadow La	010	Orifice	
	TI-R46	210th St & LIE (N.S.)	008	30”Dia	+51.10
	TI-R47	218th St & LIE (N.S.)	008	Orifice	+69.40
	TI-R48	Springfield Blvd & LIE (S.S.)	Internal	12”Dia	+75.92
	TI-R49	220th Pl & 46th Ave	008	12”Dia	+44.50
	TI-R50	157th St & 43rd Ave	Internal	24” Dia	+24.50

Table 3-9. Tallman Island WWTP Collection System Outfalls

Outfall	Location / (Regulator)	Size	Waterbody /Class	Comment
002	Treatment Plant Bypass	60" DIA	East River / SB	(Outfall bulkheaded, and outfall deleted from 2005 SPDES permit)
003	n/o 7th Ave. (REG #10A)	8'-0" x 8'-0"	Powells Cove / I	
004	151st Street (REG # 11)	72" DIA	East River / SB	
005	154th Street (REG # 12)	24" DIA	East River / SB	
006	24th Avenue	10'-0" x 7'-6"	Little Neck Bay /SB	24th Ave P.S. Bypass(1)
007	Northern Blvd (Old Douglaston. P.S.)	18" DIA	Alley Creek / I	Old Douglaston P.S. Bypass(1) To be demolished under Alley Creek CSO Storage Facility Project
008	46th Ave. (REG# 46, 47, 48, 49)	10' x 7'-6"	Alley Creek / I	Telemetered (46, 47, & 49)
009	Douglaston Bay P.S	2x8"	Alley Creek / I	Douglaston Bay P.S. Bypass(1)
010	Includes overflow from Flushing Bay CSO Retention Facility, Roosevelt Ave. (REG #29-40, 40A, 41-45, 45A, 50, 59, 60, BB Reg #14, 15,27, 27A, 28)	3BL 18' x 10'	Flushing Creek / I	Telemetered (30, 40), Boom
011	32nd Ave. (REG # 9, 51 – 54)	DBL 8' x 8'	Flushing Creek / I	Telemetered (9), Net
012	29th Ave.	12" DIA	Flushing Bay / I	122nd P.S. Bypass(1)
013	25th Avenue (REG # 8)	18" DIA	Flushing Bay / I	This has been separated. (2)
014	23rd Avenue (REG # 7)	12" DIA	Flushing Bay / I	To be separated
015	22nd Avenue (REG # 6)	1'-3" x 1'-10"	Flushing Bay / I	To be separated
016	20th Avenue (REG # 5)	60" DIA	Flushing Bay / I	To be separated
017	15th Avenue (REG # 4)	12" DIA	Flushing Bay / I	To be separated
018	14th Avenue (REG # 3)	1'-6" x 1'-2"	Flushing Bay / I	To be separated
019	9th Ave. (REG #2)	12" DIA	East River / I	

Table 3-9. Tallman Island WWTP Collection System Outfalls

Outfall	Location / (Regulator)	Size	Waterbody /Class	Comment
020	College Place (REG #1)	24" DIA	East River / I	
021	233rd Street (REG #10)	42" DIA	Little Neck Bay / I	(Connection from Reg #10 now bulkheaded; outfall deleted from 2005 SPDES permit)
022	40th Rd (REG #55-58)	7' x 6'-6"	Flushing Creek / I	Boom
023	Cryders Lane (REG #13)	13'6" x 8'	Little Bay / SB	Telemetered
024	61st Avenue	12' x 10' Box	Alley Creek / I	New Douglaston P.S. Bypass[(1)]
025	Alley Creek CSO Storage Facility [(3)]	DBL 20' x 8'-6"	Alley Creek / I	

(1) SPDES permits list sanitary pump station bypasses as CSO outfalls. These outfalls only overflow during emergency situations and do not normally overflow.
(2) TI-013 has been separated, but it can still discharge stormwater flow. The SPDES permit for Tallman Island has not yet been revised to reclassify TI-013 as a stormwater outfall. To be consistent with SPDES permit, TI-013 is still shown as a CSO in this table even though TI-013 no longer receives combined sewer overflow.
(3) The double barrel outfall is constructed and carrying flow through it during construction of the Alley Creek CSO Storage facility. Upon completion of construction of the Alley Creek CSO Storage Facility in Feb 2011, the outfall will become the overflow point for the storage facility and all flow reaching it will pass through the storage facility.

3.3.1 Combined Versus Separately Sewered Areas and Combined System Overflows

As indicated above, the Tallman Island service area includes 8,032 acres that are served by combined sewers, plus 4,893 acres in which the sewershed is served by separate sanitary sewers and storm sewers. However, the functioning of the separately sewered systems is complicated by the configuration of the sewers downstream of the sewersheds. These systems are configured as follows:

- Flow from a relatively small portion of the separately sewered area (about 610 acres) fully maintains its separate character, with the sanitary sewage conveyed to the treatment plant without encountering intervening diversions and the stormwater discharging directly to a waterbody. These sewersheds are primarily in the area surrounding the old Flushing Airport, just south of Powell's Cove.

- Several sewersheds along the Kissena Corridor are separately sewered inside the watershed, but the sanitary and storm sewage are then combined for conveyance westward to the Flushing Interceptor at Regulator TI-R31.

- In the other separately sewered areas, principally tributary to the Whitestone Interceptor and to the Old Douglaston Pump Station, the stormwater is conveyed directly to waterbody discharge via the municipal separate storm sewer system while the sanitary sewage is conveyed to treatment in combined trunk sewers and interceptors which have downstream overflows.

This demarcation of the separately sewered areas is depicted in Figure 3-4 and is allocated amongst the principal interceptors in Table 3-6.

Wet weather flows in the combined sewer system, with incidental sanitary and stormwater contributions as summarized above, results in overflows to the nearby waterbodies when the flows exceed the hydraulic capacity of the system, or the specific capacity of the local regulator structure.

3.3.2 Stormwater Outfalls

The Tallman Island SPDES discharge permit includes a list of permitted stormwater outfalls for the WWTP. The outfalls specified in the permit are listed in Table 3-10. Two of these stormwater outfalls (TI-670 and TI-672) discharge to Flushing Bay.

Table 3-10. Tallman Island Stormwater Outfalls

Outfall	Latitude	Longitude	Location	Size	Waterbody
601	40,45,46	73,50,05	Northern Blvd. (south side)	30” Dia	Flushing Creek
603	40,45,46	73,50,05	Northern Blvd. (north side)	27” Dia	Flushing Creek
605	40,45,54	73,50,28	300’ w/o Whitestone Expwy.	6’9” x 4’11”	Flushing Creek
609	40,47,00	73,50,50	121st St	36” Dia	East River
610	40,47,00	73,49,29	147th St	48” Dia	East River
611	40,47,00	73,48,27	w/o 154th St	48” Dia	East River
612	40,47,00	73,48,27	w/o 154th St	48” Dia	East River
615	40,47,00	73,47,25	9th Ave	12” Dia	Little Bay
616	40,47,29	73,47,43	12th Ave	12” Dia	Little Bay
617	40,47,00	73,47,25	12th Road	12” Dia	Little Bay
618	40,47,33	73,47,25	14th Ave	10” Dia	Little Bay
619	40,47,32	73,47,22	Cryders Lane	12” Dia	Little Bay
623	40,46,45	73,46,05	28th Ave	18” Dia	Little Neck Bay
624	40,46,22	73,45,50	35th Ave	11’ x 3’4”	Little Neck Bay
631	40,46,02	73,50,24	31st Road	54” Dia	Flushing Creek
633	40,47,11	73,46,28	s/o 17th Ave	54” Dia	Little Neck Bay
634	40,47,32	73,47,05	Fort Totten South Jetty	18” Dia	Little Bay
653	40,45,40	73,45,06	Sandhill Rd	48” Dia	Udalls Cove
654	40,45,48	73,45,07	20’ n/o North Blvd	36” Dia	Alley Creek
655	40,45,52	73,45,06	223rd St & Northern Blvd	15” Dia	Alley Creek
656	40,46,01	73,45,02	39th Ave	36” Dia	Frank Turner Inlet
658	40,46,01	73,45,02	233rd Place	40” Dia	Little Neck Bay
660	40,46,23	73,44,39	39th Ave & 248th St	12” Dia	Udalls Cove
661	40,47,25	73,47,05	208th St	30” Dia	Little Bay
665	40,46,22	73,45,15	131st St	72” Dia	East River
666	40,47,24	73,51,18	9th Ave	18” Dia	East River
669	40,50,46	73,51,05	15’ s/o 31st Rd	24” Dia	Flushing Creek
670	40,47,43	73,51,58	100’ n/o North Shore M.T.S.	60” Dia	Flushing Bay
671	40,47,23	73,51,23	w/o 8th Ave	36” Dia	East River
672	40,47,01	73,51,32	50’ n/o 111th St	30” Dia	Flushing Bay

3.3.3 Non-Sewered Areas

For several sections of the Tallman Island WWTP drainage area, storm water drains directly to receiving waters without entering the combined sewer system. These areas are depicted as “Direct Drainage” in Figure 3-4 and were delineated based on topography and the resultant direction of storm water sheet flow in those areas. In general, shoreline areas adjacent to waterbodies comprise the direct drainage category. Significant direct drainage areas include Fort Totten, Douglas Manor, and Alley Pond Park, all of which are tributary to the Alley Creek and Little Neck Bay waterbodies.

Other areas are largely comprised of parkland, such as portions of Flushing Meadows Corona Park, Kissena, Cunningham, and Clearview Parks, and Mt. Hebron and Flushing Cemeteries. These areas are depicted as "other" drainage areas in Figure 3-4. The "other" category also includes special cases, such as the former Flushing Airport in College Point (now a commercial distribution center), where sanitary flow is conveyed to the WWTP and storm water is conveyed through storm water collection systems to receiving waters.

Overall, the "other" and "direct drainage" areas cover roughly 2,171 and 1,483 acres, respectively, of the Tallman Island WWTP sewershed. No portion of land area is classified as "other" in the Flushing Bay drainage area. However, 119 acres are considered "direct drainage".

3.4 BOWERY BAY COLLECTION SYSTEM

Wastewater flows to the Bowery Bay WWTP through two interceptors, the Low Level and the High Level, separated by a 29-foot elevation differential. The Low Level Interceptor serves approximately 3,502 acres in the western side of the Bowery Bay sewershed, carrying flow from individual drainage basins along the East River extending to Newtown Creek. The High Level Interceptor serves approximately 8,383 acres in the central and eastern part of the Bowery Bay sewershed, carrying flows from individual drainage basins extending from Steinway Creek, Bowery Bay itself, and Flushing Bay. It is the High Level Interceptor drainage areas, particularly those that overflow to Flushing Bay, that are directly applicable to this report. The drainage areas that are part of the Bowery Bay WWTP service area are depicted in Figure 3-7.

The principal sewers that make up the Bowery Bay WWTP collection system are shown on Figure 3-8 and depicted schematically in Figure 3-9. Components of the High Level Interceptor portion of the collection system include:

- Seven combined sewer pump stations, as listed in Table 3-11.

- Nineteen diversion regulator structures, ten of which discharge to outfalls in Flushing Bay as listed in Table 3-12. The capacities and dry weather flow rates in this table were provided by the NYC DEP Bureau of Wastewater Treatment, Division of Collection Facilities Planning & Analysis.

- Seven permitted outfalls, three of which discharge to Flushing Bay, as listed in Table 3-13.

The drainage system tributary to the Bowery Bay High Level Interceptor includes some areas to the east of Meadow Lake and Willow Lake. Dry weather sanitary flow from areas tributary to Bowery Bay regulators 14, 15, 27, and 28 is conveyed westward in the Bowery Bay collection system. The wet weather overflows from this area, however, are carried in an outfall sewer to the Flushing Creek CSO retention facility, in which the flows are captured except during extreme weather events. When the capacity of the facility is exceeded, excess flow discharges into Flushing Creek at Outfall TI-010. (This is further described in Section 5 of the Flushing Creek Waterbody/Watershed Facility Plan in the discussion of the Flushing Creek CSO retention facility.)

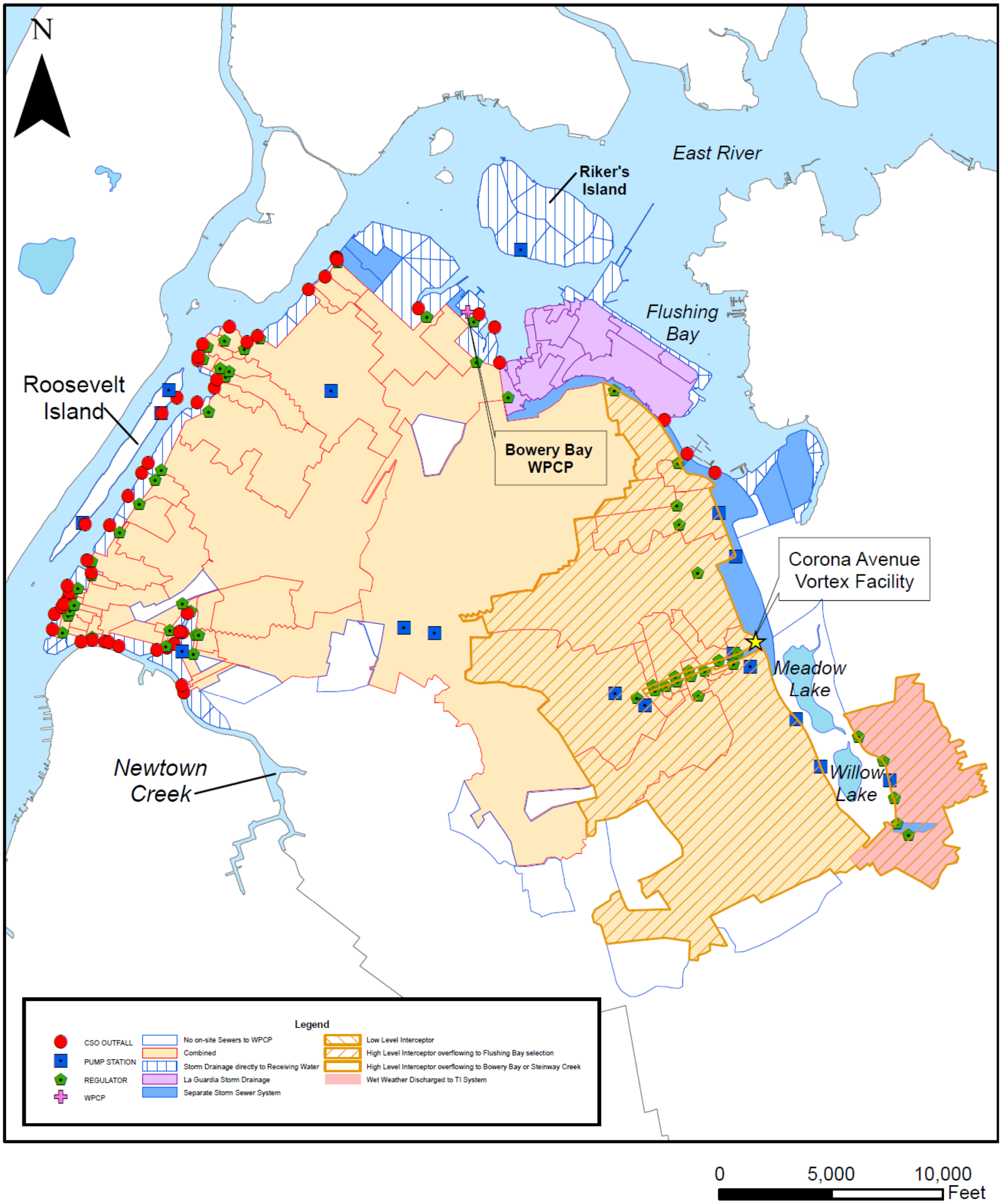
The dry weather flow from this area is joined with other system flows (both dry and wet weather) to Regulator 10, which also controls the flow from the Long Island Expressway trunk sewers. Overflows from Regulator 26 are modified by partial diversion through the Corona Avenue Vortex Facility (CAVF, further described in Section 5 of this report) and discharge to Flushing Bay via Outfall BB-006.

The High Level Interceptor itself can be considered to start at Regulator 10. Downstream of Regulator 10, it picks up additional flows at Regulators 9, 8a, 8, 7 and 6. Overflow from several of these regulators combine to discharge to Flushing Bay at Outfall BB-008.

Downstream there is one additional discharge to Flushing Bay at Outfall BB-007, originating at Regulator 5. The further downstream overflows from the High Level Interceptor system discharge to Bowery Bay itself (at Outfalls BB-005 and BB-003), and to Steinway Creek (via Outfall BB-041).

Table 3-11. Bowery Bay WWTP High Level Interceptor Pump Stations

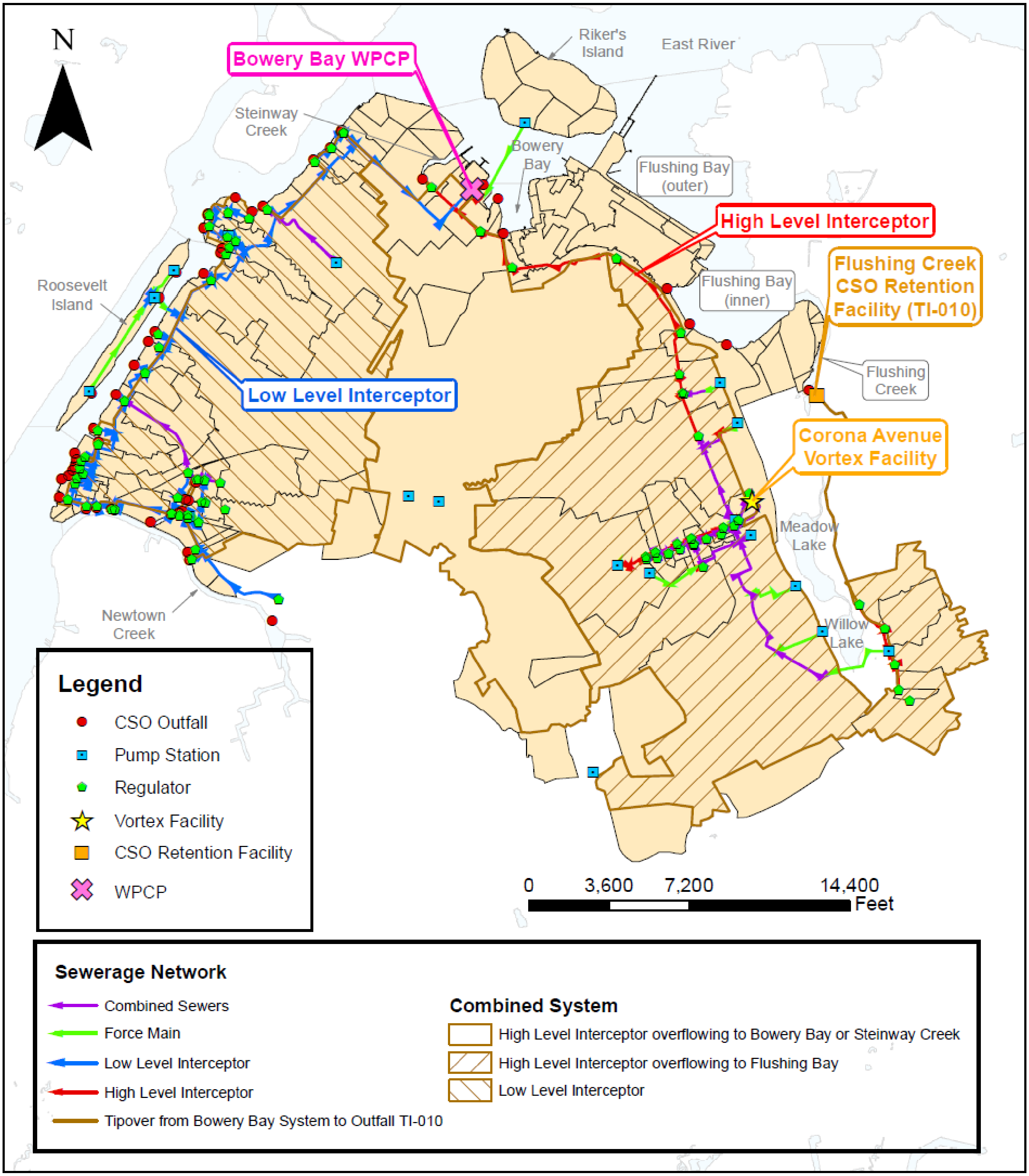
Pump Station Name	**Address**	**Type**	**No. of Pumps**	**Bypass Outfall**	**Associated Interceptor**
Pell Avenue (37th Ave.)	37th Ave. And 114th St., Corona	Comb	2	None	BB High Level
Corona (44th Ave.)	44th Ave & 114th St., Corona	Comb	2	None	BB High Level
108th Street	108th St & Long Island Expwy, Corona	Comb	5	None	BB High Level
67th Road	112th St & 67th Rd, Forest Hills	Comb	2	None	BB High Level
70th Road	Peartree & Jewel Ave, Forest Hills	Comb	2	None	BB High Level
Park Drive East	Park Dr. & 72nd Ave, Flushing	Comb	3	None	BB High Level
62nd Road	93-29 Queens Blvd., Forest Hills	Comb	2	None	Horace Harding Expressway Trunk Sewer



NYC Environmental Protection

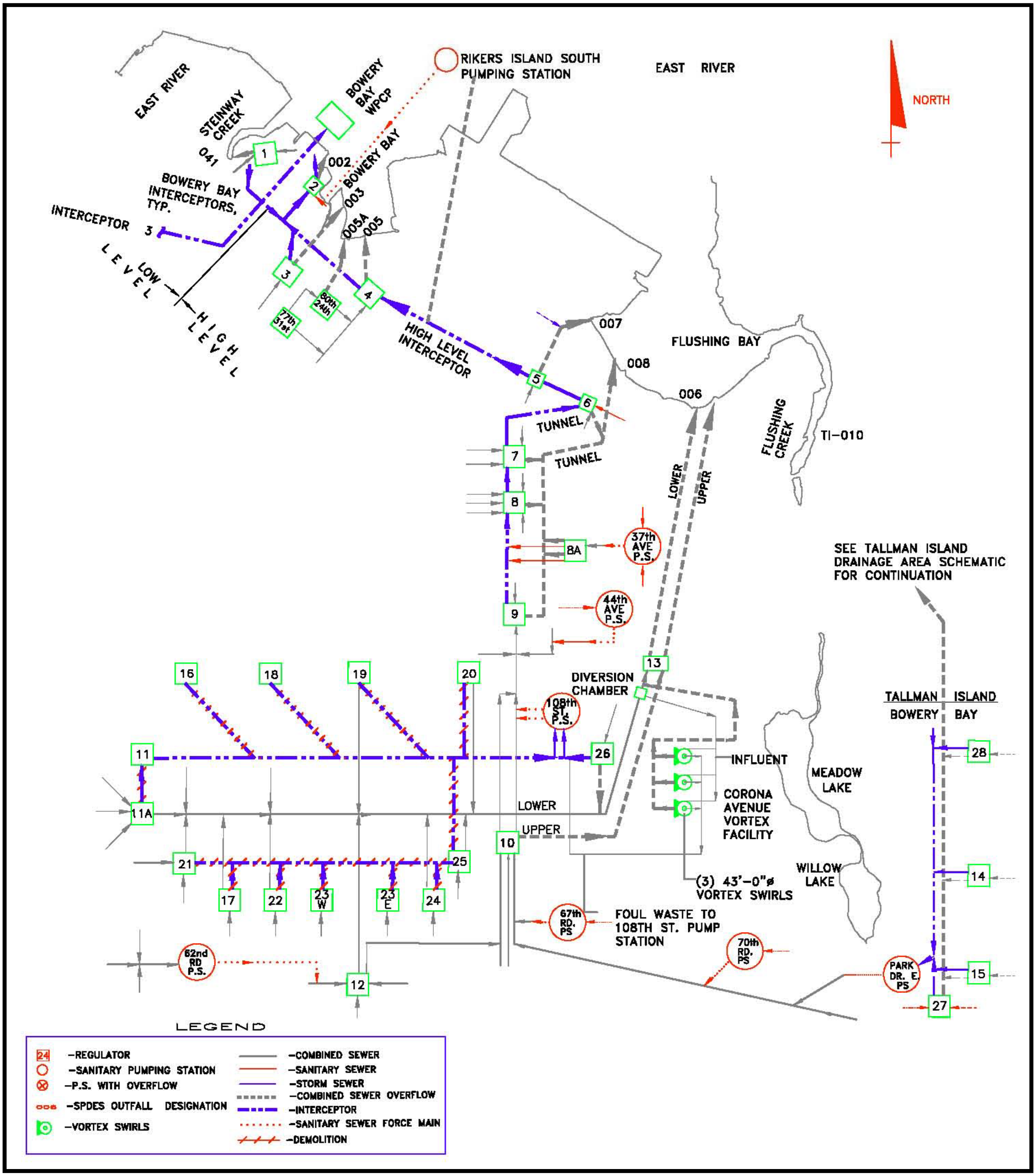
Bowery Bay WWTP Sewersheds

FIGURE 3-7



NYC Environmental Protection

Bowery Bay Collection System Facilities



NYC Environmental Protection

Bowery Bay WWTP Collection System Schematic

FIGURE 3-9

Table 3-12. Bowery Bay WWTP Collection System Regulators (High Level Interceptor)(1, 2)

Reg. ID	Location	Outfall	Flow Compartment	Elev.
01	37th St. & 19th Ave	041	24" Dia	+ 1.50
02	45th St. & Plant	002		- 3.50
03	Hagen St. & 19th St. Av.	003	18" Dia	+ 4.00
04	LaGuardia Airport	005	9'x9' Int. Sewer	+ 4.00
05	100th St. & Ditmars Blvd.	007	5'-6"x7' Int. Sewer	+ 8.10
06	108th St.& Ditmars Blvd.	008		+ 9.00
07	108th St. & 34th Ave.	008		+73.62
08	108th Sr. & 37th Ave.	008		+14.04
09	108th St. & 43rd. Ave.	008		+14.80
10	108th St. & LIE	006	7'x6'-9" Int. Sewer	+15.15
12	99th St. & 63 Rd	006	6'-6" Int. Sewer	+16.61
13	111th St. & Corona Ave.	006	Control at Reg 10	
14	72nd Ave. & Park Dr. Exp.	TI-010 *	14"x12"	17.00
15	77th Ave. & Park Dr. Exp	TI-010 *	32"x24"	+16.80
20	Xenia St. & LIE (N/S)	006	10" Dia	+0.72
26	Sautell Av. & Penrod (LIE)	006	8" Dia	+3.70
27	Union Turnpike & Park Av.	TI-010 *	18" Dia	+11.30
27A	Union Turnpike & 135th St.	TI-010 *		
28	Jewel Ave. & Park Dr.	TI-010 *	16"x16"	+26.20

Notes:
1) The regulators associated with the Long Island Expressway collection system (including 11, 11a, 12, 16, 17, 18, 19, 20, 22, 23, 23w, 24 and 25) have had their overflow outlets bulkheaded, with all flow conveyed in the lower Deck sewer for control at Regulator 13 and partial treatment at Corona Avenue Vortex Facility. They are not listed above.
2) Regulators 14, 15, 27, 27a and 28 overflow to the Tallman Island collection system, discharging via outfall TI-010 to Flushing Creek.

Table 3-13. Bowery Bay WWTP Collection System Outfalls (High Level Interceptor)

Outfall	Location / (Regulator)	Size	Waterbody /Class	Comment
002	45th St. (Reg #2)	9' x 9'	Rikers Island Channel / I	
003	Hazen St. (Reg #3)	66" Dia	Bowery Bay / I	Telemetered
005	e/o 81st St. (Reg #4)	14'7" x 8'	Bowery Bay / I	Boom
006	Corona Ave. Vortex - 114th St. (Reg #10, 12, 13, 20, 26)	4-barrel 10'6" x 9'3"	Flushing Bay / I	Corona Ave Vortex Facility Outfall, Boom
007	27th Ave. (Reg #5)	11' x 7'6"	Flushing Bay / I	
008	31st Dr. (Reg #6,7,8,9)	Double 13'9" x 8'	Flushing Bay / I	Telemetered (6 & 9), Boom
041	19th St. (Reg #1)	6’ x 6’	Steinway Creek / I	

The Bowery Bay SPDES discharge permit includes a list of permitted stormwater outfalls for the WWTP. The outfalls specified in the permit are listed in Table 3-14. Two of these stormwater outfalls (TI-601 and TI-602) discharge to Flushing Bay.

Table 3-14. Bowery Bay Stormwater Outfalls

Outfall	Latitude	Longitude	Location / Regulator	Size	Waterbody
601	40,45,53	73,50,33	Flushing Bay & 127th Street	60" Diameter	Flushing Bay
602	40,45,48	73,50,43	Flushing Bay & 126th Street	60" Diameter	Flushing Bay

3.5 SEWER SYSTEM MODELING

Mathematical watershed models are used to simulate the hydrology (rainfall induced runoff) and hydraulics (sewer system responses) of a watershed, and are particularly useful in characterizing sewer system conditions during wet weather and in evaluating engineering alternatives on a performance basis. In the hydrology portion of the model, climatic conditions (such as rainfall intensity) and physical watershed characteristics (such as slope, imperviousness and infiltration) are used to calculate rainfall-runoff hydrographs from individual smaller drainage areas (subcatchments). These runoff hydrographs are then applied at corresponding locations (manholes) in the sewer system as inputs to the hydraulic portion of the model. In the hydraulic portion, the resulting hydraulic grade lines and flows are calculated based on the characteristics and physical features of the sewer system, such as pipe sizes, pipe slopes, and flow-control mechanisms like weirs. Model output includes sewer system discharges which, when coupled with pollutant concentration information, provide the pollutant loadings necessary for receiving-water models to assess water quality impacts. The following generally describes the tools employed to model the Flushing Bay watershed. A more detailed description of the model setup, calibration and model-projection processes are provided under separate covers *City-wide Long Term Control Planning Project Landside Modeling Report, Vol. 2, Bowery Bay WWTP and City-wide Long Term Control Planning Project Landside Modeling Report, Vol. 13, Tallman Island WWTP*.

3.5.1 Hydraulic Modeling Framework

The hydraulic modeling framework used in this effort is a commercially available, proprietary software package called InfoWorks CS™, developed by Wallingford Software, U.K. InfoWorks CS™ is a hydrologic/hydraulic modeling package capable of performing time-varying simulations in complex urban settings for either individual rain events or long-term periods comprising many rain events. The outputs include calculated hydraulic grade lines and flows within the sewer system network and at discharge points. InfoWorks CS™ solves the complete St. Venant hydraulic routing equations representing conservation of mass and momentum for sewer-system flow and accounts for backwater effects, flow reversals, surcharging, looped connections, pressure flow, and tidally affected outfalls. Similar in many respects to the USEPA's Storm Water Management Model (SWMM), InfoWorks CS™ offers a state-of-the-art graphical user interface with greater flexibility and enhanced post-processing tools for analysis of model generated outputs. In addition, InfoWorks utilizes a four-point implicit numerical solution technique that is generally more stable than the explicit solution procedure used in SWMM.

Model input for InfoWorks CS^{TM} includes watershed characteristics for individual subcatchments, including area, surface imperviousness and slope, as well as sewer-system characteristics, such as information describing the network (connectivity, pipe sizes, pipe slopes, pipe roughness, etc.) and flow-control structures (pump stations, regulators, outfalls, WWTP headworks, etc.). Hourly rainfall patterns and tidal conditions are also important model inputs. InfoWorks CS^{TM} allows interface with geographic information system (GIS) data to facilitate model construction and analysis.

Model output includes flow and/or hydraulic gradient line (HGL) at virtually any point in the modeled system and also at virtually any time during the modeled period. InfoWorks CS^{TM} provides full interactive views of data using geographical plan views, longitudinal sections, spreadsheet-style grids and time-varying graphs. A three-dimensional junction view provides an effective visual presentation of hydraulic behavior in manholes during wet or dry weather periods. Additional post-processing of model output allows the user to view the results in various ways as necessary to evaluate the system response, and also to visualize the improvements resulting from various engineering alternatives.

3.5.2 Application of Model to Collection Systems

Both the Bowery Bay and Tallman Island Collection Systems contribute CSO to Flushing Bay. Within the Bowery Bay Collection System, only the High Level portion of the Bowery Bay (BB) drainage area contributes overflows to the Flushing Bay. Therefore, with respect to the Bowery Bay system, the discussion here will be limited to the High Level Interceptor (BB-HLI) sewer characteristics and performance. Both the Bowery Bay High Level and Low Level Interceptors have their own separate wet wells and are controlled primarily by their own pumping stations, therefore, BB-HLI is discussed here as a stand-alone drainage area. Only a portion of the Tallman Island system discharges to Flushing Bay through outfalls located along the College Point shoreline. As discussed in Section 5, the College Point Sewer Separation project will eliminate CSO discharge through these outfalls. When this project is complete CSO from the Tallman Island system will no longer discharge to Flushing Bay.

The InfoWorks models for both the BB-HLI and Tallman Island Collection Systems were constructed using information and data compiled from the DEP's as-built drawings, WWTP data, previous and ongoing planning projects, regulator improvement programs, and inflow/ infiltration analyses. This information includes invert and ground elevations for manholes, pipe dimensions, pump-station characteristics, and regulator configurations and dimensions.

Model simulations for both collection systems includes WWTP headworks, interceptors, branch interceptors, major trunk sewers, all sewers greater than 48-inches in diameter plus other smaller, significant sewers, and control structures such as pump stations, diversion chambers, tipping locations, reliefs, regulators and tide gates. As presented in the LTCP Landside Modeling Reports for Bowery Bay and Tallman Island drainage areas, the model was calibrated and validated using flow and hydraulic-elevation data collected historically in these two areas. All CSO and stormwater outfalls permitted by the State of New York are represented in the models, with stormwater discharges from separately sewered areas simulated using separate models as necessary. Finally, the runoff generated and discharged directly from areas adjoining the receiving waters is also modeled separately.

Conceptual alternative scenarios representing no-action (Baseline) and other alternatives were simulated for a typical year (1988 JFK rainfall). Tidal influence on the outfalls was explicitly modeled using the tidal boundary conditions and tide gates, where present. Depending on the number of regulators that contributed flows to each outfall, the discharges from those regulators were combined to develop the total discharges on a time-variable basis. The portions of sanitary flow and impervious (street, sidewalk, root, etc.) runoff storm water at each time-step were determined using the pollutant routing algorithm built in InfoWorks CS^{TM}. Pollutant concentrations selected from field data and best professional judgment were assigned to the sanitary and stormwater (runoff) components of the combined sewer discharges to calculate variable pollutant loadings. Similar assignments were made for stormwater discharges in separated areas or to flows discharged from direct drainage areas. Discharges and pollutant loadings were then post-processed and used as inputs to the receiving-water model, described in Section 4.

3.5.3 Baseline Design Condition

Watershed modeling can be an important tool in evaluating the impact of proposed physical changes to the sewer system and/or of proposed changes to the operation of the system. In order to provide a basis for these comparisons, a "Baseline condition" was developed.

Establishing the future Tallman Island and Bowery Bay WWTP dry weather sewage flows is a critical step in the WB/WS Planning analysis since one key element in the City's CSO control program is the use of the WWTPs to reduce CSO overflows. Increases in sanitary sewage flows associated with increased populations will reduce the amount of CSO flow that can be treated at the existing WWTPs since the increased sewage flows will use part of the WWTP wet weather capacity.

Dry weather sanitary sewage flows used in the Baseline modeling were escalated to reflect anticipated growth within the City. At the direction of the Mayor's Office, NYCDCP has made assessments of the growth and movement of the City's population between the year 2000 census and 2010 and 2030 (NYCDCP 2006). This information is contained in a set of projections made for 188 neighborhoods within the City. DEP has escalated these populations forward to 2045 by assuming the rate of growth between 2045 and 2030 would be 50 percent of the rate of growth between 2000 and 2030. These populations were associated with each of the landside modeling sub-catchment areas tributary to each CSO regulator using geographical information system (GIS) calculations. Dry sanitary sewage flows were then calculated for each of these sub-catchment areas by associating a conservatively high per capita sanitary sewage flow with the population estimate. The per capita sewage flow was established as the ratio of the year 2000 dry weather sanitary sewage flow for each WWTP service area and the year 2000 population of each WWTP area.

Increasing the sewage flows for the Tallman Island and Bowery Bay WWTPs from the 2003 flows to the estimated future 2045 flows shown below will properly account for the potential reduction in wet weather treatment capacity associated with projections of a larger population.

For the Tallman Island Model, the Baseline conditions parameters were as follows:

1. Dry-weather sanitary sewage flow rates reflect year 2045 projections (60 MGD);

2. Wet-weather treatment capacity of 122 MGD at the Tallman Island WWTP (capacity based on hydrographs from the top 10 storms in 2003); and

3. Documented sedimentation in sewers.

For the Bowery Bay collection system model, the Baseline conditions parameters were as follows:

1. Dry-weather sanitary sewage flow rates reflect year 2045 projections (89.0 MGD for BB-HLI and 37.7 MGD for BB-LLI);

2. Wet-weather treatment capacity of 127 MGD[1] at the Bowery Bay High Level wet well; and

3. Documented sedimentation in sewers.

In addition to the above watershed/sewer system conditions, a comparison between model calculations also dictates that the same meteorological (rainfall) conditions are used in both WWTP drainage areas. In accordance with the Federal CSO Control Policy a typical/average rainfall year was used. Long-term rainfall records measured in the New York City metropolitan area were analyzed to identify potential rainfall design years to represent long-term, annual average conditions. Annual statistics were compiled included:

- Total rainfall depth number of storms;
- Average storm volume and intensity;
- Total and average storm duration; and
- Average inter-event time

A more detailed description of these analyses is provided under separate cover (HydroQual, 2004). Although no year was found having the long-term average statistics for all of these parameters, the rainfall record measured at the National Weather Service gage at John F. Kennedy (JFK) International Airport during calendar year 1988 is representative of overall, long-term average conditions in terms of annual total rainfall and storm duration. In addition, the JFK 1988 rainfall record includes high-rainfall conditions during July (recreational) and November (shellfish) periods, which are useful for evaluating potential CSO impacts on water quality

[1] Model results showed of the total 236 MGD available capacity at Bowery Bay WWTP, 54 percent is allocated for the High Level Interceptor and 46 percent is allocated for the Low Level Interceptor. Total plant capacity is based on hydrographs from the top ten storms in 2003.

during those particular periods. As a result, the JFK 1988 rainfall record was selected as an appropriate design condition for which to evaluate sewer system response to rainfall. The JFK 1988 record has also been adopted by the New York Harbor Estuary Program and the New Jersey Department of Environmental Protection for water quality and CSO performance evaluations. Table 3-15 summarizes some of the statistics for 1988 and a long-term (1970-2002) record at JFK.

Table 3-15. Comparison of Annual 1988 and Long-Term JFK Rainfall Record

Rainfall Statistic	1988 Statistics	Long-Term Median (1970-2002)
Annual Total Rainfall Depth (inches) Return Period (years)	40.7 2.6	39.4 2.0
Average Storm Intensity (inch/hour) Return Period (years)	0.068 11.3	0.057 2.0
Annual Average Number of Storms Return Period (years)	100 1.1	112 2.0
Average Storm Duration (hours) Return Period (years)	6.12 2.1	6.08 2.0

3.6 DISCHARGE CHARACTERISTICS

As indicated in Section 3.5, sewer-system modeling is useful to characterize flows and pollutant loads discharged from various outfalls in the drainage area. Because long-term monitoring of outfalls is difficult and expensive, and sometimes not accurate in tidal areas, sewer-system models that have been calibrated to available measurements of water levels and flows can offer a useful characterization of discharge quantities. Sewer system models can also be used to estimate the relative portions of sanitary sewage and rainfall runoff discharged from a CSO. This is particularly helpful when developing CSO pollutant concentrations, since this sanitary/runoff split for the discharge volume can be used to develop CSO concentrations and subsequently loadings. This method of utilizing concentrations associated with sanitary and runoff is somewhat more reliable than developing CSO concentrations based on pollutant concentrations measured in combined sewage (e.g., the event mean concentrations, EMC), which are particularly variable. To be as conservative as possible, both the sewer system and water quality models treated overflows from the Flushing Creek CSO retention facility as CSO discharges.

3.6.1 Landside Modeling

The calibrated watershed models described in Section 3.5 were used to characterize discharges to Flushing Bay for the Baseline condition. Tables 3-16 and 3-17 summarize the results with statistics relating the annual CSO and stormwater discharges from each point-source outfall for the Baseline condition.

For the Tallman Island sewer system, T-016 is the largest CSO discharger to Flushing Bay, accounting for 55 percent of the Tallman Island CSO discharges. However, the Tallman Island system's total CSO contribution is small compared to the Bowery Bay system, accounting for only 2.5 percent of the CSO discharge to Flushing Bay.

For the Bowery Bay WWTP sewer system about 73 percent of the total annual CSO volume to the Flushing Bay is discharged from BB-006. Approximately 27 percent of the CSO volume is discharged at BB-008. A small portion of the CSO volume from Outfall BB-006 gets some level of treatment from the Corona Avenue Vortex Facility designed to capture flows from the lower deck of this outfall.

Table 3-16. Tallman Island Discharge Summary for Baseline Conditions [1,2,3]

Combined Sewer Outfall	Water Body	Discharge Volume (MG)	Number of Discharges
TI-012[4]	Flushing Bay	6	0
TI-013[4]	Flushing Bay	12	0
TI-014	Flushing Bay	2	32
TI-015	Flushing Bay	1	29
TI-016	Flushing Bay	28	45
TI-017	Flushing Bay	0*	10
TI-018	Flushing Bay	2	34
Total CSO		51	NA

(1) Baseline condition reflects design precipitation record (JFK, 1988), treatment plant capacity reaches two times design dry weather flow and projected sanitary flows for year 2045.
(2) Totals may not sum precisely due to rounding.
(3) Tallman Island Operating Capacity 122 MGD
(4) These discharges were all stormwater, thus the number of CSO events was zero.
* The model predicted only trace discharges, 0.4 MG, from TI-017

Table 3-17. Bowery Bay Discharge Summary for Baseline Conditions [1,2,3]

Combined Sewer Outfall	Water Body	Discharge Volume (MG)	Number of Discharges
BB-006	Flushing Bay	1,530	60
BB-007	Flushing Bay	4	18
BB-008	Flushing Bay	594	56
Total CSO		2,127	NA

(1) Baseline condition reflects design precipitation record (JFK, 1988), treatment plant capacity reaches 2003 sustained wet weather flow and projected sanitary flows for year 2045.
(2) Totals may not sum precisely due to rounding.
(3) Bowery Bay HLI – Operating Capacity 127 MGD (54% of 236 MGD)

3.6.2 Baseline Pollutant Concentrations

Pollutant concentrations associated with intermittent, wet weather-related discharges are highly variable and difficult to properly characterize without an extensive sampling program. Further, with some 450 CSO overflow locations within the City, characterization of CSOs from each outfall would be prohibitive. For this reason, analyses documented in this report to characterize discharged pollutants utilized estimates of the relative split of sanitary sewage versus rainfall runoff in discharged flows. Pollutant concentrations for sanitary sewage are attributed to the sanitary portion, and concentrations for storm water are attributed to the rainfall runoff portion of the discharged flow volumes.

Tables 3-18 and 3-19 present the pollutant concentrations associated with the sanitary and storm water components of discharges to Flushing Bay from Tallman Island and BB-HLI, respectively. Sanitary concentrations were developed based on sampling of WWTP influent during dry-weather periods, as described elsewhere in more detail (DEP, 2002). Storm water concentrations were developed based on sampling conducted citywide as part of the Inner Harbor Facility Planning Study (Hazen and Sawyer, et. al., 1994), and sampling conducted citywide by DEP for the USEPA Harbor Estuary Program (HydroQual, 2005b). Stormwater concentrations applied in the Bowery Bay drainage area are higher than those applied in the Tallman Island drainage area to represent the higher levels of street surface pollutant concentrations expected in the area of high population density (HydroQual, 2005b).

Table 3-18. Tallman Island Baseline Pollutant Concentrations

Constituent	Sanitary Concentration	Storm Water (Runoff) Concentration
CBOD (mg/L)	140[1]	15[2]
TSS (mg/L)	130[1]	15[2]
Total Coliform Bacteria (MPN/100mL)	25×10^{6}[2]	150,000[2,3]
Fecal Coliform Bacteria (MPN/100mL)	4×10^{6}[2]	35,000[2,3]
Enterococci (MPN/100mL)	1×10^{6}[2]	15,000[2,3]

(1) DEP, 2002
(2) Hazen and Sawyer, et al, 1994
(3) Memo to DEP, (HydroQual,Inc 2005b)
(4) Bacterial concentrations expresses as “most probable number” of cells per 100 mL.

Table 3-19. Bowery Bay Baseline Pollutant Concentrations

Constituent	Sanitary Concentration	Storm Water (Runoff) Concentration
CBOD (mg/L)	140[1]	15[2]
TSS (mg/L)	120[1]	15[2]
Total Coliform Bacteria (MPN/100mL)	$25x10^{6}$[2]	300,000[2,3]
Fecal Coliform Bacteria (MPN/100mL)	$4x10^{6}$[2]	120,000[2,3]
Enterococci (MPN/100mL)	$1x10^{6}$[2]	50,000[2,3]

(1) DEP, 2002
(2) Hazen and Sawyer, et al, 1994 3) HQI Memo to DEP, 2005b
(4) Bacterial concentrations expressed as "most probable number" of cells per 100 mL.

3.6.3 Baseline Pollutant Loads

Pollutant-mass loadings were calculated using the pollutant concentrations shown in Tables 3-18 and 3-19, applied to the discharge volumes and sanitary/rainfall-runoff splits provided by the watershed model, as described above. Table 3-20 presents a summary of the annual discharges to Flushing Bay under Baseline condition. As shown in Table 3-20, CSOs dominate the loadings of fecal and total coliform bacteria to Flushing Bay.

Table 3-20. Flushing Bay CSO and Stormwater Discharge Loadings, Baseline Conditions

Constituent	Bowery Bay WWTP Side of Bay[1,2]		Tallman Island WWTP Side of Bay[1,3]	
	CSO Loading	Storm Water Direct Runoff Loading	CSO Loading	Storm Water Direct Runoff Loading
CBOD (1000 lb/yr)	691	64	41	2
TSS (1000 lb/yr)	623	64	38	2
Total Coliform Bacteria (#/yr)	$405x\ 10^{15}$	$5.8x10^{15}$	$31.4x10^{15}$	$0.076x10^{15}$
Fecal Coliform Bacteria (#/yr)	$69\ x\ 10^{15}$	$2.36\ x\ 10^{15}$	$5.0x10^{15}$	$0.018x10^{15}$
Enterococci (#/yr)	$19\ x\ 10^{15}$	$0.97\ x\ 10^{15}$	$1.3x10^{15}$	$0.0076x\ 10^{15}$

(1)Loadings represent annual total during Baseline simulation.
(2)Bowery Bay WWTP Operating Capacity 127 MGD High Level Interceptor
(3)Tallman Island WWTP Operating Capacity 122 MGD

3.6.4 Effect of Urbanization on Drainage

The urbanization of the Flushing Bay drainage area from a pastoral watershed to an urban sewershed is described in Section 2. The pastoral condition featured undeveloped uplands that provided infiltration of incident rainfall and contributed continuous freshwater inputs. Urbanization brought increased population, increased pollutants from sewage and industry, construction of sewer systems, and physical changes affecting the surface topography and imperviousness of the watershed. Increased surface imperviousness generates more runoff that is less attenuated by infiltration processes, and the sewer systems replaced natural overland runoff pathways with a conveyance system that routes the runoff directly to the waterbody, without the attenuation formerly provided by surrounding wetlands. As a result, more runoff is generated, and it is conveyed more quickly and directly to the waterbody. These changes also affect how pollutants are transferred along with the runoff on its way to the waterbody. Furthermore, the urbanized condition also features additional sources of pollution from CSOs and industrial/commercial activities.

Urbanization of the watershed has altered its runoff yield tributary to Flushing Bay by increasing its imperviousness. Imperviousness is a characteristic of the ground surface that reflects the percentage of incident rainfall that runs off the surface rather than is absorbed into the ground. While natural areas typically exhibit imperviousness of 10 to 15 percent, imperviousness in urban areas can be significantly higher (60 to 90 percent).

In a pastoral condition, runoff from a watershed typically reaches the receiving waters through a combination of overland surface flow and subsurface transport, typically with ponding and other opportunities for retention and infiltration. The extensive tidal wetland areas previously surrounding Flushing Bay would have further attenuated wet-weather discharges. The urbanization of the watershed reduced infiltration and natural subsurface transport and eliminated natural streams previously tributary to Flushing Bay. Runoff is transported via roof leaders, street gutters and catch basins into the combined and separate sewer system, which then discharges directly to Flushing Bay since the wetlands have been eliminated. Urbanization has thus simultaneously decreased retention and absorption of runoff during transport and decreased the travel time for runoff to reach the waterbody. When combined with the increased runoff due to increased imperviousness of the watershed, the end result is increased peak discharge rates and higher total discharge volumes to the waterbody during wet weather and lower flow volumes during dry weather periods.

Urbanization has also altered the pollutant characteristics of wet-weather discharges from the watershed. The original rural landscape of forests, fields and wetlands represents pristine conditions with pollutant loadings resulting from natural processes (USEPA, 1997). These natural loadings, while having an impact on water quality in the receiving water, are subjected to natural attenuation process. For example, depending on the holding time, the volume of water in the wetland may go through nutrient attenuation or bacterial decay before discharging into Flushing Bay.

On the other hand, wet-weather discharges from urbanized areas are significantly stronger in pollutant concentrations than natural runoff. These pollutants include coliform bacteria, oxygen-demanding materials, suspended and settleable solids, floatables, oil and grease, and other materials.

A summary of the hydrologic changes caused by urbanization in the Flushing Bay watershed is presented in Table 3-21. The pre-urbanized condition is assumed circa 1900. The overall size of the watershed has increased by approximately 31 percent. Runoff yield for an average precipitation year as calculated by the RAINMAN model has increased from approximately 424 MG of natural runoff to 3,054 MG discharged by combined and separate sewer systems to Flushing Bay, an increase of over 600 percent. Significantly larger discharges are now made directly to the Flushing Bay at higher rates since they are no longer attenuated, filtered, and mitigated by “natural” overland mechanisms.

Table 3-21. Effects of Urbanization on Watershed Yield

Watershed Characteristic	Pre-Urbanization	Urbanized[1]
Drainage Area (acres)	4,858[2]	6,376
Population	Unknown	373,960[3]
Imperviousness (%)	10%	40%
Annual Runoff Yield (MG)	424	3,054[4]
Peak Storm Runoff Yield (MG)	28	192

(1) Existing condition, includes Meadow and Willow Lakes
(2) Based on Contour information
(3) Urbanized estimate based on Year 2000 U.S. Census.
(4) For an average precipitation year (JFK, 1988), including stormwater

A pollutant loading comparison is summarized in Table 3-22 using typical pollutant concentrations from literature sources. The table compares pre-urbanized pollutant loadings of total suspended solids and biochemical oxygen demand to the existing urbanized condition. The annual volumes used for this table are taken from those of Table 3-21 assuming an average precipitation year. Typical stormwater concentrations are used for the pre-urbanized condition, which are higher than those for a rural or pristine condition. The urbanized condition accounts for existing CSO and stormwater discharges. The table demonstrates that urbanization of the watershed has increased pollutant loadings to Flushing Bay by more than seven times the pre-urbanized amount.

Table 3-22. Effects of Urbanization on Watershed Loading

	Pre-Urbanization[1]	Urbanized[2]	Change(%)
Total Suspended Solids (TSS) [lbs/yr]	53,042	382,055	620
Biochemical Oxygen Demand (BOD) [lbs/yr]	53,042	382,055	620

(1) Circa 1900, using stormwater concentrations
(2) For an average precipitation year (JFK, 1988)

3.6.5 Toxics Discharge Potential

For industrial source control in separate and combined sewer systems, the USEPA required approximately 1,500 municipalities nationwide to implement Industrial Pretreatment Programs (IPPs). The intent of the IPP is to control toxic discharges to public sewers that are tributary to sewage treatment plants by regulating Significant Industrial Users (SIU). If a proposed IPP is deemed acceptable, USEPA decrees the local municipality a Control Authority. DEP has been a control authority since January 1987, and enforces the IPP through Chapter 19 of Title 15 of the Rules of the City of New York (Use of the Public Sewers), which specifies excluded and conditionally accepted toxic substances along with required management practices for several common discharges such as photographic processing waste, grease from restaurants and other businesses, and perchloroethylene from dry cleaning. DEP has been submitting annual reports on its activities since 1996. The 310 SIUs that were active at the end of 2004 discharged an estimated average total mass of 38.2 lbs/day of the following metals of concern: arsenic, cadmium, copper, chromium, lead, mercury, nickel, silver and zinc.

Early efforts to reduce the amount of toxic contaminants being discharged to the New York City open and tributary waters focused on industrial sources and metals. As part of the

IPP, DEP analyzed the toxic metals contribution of sanitary flow to CSOs by measuring toxic metals concentrations in WWTP influent during dry weather in 1993. This program determined that only 2.6 lbs/day (1.5 percent) of the 177 lbs/day of regulated metals being discharged by regulated industrial users were bypassed to CSOs. Of the remaining 174.4 lbs, approximately 100 lbs ended up in biosolids, and the remainder was discharged through the WWTP effluent outfall. Recent data suggest even lower discharges. In 2004, the average mass of total metals discharged by all regulated industries to the New York City WWTPs would translate into less than 1 lb/day bypassed to CSOs from regulated industries if the mass balance calculated in 1993 is assumed to be maintained. A similarly developed projection was cited by the 1997 DEP report on meeting the nine minimum CSO control standards required by federal CSO policy, in which DEP considered the impacts of discharges of toxic pollutants from SIUs tributary to CSOs (DEP, 1997). The report, audited and accepted by USEPA, includes evaluations of sewer system requirements and industrial user practices to minimize toxic discharges through CSOs. It was determined that most regulated industrial users (of which SIUs are a subset) were discharging relatively small quantities of toxic metals to the NYC sewer system.

As discussed in Section 4.4, currently there is one SIU located within the sewershed associated with combined sewer outfalls that discharge to Flushing Bay. In addition, DEC has not listed Flushing Bay as being impaired by toxic pollutants. As such, metals and toxic pollutants are not currently considered to be CSO-related pollutants of concern for the development of this Waterbody/Watershed Plan.

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4.0 WATERBODY CHARACTERISTICS

Located in north-central Queens, Flushing Bay is bounded by the East River to the north between LaGuardia Airport and the community of College Point. The bay is designated as all the water south of this point to the mouth of Flushing Creek. The Flushing Bay assessment area is composed of 6,423 acres of land in Queens, NY.

The following sections discuss the physical, chemical, and ecological conditions in Flushing Bay.

4.1 CHARACTERIZATION METHODOLOGY

The DEP's comprehensive watershed-based approach to long-term CSO control planning follows the USEPA's guidance for monitoring and modeling (USEPA, 1999). The watershed approach "represents a holistic approach to understanding and addressing all surface water, ground water, and habitat stressors within a geographically defined area, instead of addressing individual pollutant sources in isolation" (USEPA, 1999). The guidance recommends identifying appropriate measures of success based on site-specific conditions to both characterize water quality conditions and measure the success of long-term control plans. The measures of success are recommended to be objective, measurable, and quantifiable indicators that illustrate trends and results over time. USEPA's recommended measures of success are administrative (programmatic) measures, end-of-pipe measures, receiving waterbody measures, and ecological, human health, and use measures. USEPA further states that collecting data and information on CSOs and CSO impacts provides an important opportunity to establish a solid understanding of the "baseline" conditions and to consider what information and data are necessary to evaluate and demonstrate the results of CSO control. USEPA acknowledges that since CSO controls must ultimately provide for the attainment of water quality standards, the analysis of CSO control alternatives should be tailored to the applicable standards such as those for DO and coliform bacteria. Since the CSO Control Policy recommends reviews and revision of water quality standards, as appropriate, investigations should reflect the site-specific wet weather impacts of CSOs. The waterbody/watershed assessment of Flushing Bay therefore required a compilation of existing data, identification of data gaps, collection of new data, and cooperation with field investigations being conducted by other agencies, such as the United States Army Corps of Engineers (USACE), who was conducting its Flushing Bay Ecosystem Restoration Feasibility Study with DEP as a non-federal local sponsor. The USACE required data and information very similar to that required by DEP.

DEP has implemented its CSO facility planning projects consistently with this guidance and has developed these categories of information on waterbodies such as Flushing Bay. Waterbody/watershed characterization activities were conducted following the work plans and field sampling programs developed during the Use and Standards Attainment (USA) Project. These efforts yielded valuable information for characterizing Flushing Bay and its watershed as well as supporting mathematical modeling and engineering efforts. The following describes these activities.

4.1.1 Compilation of Existing Data

A comprehensive review of past and ongoing data collection efforts was conducted to identify programs focused on or including Flushing Bay and nearby waterbodies. The effort facilitated a compilation of existing biological, water quality and sediment data, and watershed information whenever available. Several sources of water quality and sediment data were available for Flushing Bay. In general, biological studies have been limited to Flushing Bay, and contiguous portions of Upper New York Bay and the East River. Since 1982, DEP has conducted facility planning projects that collected waterbody and watershed data pertinent to this waterbody/watershed assessment.

Previously reported water quality field surveys of the Flushing Bay system are summarized below.

1985 - "Field Investigations of Flushing Bay and Creek and Meadow and Willow Lakes" (Lawler, Matusky & Skelly, 1986). LMS performed several field data collection studies for the DEP during 1985. Studies included measurement of discharge and pollutant loadings from CSOs that discharge into Flushing Bay and Creek, in-situ water quality measurements, dye studies, and sediment oxygen demand (SOD) measurements. The water quality surveys were performed during three wet weather periods and one dry weather period. Weekly water quality samples were also collected.

1992 - "Additional Water Quality Investigations of Flushing Bay and Creek" (Lawler, Matusky & Skelly, 1993). LMS performed one dry weather survey and two wet weather surveys in 1992. Two stations were primarily sampled, one in Flushing Bay and one in Flushing Creek.

2000 -Water Quality Sampling Program (Lawler, Matusky & Skelly, 2001). A set of additional water quality surveys was conducted in the summer of 2000 as part of a cooperative ecological restoration program sponsored by DEP and the USACE. Study elements are summarized in Table 4-1.

Table 4-1. Year 2000 Flushing Bay and Creek Field Sampling Program Summary

Survey Component	Parameters	Stations / Locations	Surveys / Duration
1. Hydrodynamics	Current velocity w/ depth Current velocity over tidal cycle Tidal stage	3 stations 6 transects 4 locations	6 weeks 2 surveys 17 weeks
2. Intensive surveys	Primary [a], secondary [b], tertiary [c] Rainfall	6 stations (top, bottom) 2 stations	3 surveys 16 weeks
3. Weekly vertical profiles	DO, conductivity (salinity), temperature, secchi depth	6 stations	13 surveys
4. Photosynthesis/Respiration	Light/dark bottle DO, temperature, chlorophyll-a, sunlight radiation, secchi depth	3 stations	3 surveys
5. Sediment Oxygen Demand	In-situ: DO uptake, H_2S flux, NH_3 Laboratory: DO uptake, H_2S, NH_3	4 stations 10 cores	2 surveys
6. Hydrogen Sulfide	In-situ: sed H_2S flux; DO temp; conductivity (salinity), pH, depth Laboratory: sediment cores analyzed for TS, TVS, at 3 depths	20 stations 20 cores	2 surveys

[a] Primary parameters: temperature, conductivity (salinity), DO
[b] Secondary parameters: total BOD_5, total and dissolved hydrogen sulfide, total suspended solids
[c] Tertiary parameters: total Kjeldahl nitrogen, ammonia, nitrate, total phosphorus, filtered BOD_5, total volatile suspended solids, total organic carbon, dissolved organic carbon, chlorophyll-a, secchi depth

DEP's Harbor Survey program has been monitoring water quality in New York Harbor waters since 1909. Two Harbor Survey stations are in Flushing Bay: Station E6 at the mouth of the bay at the East River (monitored since 1914); and Station E15 located at a point on a line extending from the tidal breakwater in the bay, where the inner bay and outer bay meet (monitored from 1984 through 2000). Sampling occurs at Harbor Survey stations on a monthly basis during winter months and weekly during summer months. Harbor Survey monitoring locations are shown on Figure 4-1.

DEP’s Sentinel Monitoring Program has collected water quality data since 1999 to identify, monitor, and abate illegal sanitary connections that elevated bacteria levels may indicate. Stations are sampled on an approximately quarterly basis for fecal coliform bacteria at a station southeast of the La Guardia Airport runways (Station S66), at the mouth of the bay as it joins the East River (Station S65), and at the mouth of Flushing Creek (Station S06). Sentinel Monitoring Program sampling stations are shown on Figure 4-1.

4.1.2 Biological and Habitat Assessments

USEPA has for a long time indicated that water quality based planning should follow a watershed based approach. Such an approach considers all factors impacting water quality including both point and nonpoint (watershed) impacts on the waterbody. A key component of such watershed based planning is an assessment of the biological quality on the waterbody. The compilation of existing data indicated that recent and ongoing projects and programs have collected a variety of data in and around Flushing Bay and its watershed. The data can be used for waterbody/watershed characterizations, evaluating existing conditions, and identifying use attainability for aquatic life, recreation and aesthetics. Information has been collected in specialized projects to describe sewer system characteristics and performance.

Environmental Protection

Recent Receiving Water Monitoring Locations

FIGURE 4-1

The Flushing Bay waterbody/watershed assessment has compiled information regarding: landside runoff characteristics, sewer dry weather flow conditions, combined sewer system regulator configurations and outfall status, waterbody bathymetry, biotic communities, physical, chemical and biological sediment characteristics, and water column and sediment toxicity.

Fish and aquatic life use evaluations require identifying regulatory issues (aquatic life protection and fish survival), selecting and applying the appropriate criteria, and determining the attainability of criteria and uses. According to guidance published by the Water Environment Research Foundation (Michael & Moore, 1997; Novotny et. al., 1997), biological assessments of use attainability should include "contemporaneous and comprehensive" field sampling and analysis of all ecosystem components. These components include phytoplankton, macrophytes, zooplankton, benthic invertebrates, fish and wildlife. The relevant factors are dissolved oxygen, habitat (substrate composition, organic carbon deposition, sediment pore water chemistry), and toxicity.

Biological components and factors were prioritized to determine what was most in need of contemporary information relative to existing data or information expected to be generated by other ongoing studies, and/or, which biotic communities would provide the most information relative to the definition of use classifications and the applicability of particular water quality criteria and standards. The biotic communities selected for sampling included:

- Subtidal benthic invertebrates, historically used as an indication of environmental quality because most are sessile;
- Epibenthic organisms colonizing standardized substrate arrays suspended in the water column, thus eliminating substrate type as a variable in assessing water quality;
- Fish eggs and larvae, whose presence is related to fish procreation; and
- Juvenile and adult fish, whose presence is related to habitat preferences and water quality tolerances).

The waterbody/watershed assessment conducted a biological Field Sampling and Analysis Program (FSAP) designed to fill ecosystem data gaps for Flushing Bay. DEP's FSAPs were designed and implemented in conformance with USEPA's Quality Assurance Project Plan guidance (USEPA, 1998, 2001a, 2001b), its standard operation and procedure guidance (USEPA, 2001c), and in consultation with USEPA's Division of Environmental Science and Assessment in Edison, NJ. The FSAPs collected information to identify uses and use limitations within waterbodies assessing aquatic organisms and factors that contribute to use limitations (dissolved oxygen, substrate, habitat and toxicity). Some of these FSAPs were related to specific waterbodies; others to specific ecological communities or habitat variables throughout the harbor; and still others to trying to answer specific questions about habitat and/or water quality effects on aquatic life. Several FSAPs were conducted by DEP during the USA Project that included investigation of Flushing Bay.

DEP conducted its Harbor-Wide Ichthyoplankton FSAP in 2001 to identify and characterize ichthyoplankton communities in the open waters and tributaries of New York Harbor (HydroQual, 2001b). Information developed by this FSAP identified what species are spawning, as well as where and when spawning may be occurring in New York City's waterbodies. The FSAP was executed on a harbor-wide basis to assure that evaluations would be performed at the same time and general water quality conditions for all waterbodies. Sampling was performed at 50 stations throughout New York Harbor, its tributaries, and at reference stations outside the harbor complex. The locations of sampling stations are shown on Figure 4-2. Two stations were located in Flushing Bay. Samples were collected using a fine-mesh plankton net with two replicate tows taken at 50 stations in March, May and July 2001. In August 2001, 21 of the stations were re-sampled to evaluate ichthyoplankton during generally the worst case temperature and DO conditions.

DEP conducted a Harbor Wide Epibenthic Recruitment and Survival FSAP in 2001 to characterize the abundance and community structure of epibenthic organisms in the open waters and tributaries of New York Harbor (HydroQual, 2001c). The recruitment and survival of epibenthic communities on hard substrates was evaluated because these sessile organisms are good indicators of long-term water quality. This FSAP provided a good indication of both intra- and inter-waterbody variation in organism recruitment and community composition. Artificial substrate arrays were deployed at 37 stations throughout New York Harbor, its tributaries, and at reference stations outside the harbor complex. The locations of sampling stations are shown on Figure 4-3. Two stations were located in Flushing Bay. The findings of previous waterbody-specific FSAPs indicated that six months was sufficient time to characterize the peak times of recruitment, which are the spring and summer seasons. Therefore arrays were deployed in April 2001 at two depths (where depth permitted) and retrieved in September 2001.

A special field investigation was conducted during the summer of 2002 to evaluate benthic substrate characteristics in New York Harbor tributaries (HydroQual, 2002). The goals of this FSAP were to assist in the assessment of physical habitat components on overall habitat suitability and water quality and assist in the calibration of the water quality models as they compute bottom sediment concentrations of total organic carbon (TOC). Physical characteristics of benthic habitat directly and critically relate to the variety and abundance of the organisms living on the waterbody bottom. These benthic organisms represent a crucial component of the food web, and, therefore, the survival and propagation of fish. Samples were collected from 103 stations in New York Harbor tributaries using a petit ponar grab sampler in July 2002. The locations of sampling stations are shown on Figure 4-4. Fifteen of the stations were located in Flushing Bay. Two samples from each station were tested for TOC, grain size, and percent solids.

DEP conducted a Tributary Toxicity Characterization FSAP in 2003 to determine whether toxicity is a significant issue of concern for DEP’s waterbody evaluations (HydroQual, 2003b). Water column and sediment samples were collected from a total of twenty locations, including five locations in Flushing Bay (Figure 4-5). Water column toxicity was tested using 7-day survival and growth toxicity tests with Sheepshead minnow and 7-day survival, growth and consistency toxicity tests with mysid shrimp. Sediment chronic toxicity was evaluated using 28-day whole sediment chronic toxicity tests with Leptocheirus plumulosus. Survival, growth and fecundity of the species were evaluated. In addition to the toxicity tests, sediment samples were collected using an Ekomar dredge sampler and tested TOC, percent solids, and grain size to help determine the benthic substrate characteristics of the subtidal sediments related to sediment toxicity (if any). Sampling was conducted in August 2003.

As described above, numerous physical, chemical and biological FSAPs were executed by DEP to fill several key data gaps. The FSAPs were executed according to procedures defined in a Field and Laboratory Standard Operating Procedure (SOP) that was revised and enhanced as new investigations were identified and additional procedures were required. The SOP follows USEPA's Quality Assurance Project Plan (QAPP) guidelines to assure quality assurance and quality control (QA/QC). Data collected during these FSAPs were compiled in a relational database with QA/QC. Figure 4-6 is a composite map of the biological FSAP sampling station locations in Flushing Bay.

4.1.3 Other Data Gathering Programs

The USACE conducted its Flushing Bay Ecosystem Restoration Feasibility Study, with DEP and the Port Authority of New York and New Jersey as non-federal sponsors that funded fifty percent of the study. The feasibility study assessed environmental issues in Flushing Bay related to ecosystem restoration. A reconnaissance report was completed as part of the study in April 1996 (USACE, 1996), which demonstrated a federal interest for further study at the feasibility level. It identified six measures which might be taken in the interest of ecosystem restoration:

1) tidal wetlands restoration,
2) freshwater wetlands restoration,
3) dredging of parts of the bay and creek,
4) removal of part or all of the earthen dike,
5) reorientation of the federal navigation channel, and
6) shoreline bank stabilization, site cleanup and debris removal.

As part of the feasibility phase of the project, the USACE conducted or sponsored a number of substudies and field investigations, summarized as follows:

Northern Ecological Associates (2002a) reported on surveys of benthic macroinvertebrate sampling that was conducted in September 2001 in Flushing Bay (and in Flushing Creek as well as in nearby stations in the East River at College Point and Powell's Cove). A total of 29 invertebrate taxa were identified in the Flushing Bay and Creek samples. The abundance of annelids, the occurrence of nematode worms, and the lack of amphipods indicate poor benthic habitat quality. These findings were found to be consistent with the results of a 1995 survey of several New York and New Jersey bays (Iocco et al. 2000) that showed that Flushing Bay had some of the highest abundances of pollutant-tolerant species in the survey. The limited taxa diversity identified in the inventory is attributed to the fine grained organics-rich substrate and low oxygen concentrations.

Environmental Protection

Harbor-Wide Ichthyoplakton Sampling Stations (2001)

Flushing Bay Waterbody/Watershed Facility Plan

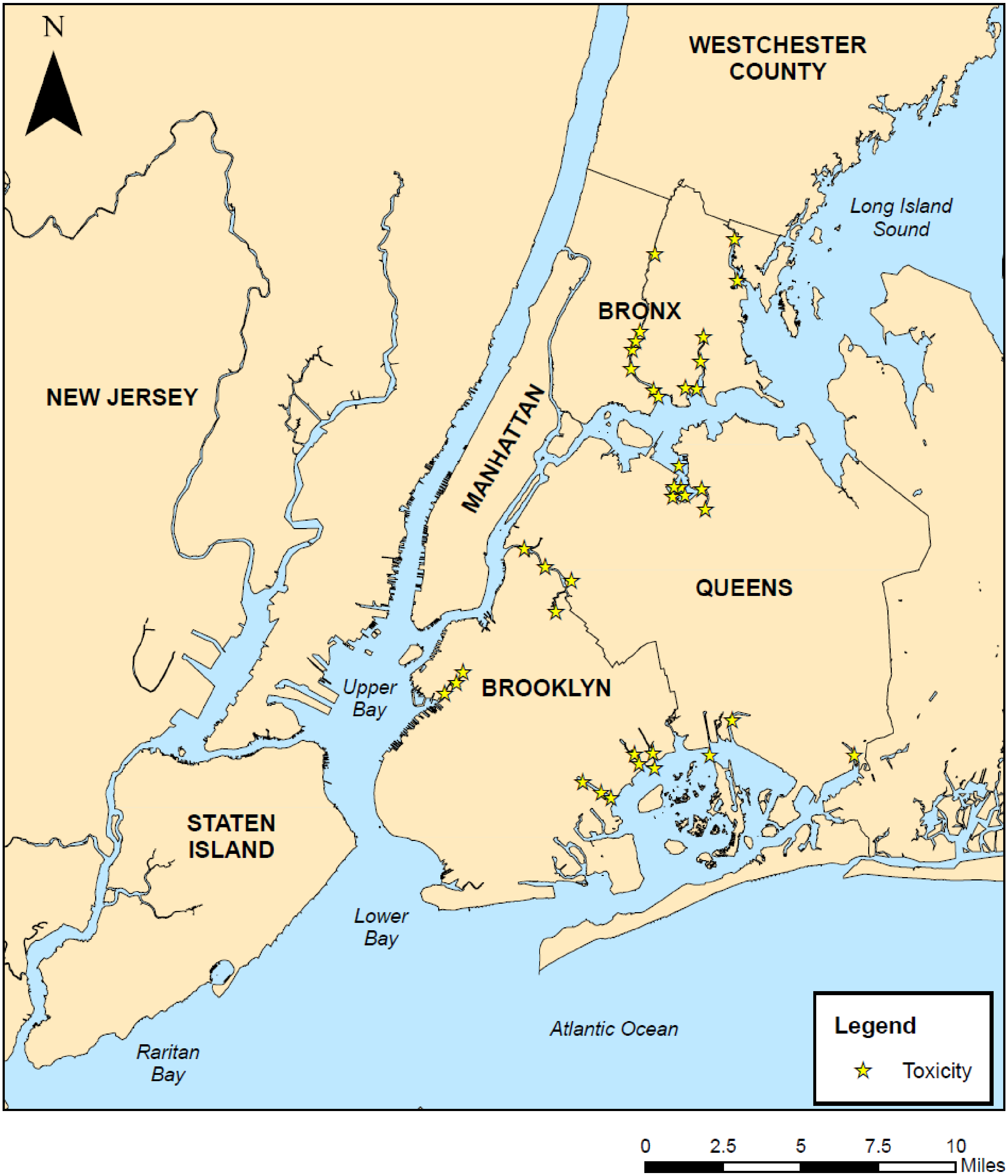
FIGURE 4-2

Environmental Protection

Harbor-Wide Epibenthic Recruitment and SurvivalSampling Stations (2001)

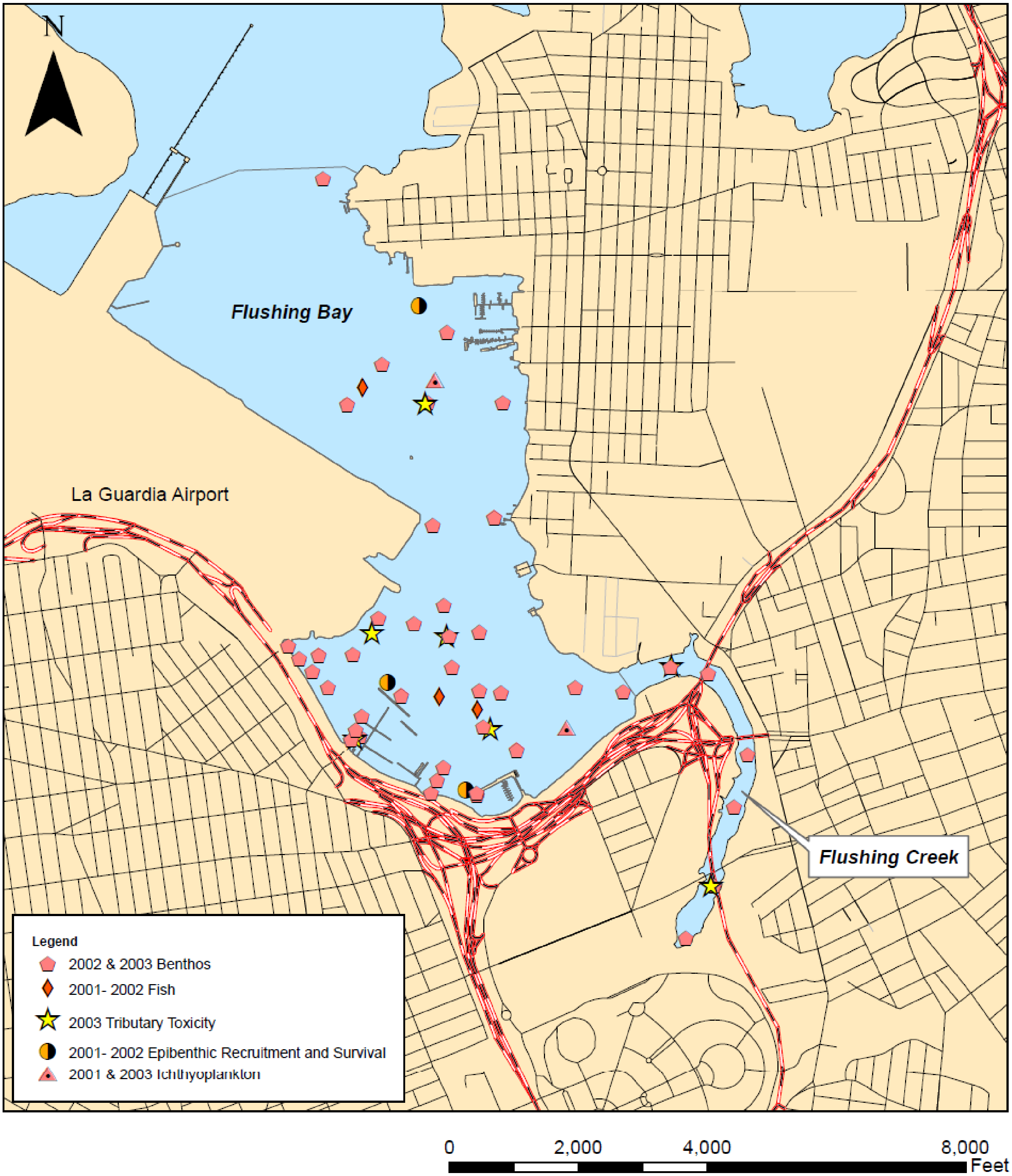
NYC Environmental Protection

Tributary Benthos Characterization Sampling Stations (2002)



Environmental Protection

Tributary Toxicity Characterization Sampling Stations (2003)



Flushing Bay Biological FSAP Sampling Locations

A companion study was also published at the same time on finfish (Northern Ecological Associates (2002b). This document characterized finfish species that had been reported to have been collected in Flushing Bay during the summer of 2001; however, densities of the reported species were not available. The descriptive narrative of the report utilized was primarily based on compilation of information accrued from regional data of the identified species, to supplement the limited subset of specific Flushing Bay data.

4.1.4 Receiving Water Quality Model

A set of coupled mathematical models were developed and calibrated to simulate the influence of CSO and stormwater loads on water quality in Flushing Bay. Flushing Bay is part of the East River Tributaries Model (ERTM), which encompasses the lower and upper East River and its principal tributaries and embayments, as well as part of western Long Island Sound. Hydrodynamic and water-quality information at ERTM's open boundaries are provided by the larger-scale System-Wide Eutrophication Model (SWEM), which encompasses all of NY-NJ Harbor, the Hudson River as far upstream as Poughkeepsie, the East River, Long Island Sound, and the continental shelf of the New York-New Jersey Bight from Cape May, New Jersey in the southwest to the Nantucket Shoals in the northeast (HydroQual, 2001d). Whereas SWEM's coarse-resolution grid provides basic hydrodynamic and water-quality results in the open waters of the model's large domain, ERTM's finer-resolution grid was designed specifically to provide more detailed hydrodynamic and water-quality results in the smaller CSO-impacted waterbodies of New York City's East River. ERTM and SWEM are both three-dimensional, time-variable, coupled hydrodynamic and water-quality models based on finite-difference approximations. A variety of calibrated watershed/sewershed models (InfoWorks CS, XP-SWMM, RAINMAN, RRMP) were used to determine stormwater and CSO flows and loads to the receiving waters in different parts of the model domains. Schematics of the SWEM and ERTM model grids are shown in Figures 4-7 and 4-8.

The hydrodynamic component solves the three-dimensional advection-diffusion equations for water motion and includes forcing due to winds, tides, surface heat flux, freshwater discharge and other lateral boundary conditions. Vertical turbulent mixing is driven by a Mellor Yamada (1982) level-2.5 turbulence closure scheme as modified by Galerpin et al. (1988). ERTM hydrodynamics include a "wetting and drying" algorithm that allows the model to simulate the emergence and submergence of extensive intertidal mudflats that occur in many of the East River tributaries and embayments, including the 2,250-ft, partially dismantled breakwater that extends into Flushing Bay from the southeastern tip of La Guardia Airport.

The water-quality component incorporates advection-diffusion and temperature-salinity results from the hydrodynamic models to solve three-dimensional coupled kinetic mass-balance equations describing the biochemical interactions between aquatic biota (phytoplankton, zooplankton, and benthic bivalves), nutrients (nitrogen, phosphorus, and silica), various forms of organic carbon, dissolved oxygen (DO), as well as special contaminants of interest (e.g., total and fecal coliforms and enterococci). A sediment-flux submodel couples water-column biochemistry with sediment diagenesis, remineralization of settled particulate organic matter (POM), and the resultant uptake of near-bottom DO through sediment oxygen demand (SOD). Sources of nutrient and contaminant loads to the water-quality models include wet and dry atmospheric deposition, rivers and creeks, stormwater, CSOs, and effluent from major municipal and industrial wastewater treatment plants. DO kinetics include surface reaeration, nitrification, photosynthesis, metabolic oxidation, and SOD. In-stream aeration can be included as required by water-quality projection alternatives.

The model system described above was used to establish baseline conditions against which all alternatives are compared for quantifying water-quality benefits. Table 4-2 summarizes the assumptions used for the Baseline simulation.

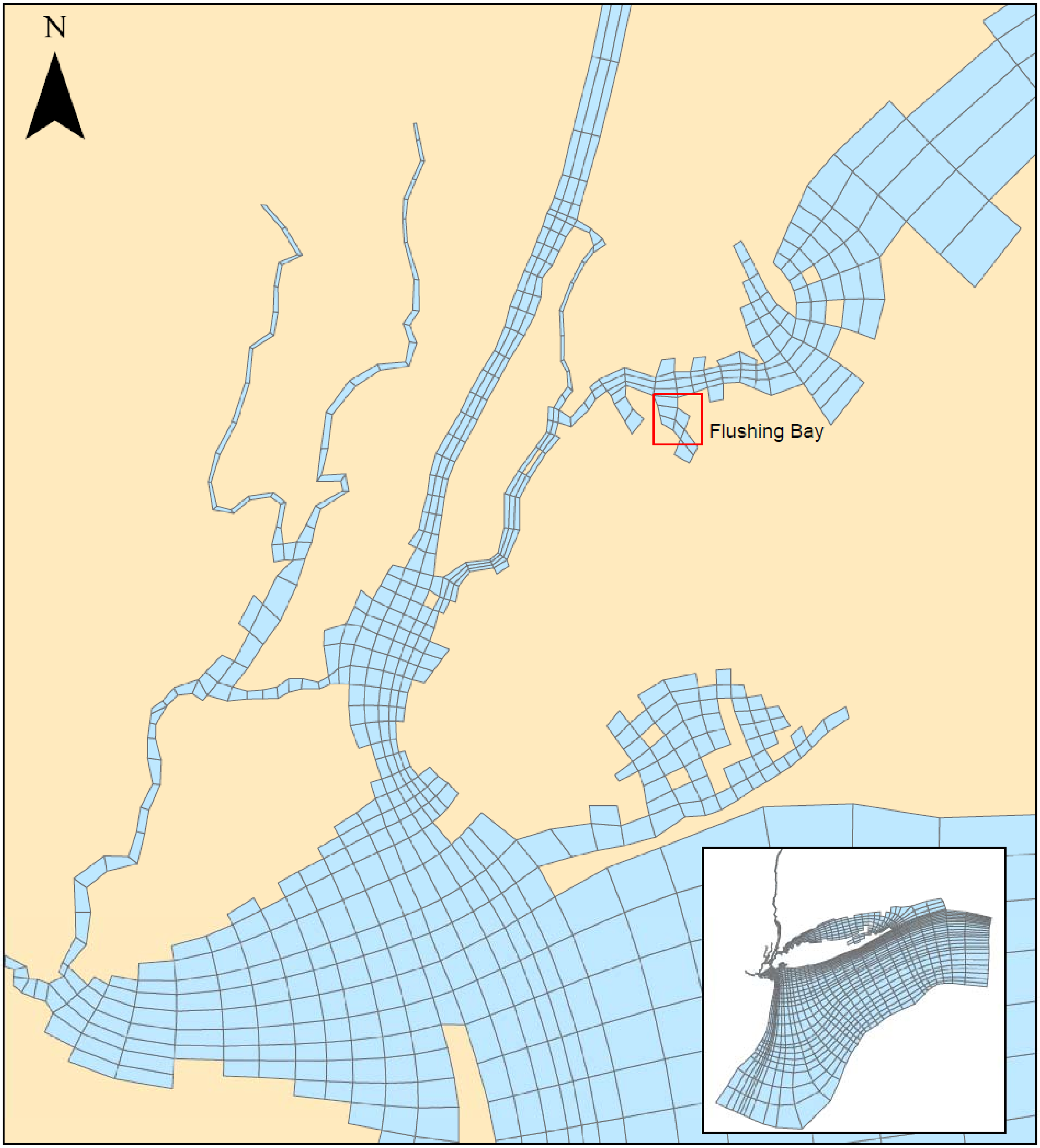
Table 4-2. Baseline Water-Quality Modeling Conditions

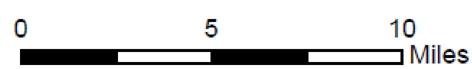
Model Component	Model	Baseline Conditions
Watershed Pollutant Flows and Loads	InfoWorks CS, XP-SWMM, RRMP, RAINMAN	1988 precipitation for wet-weather flows; 2045 population projection for dry-weather flows; 2003 sustained wet weather flow capacity at Tallman Island and Bowery Bay WWTPs
Boundary Conditions	SWEM	1988 precipitation, meteorological and tidal forcing, river and creek discharge, and insolation; nitrogen loads in Long Island Sound adjusted to meet Phase III TMDL requirements
Regional Water Quality	ERTM	1988 precipitation, meteorological and tidal forcing, river and creek discharge, and insolation; 2045 projected WWTP loads
Receiving Water	Flushing Bay	Calculated results

4.2 PHYSICAL WATERBODY CHARACTERISTICS

Flushing Bay is classified as an embayment due to its shape and size. Flushing Bay (Figure 2-2) can be divided into two parts, the outer bay and the inner bay, and the inner bay is further subdivided in two. The outer bay is bounded on the north by its interface with the East River, on the east by the College Point neighborhood of Queens and on the west by LaGuardia Airport runways. The inner bay is subdivided by a manmade “finger dike” or breakwater which extends southward from the end of the La Guardia Airport. The principal flow channel running from Flushing Creek on the south to the outer bay on the north traverses through the inner bay on the east side of the breakwater. The west side of the inner harbor (west of the breakwater) is shallower. It contains a number of marinas for recreational vessels. The effects of the breakwater have been controversial, with some parties hypothesizing that the breakwater isolates this portion of the inner bay, and contributes to excessive settling of organic matter with resultant odorous sediment deposits. However, mathematical hydrodynamic modeling of the bay indicate that the breakwater does not have substantial impact, and that currents in the bay would not be substantially different if it were not there (US Army Corps of Engineers, 2003).

Flushing Bay is completely within the Coastal Zone Boundary as designated by the New York City Department of City Planning (NYCDCP). The NYCDCP has also designated a portion of the western shore of Flushing Bay, between the northeastern corner of LaGuardia Airport and the mouth of Flushing Creek, as a Significant Natural Waterfront Area (SNWA). As designated by NYCDCP, an SNWA is a large area of concentrated natural resources, such as wetlands and natural habitats, which possesses a combination of important coastal ecosystem features.



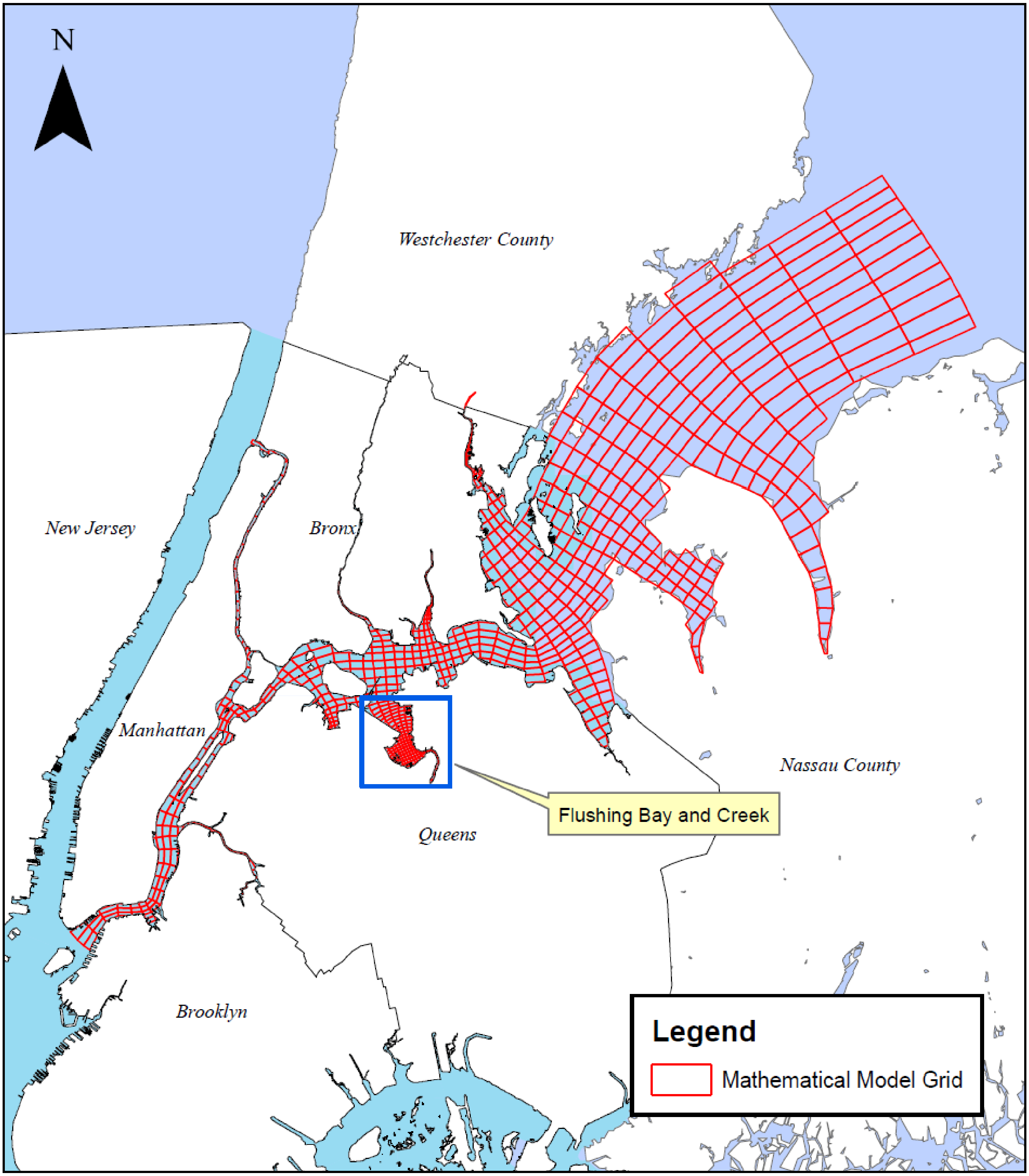


Environmental Protection

SWEM Segmentation Grid

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE 4-7



1 inch equals 3.6 miles

Environmental Protection

ERTM Segmentation Grid

FIGURE 4-8

4.2.1 Physical Shoreline Characterization

Flushing Bay has been significantly altered due to dredging, bulkhead, rip rap, marina construction and the addition of fill material. The shorelines of Flushing Bay are composed primarily of rip-rap, bulkhead, and marinas, although areas of natural, sand shoreline and natural, vegetated shoreline exist. The western shoreline is comprised mainly of rip-rap, with areas of marinas, bulkhead and natural, vegetated shoreline. Natural areas are located along the southern and western shorelines, between the piers within the World's Fair Marina and along the eastern boundary of LaGuardia Airport. The areas of natural shoreline within the World's Fair Marina and along the eastern boundary of LaGuardia Airport are predominantly vegetated, with an area of sand shoreline located at the northeast tip of LaGuardia Airport. The breakwater extending from the airport into the bay is classified as natural due to the vegetation present on this intermittently exposed strip of manmade land. The eastern shoreline of the bay is composed mainly of rip-rap, interspersed with areas of pier and bulkhead. Four areas of natural shoreline are located along the eastern shoreline. An area of vegetated shoreline is located just west of the mouth of Flushing Creek and extends approximately 1,200 feet to the west. A 500-foot stretch of sand shoreline is located just south of 31st Avenue. Another area of sand shoreline interspersed with piers stretches for roughly 2,200 feet between 30th Avenue and 25th Road. Lastly, a small area of vegetated shoreline, approximately 100 feet in length, is located at the terminus of 22nd Avenue.

4.2.2 Benthos

The bottom of Flushing Bay system is generally characterized as mud/silt/clay with some areas of sand. This classification has been assigned based on the following six sediment sampling programs which analyzed sediment grain size:

1. Nine core samples taken by the USACE during a dredging study in 2001;
2. Grab samples taken at one USEPA station in 1991;
3. Sampling performed at seventy-five National Oceanographic and Atmospheric Association (NOAA) stations during benthic habitat studies in 1994 and 1995;
4. Grab samples taken at one HydroQual, Inc. sampling station in 2001;
5. Grab samples taken at nineteen HydroQual, Inc. sampling stations in 2002;
6. Grab samples taken at twenty HydroQual, Inc, sampling stations in 2003.

For the purpose of defining surficial geology/substrata, those areas where bottom samples were more than 50 percent mud/silt/clay were listed as mud/silt/clay.

2001 USACE Dredging Study

The USACE dredging study included sampling in both Flushing Bay and Flushing Creek. Collected core samples were composited, then analyzed for grain size. Based on nine samples collected for the USACE dredging study in Flushing Bay, bottom mud/silt/clay percent composition was approximately 96.1 percent; and sand percent composition was approximately 3.7 percent.

1991 USEPA Grab Samples

Based on USEPA sampling, bottom mud/silt/clay percent composition was 92.6 percent.

1994 and 1995 NOAA Sampling

As part of a larger New York harbor-wide study, the NOAA performed two types of sediment sampling techniques in Flushing Bay. Fifty-nine sediment samples were taken from benthic grabs in Flushing Bay. These samples were later analyzed using a sieve system to determine grain size. Sediment Profile Imaging (SPI) data was also collected utilizing a sediment profile camera apparatus. Two photographs were taken at each of 59 stations in Flushing Bay.

Based on sixteen NOAA grab samples, bottom mud/silt/clay percent composition ranged from approximately 76.54 percent to 99.8 percent; and bottom sand percent composition ranged from 0.20 percent to 23.46 percent. Based on 58 of 59 SPI samples, bottom composition of Flushing Bay consisted primarily of mud/silt/clay. One SPI sample consisted of rock; however grab samples collected in the immediate vicinity of that station yielded mud/silt/clay results and the station was located near shore in close proximity to a rip rap shoreline.

2001 HydroQual Grab Samples

Based on HydroQual sampling in August 2001, bottom mud/silt/clay percent composition was approximately 95.35 percent; sand percent composition was 4.65 percent.

2002 HydroQual Grab Samples

HydroQual sampling in July 2002 consisted of grab samples collected at thirteen stations in Flushing Bay and six stations in Flushing Creek. Samples taken in Flushing Bay indicated a predominantly mud/silt/clay bottom, with some areas of sand bottom. Areas designated mud/silt/clay ranged from a mud/silt/clay percent composition of 61.98 percent to 90.94 percent; and sand percent composition of 9.06 percent to 38.02 percent. Areas designated sand ranged from a mud/silt/clay percent composition of 28.80 percent to 47.69 percent; and sand percent composition of 52.31 percent to 71.20 percent.

2003 HydroQual Grab Samples

HydroQual sampling for the *Flushing Bay and Creek Benthos Characterization Field Sampling Analysis Program* (HydroQual 2003a) in August 2003 consisted of grab samples collected at nineteen stations in Flushing Bay. Sixteen of the nineteen samples taken in Flushing Bay indicated a predominantly mud/silt/clay bottom, with some areas of sand bottom. Areas designated mud/silt/clay ranged from a mud/silt/clay percent composition of 66.33 percent to 99.19 percent and gravel percent composition of 0 percent to 6.79 percent. Two samples were designated sand, and ranged from a mud/silt/clay percent composition of 21.02 percent to 38.21 percent; sand percent composition of 54.72 percent to 63.61 percent; and gravel percent composition of 0 percent to 15.37 percent. The remaining sample, taken northeast of the western shoreline of Flushing Bay in the World’s Fair Marina, was comprised of 31.34 percent mud/silt/clay; 31.54 percent sand; and 37.12 percent pebbles.

4.2.3 Waterbody Access

As discussed in Section 2, there are many locations for public access to Flushing Bay, including the World's Fair Marina, the marinas and yacht clubs located along the eastern shore of the Bay along College Point, and the Flushing Bay Promenade.

4.2.4 Hydrodynamics

Hydrodynamic characteristics of Flushing Bay are controlled by its physiography, its tidal exchange with the East River, and the mostly episodic input of freshwater from the surrounding watershed. The mean diurnal tidal range in Flushing Bay is about 7.1 feet and 8.3 feet during spring tides. A short tidal prism, however, limits tidal flow, which attenuates rapidly from the confluence of the bay and the East River. Despite large ranges in tidal height, tidal exchange is restricted, and the bay becomes a depositional area exhibiting low bottom shear stresses. Modeling and dye studies suggest an exchange half life of 22 to 24 h in the southern portion of Flushing Bay. Once fluid from the bay has exchanged with the fast flowing and well-mixed East River, however, less than five percent will be reintroduced back to the bay.

Much of Flushing Bay is shallow, with depths varying from 2 to 10 feet. Large expanses of intertidal mudflats are exposed at low tides, particularly along the periphery of LaGuardia Airport. A 300-ft wide, 16-ft deep navigation channel bisects the throat of the Bay tends to channelize tidal flow between the inner bay and the East River. Flow patterns in the bay are altered by the remnants of a partially dismantled breakwater that extends southward some 2,250 feet from the southeastern tip of LaGuardia Airport. This breakwater is submerged by several feet during moderately high tides, allowing direct exchange between the inner bay behind the breakwater and the deep navigation channel connecting to the East River. When the breakwater reemerges with an ebbing tide, exchange between the inner bay and the outer bay must divert around the tip of the breakwater.

Due to urbanization of the surrounding watershed, natural freshwater flow to Flushing Bay is limited to the minimal base flow (~ 5 cfs) at the head of Flushing Creek, which originates as groundwater flow to the two man-made lakes. Thus, during dry weather, Flushing Bay is "estuarine" only in the sense that the source water from the East River is comprised of ocean water mixed with freshwater from the Hudson River, as well as several smaller freshwater tributaries to the East River and to Long Island Sound. More significant, but episodic, sources of freshwater to the bay are discharges from stormwater and combined-sewer outfalls, as well as direct runoff from the watershed. Thermohaline stratification can occur in Flushing Bay following large to moderate rainfall events, suppressing oxygen exchange between the surface and bottom water. Since stormwater and combined-sewer discharges are also significant sources of reactive organic carbon, the rainfall-induced stratification coupled with a high oxygen demand in the water and sediments can result in intervals of hypoxia and even anoxia in limited areas of inner Flushing Bay. This condition is exacerbated during the warmer months of the year, when organic decomposition is accelerated and oxygen saturation in water is naturally lower. In the absence of additional rainfall, thermohaline stratification in the bay usually breaks down within a few tidal cycles, due to vertical turbulent mixing and exchange of fluid with the East River.

Another feature of Flushing Bay that has attracted much attention is the finger dike or breakwater. Visual observation and historical anecdotes both suggest that the Flushing Bay finger dike has impeded circulation and contributed to the accumulation and shoaling of organically rich fine-grained sediments in the inner bay, with attendant detrimental impacts on water quality. However, previous simulations with a coupled hydrodynamic and water-quality model found that finger-dike removal would not improve water quality, as characterized by the concentration of dissolved oxygen (USACE 2003). During assessments conducted by the USACE as part of their ecosystem restoration evaluations, an Einstein-Krone relationship for mass deposition rate was added to a hydrodynamic-eutrophication model to see whether finger-dike removal might result in beneficial hydrodynamic changes (e.g., increased bed shear stresses or decreased fluid residence times) that would decrease the net deposition of fine-grained sediments and, thereby, improve sediment and water quality by reducing sediment organics and sediment oxygen demand (USACE 2003). Simulations were conducted for both a shallow- and a deep-removal scenario, but resulting changes in depositional patterns did not produce significant improvements in sediment quality, as characterized by the concentration of total organic carbon (TOC). That is not to say that the finger dike has not contributed to local deposition and accelerated shoaling of fine-grained sediments. It indicates, instead, that in the absence of the finger dike, the sediments would have accumulated elsewhere in the bay, with the same overall effect on sediment and water quality. It was concluded from this work that finger-dike removal would not significantly improve sediment, water-quality, and ecosystem conditions, nor reduce the occurrence of nuisance odors that are bothersome to the community.

4.3 CURRENT WATERBODY USES

Flushing Bay has a significant mix of commercial and recreational uses along the immediate shoreline. The recreational uses include boating, fishing, and use of immediate shoreline amenities. All of these would be considered secondary contact recreational uses. There are no recognized public or private beaches, and searches of internet posted documentation did not yield any instances of informal recreational bathing activities.

A principal area of recreational use is along the southwestern shoreline of the inner bay. The city has promoted waterfront access along this shoreline with the Flushing Bay Promenade, which stretches from LaGuardia Airport in the north to Citi Field in the south. Most of this shoreline occupied by the World's Fair Marina, which is owned and operated by the New York City Department of Parks and Recreation. This marina operates year-round with both summer and winter contracts. The marina has potential for approximately 800 slips; however, is currently operating with approximately 330 slips. According to the marina dockmaster (Smith, 2005), the impacts of discharges from the local CSO outfalls (principally outfalls BB-006 and BB-008) located right in the midst of the marina are a significant factor in the reduced number of boat slips. Sediment mounds in the immediate vicinity of these outfalls are a source of substantial adverse odors, and the accumulated sediment mounds physically interfere with boat operation in low tide conditions.

Fishing is also promoted along the southwest shoreline, with the Queens Community Board 3 citing that "there are many pleasant fishing spots along the Flushing Bay Promenade" (Queens Community Board 3, 2004). However, the web site goes on to qualify this recommendation by noting that "one downside to the spot is a strong odor that sometimes presents itself at low tide. Caused by a poorly designed sewerage system and the "finger," a water calming feature built for the 1964 World's Fair, this problem has been a priority for the Queens Community Board 3 for many years."

Two other privately operated marinas are located on the College Point shoreline on the northeast shoreline of the outer bay. These are the Williamsburg Yacht Club and the Skyline Marina. There are some additional marina structures along the eastern shore that are no longer operating.

4.4 CURRENT WATER QUALITY CONDITIONS

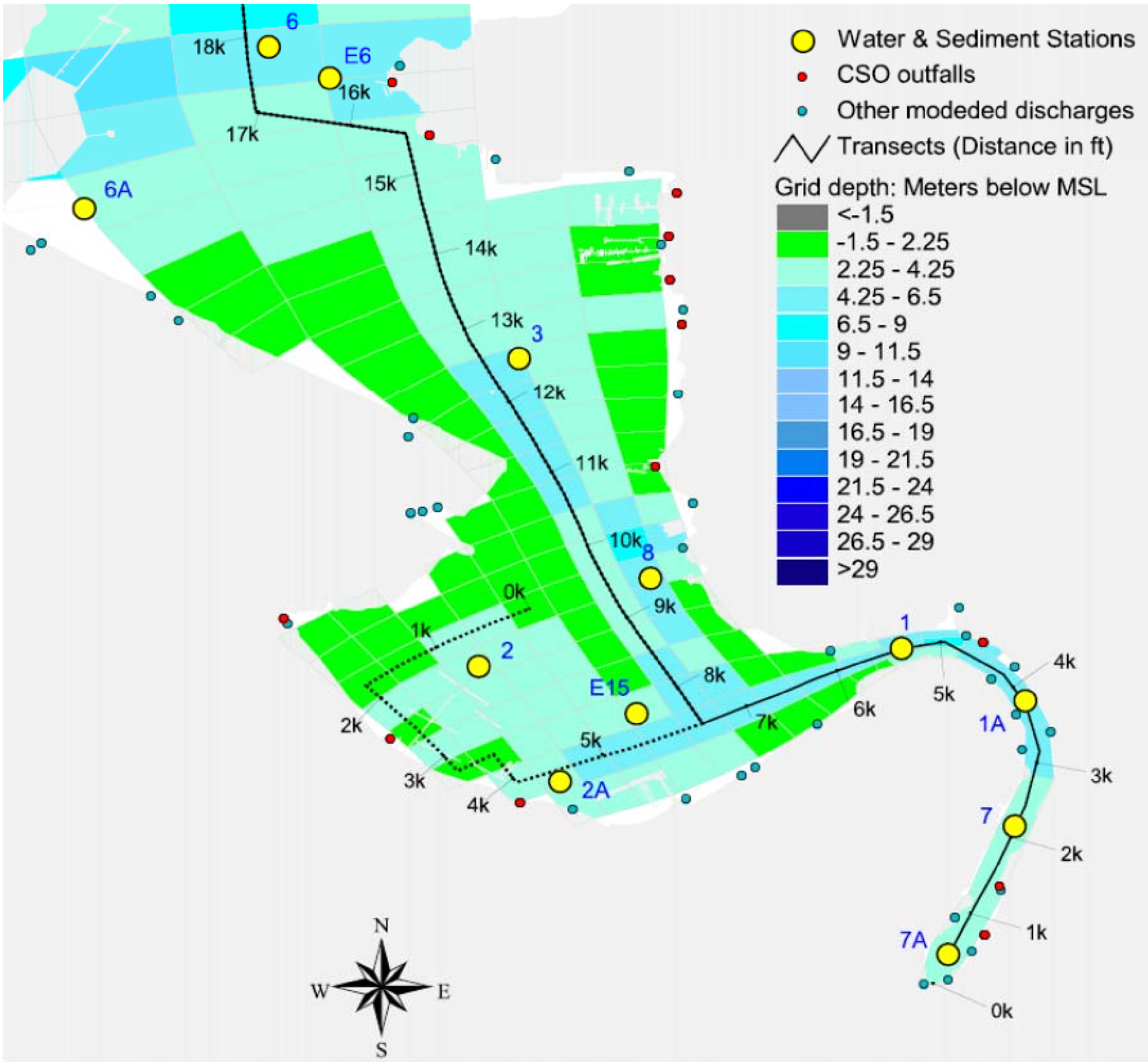
A mix of historical data and receiving water quality modeling is used to establish water quality conditions in Flushing Bay. As discussed in Section 4.1.1, there have been several water quality investigations over the last two decades. However, for the purposes of alternatives evaluations, existing and historical conditions do not provide an appropriate point of comparison, so the water quality model is necessary to provide a projection of future water quality both with and without CSO controls.

4.4.1 Dissolved Oxygen

The weekly vertical profiles of conductivity, temperature and depth (CTD) from the LMS 2001 Water Quality Sampling Program included measurements of dissolved oxygen at multiple depth levels. Table 4-3 presents the vertically and temporally averaged DO measurements for each weekly survey at each of the six stations (all values expressed in mg/L). There are a total of eight sampling locations marked 1 through 8, with two of the eight locations situated outside of the watershed (locations 4 and 5). All sampling locations within the watershed boundary are shown in Figure 4-9, along with three Harbor Survey sampling locations (E14, E15 and E6 shown on Figure 4-1 and 4-9), and the transect lines for the ERTM model.

Table 4-3. Flushing Bay LMS 2000 Weekly Dissolved Oxygen Data, Sampling Event Average

Date	LMS Station 2	LMS Station 8	LMS Station 3	LMS Station 6
06/07	4.4	5.2	5.5	5.8
06/14	3.8	4.5	4.7	4.9
06/21	7.8	7.2	5.8	5.1
06/28	2.8	3.6	3.8	3.9
07/06	5.8	5.2	4.7	4.3
07/12	7.5	7.1	5.6	4.0
07/19	5.1	5.1	4.5	3.3
07/27	2.5	3.6	3.6	3.7
08/04	3.1	3.6	3.6	3.7
08/10	5.3	5.4	4.6	3.3
08/18	4.7	4.9	4.4	4.2
08/24	5.4	5.5	4.8	4.4
08/31	3.1	3.9	4.0	3.9
Average	**4.7**	**5.0**	**4.6**	**4.2**
Note: Sampling station locations are shown on Figure 4-9. All the stations shown on Figure 4-9 are LMS stations. Therefore, only the numeric portion of the ID is shown on the figure.				



ERTM Model Grid with Water Quality Modeling Locations (LMS 2000 and Harbor Survey Stations

All stations had average DO values at or above the state standard (4.0 mg/L) during only seven of the thirteen surveys (06/07, 06/21, 07/06, 07/12, 07/19, 08/18, and 08/24). In addition, average DO values at all stations were below the state standard during three of the surveys (06/28, 07/27, and 08/04).

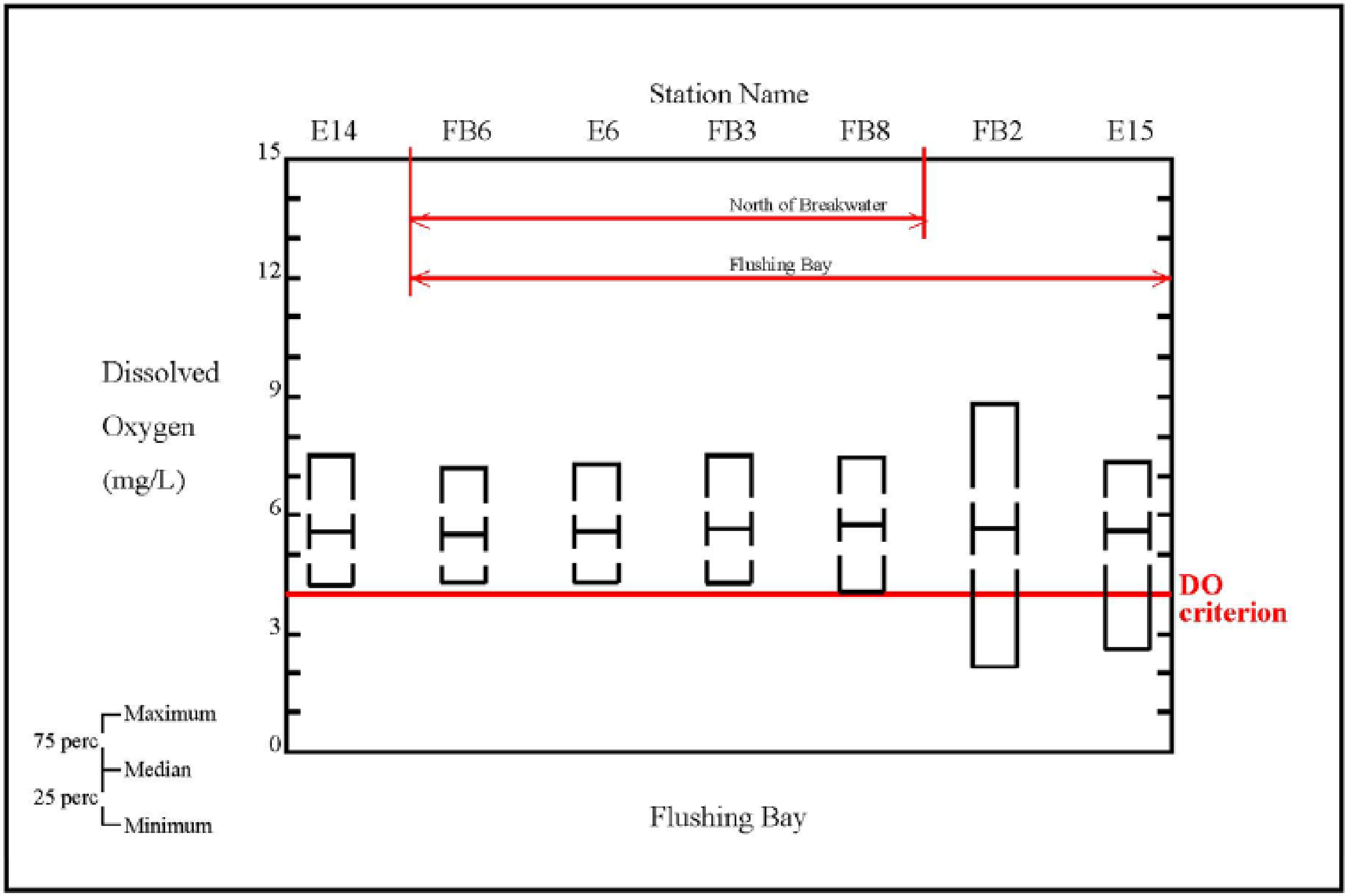
Data collected from Harbor Survey locations within Flushing Bay during the year 2000 is shown in Table 4-4. The location of these sampling points is shown in Figures 4-1 and 4-9. The data was collected between mid-May through September 2000. Average DO for these stations were at or above the state standard (4.0 mg/L) during all of the eleven surveys.

Table 4-4. Year 2000 Winkler DO Concentrations at Harbor Survey Stations E6 and E15

	Station E6		**Station E15**	
Date	**DO Bottom**	**DO Surface**	**DO Bottom**	**DO Surface**
5/15/2000	7.0	7.1	6.7	7.0
5/22/2000	5.4	6.2	4.7	5.3
5/31/2000	6.2	6.4	7.4	5.9
6/28/2000	4.4	4.7	4.3	4.1
7/12/2000	4.7	10.9	7.3	15.5
7/24/2000	5.8	6.1	12.6	10.8
8/17/2000	4.7	4.6	6.5	8.7
8/23/2000	7.2	6.4	5.7	7.8
8/30/2000	5.0	5.0	4.6	5.0
9/11/2000	4.5	4.8	4.8	5.5
9/25/2000	4.1	4.3	4.1	4.5
ALL	**5.4**	**6.0**	**6.2**	**7.3**

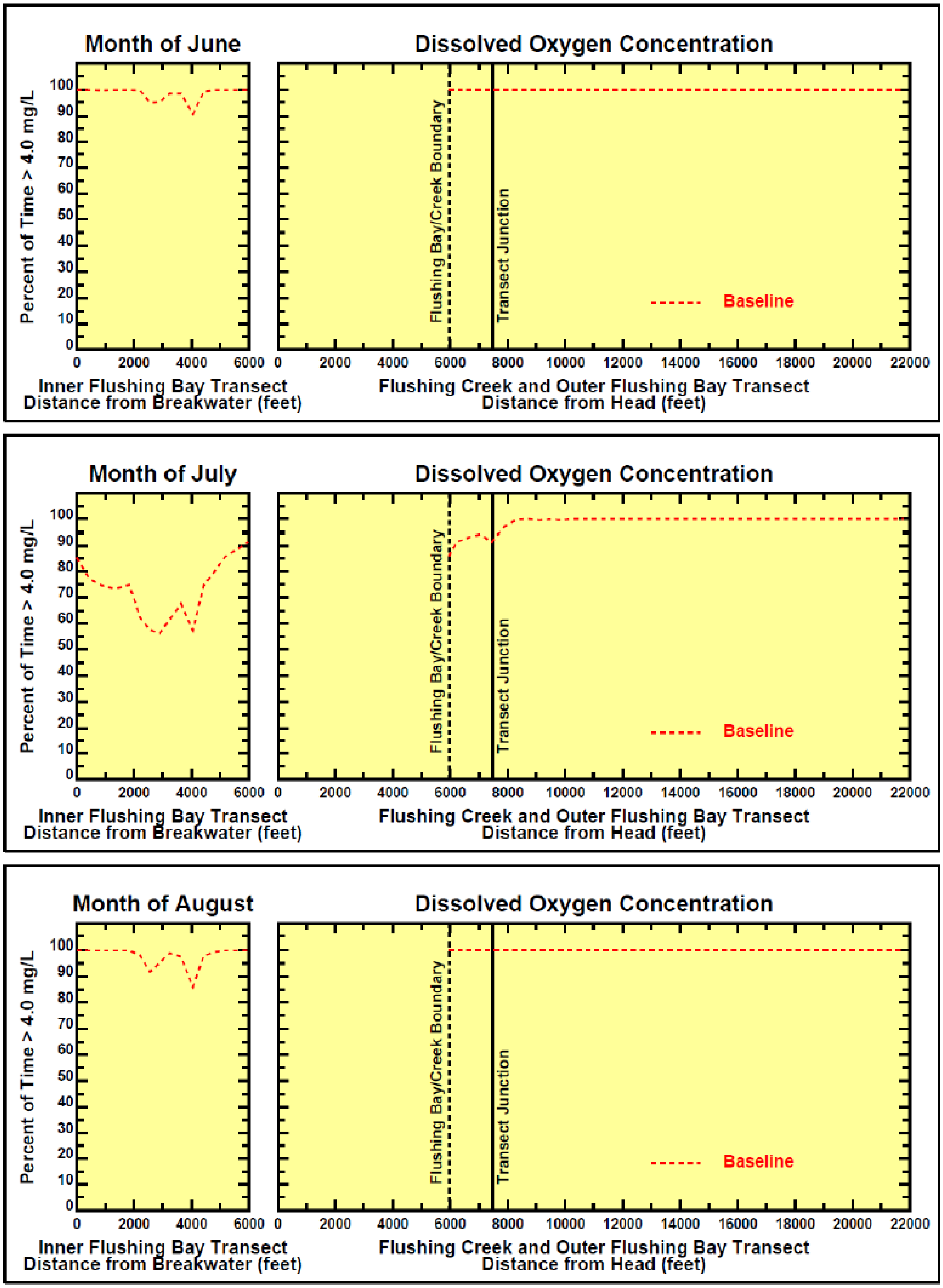
The ERTM receiving water quality model was run to establish Baseline conditions in Flushing Bay for alternatives evaluations. The range of model calculated hourly average DO values for the stations shown in Figure 4-9 are shown in Figure 4-10 (LMS sampling stations are numbered 1 through 8 and are shown on Figure 4-9, all other stations are shown on Figure 4-1)). Figure 4-10 also shows modeled DO values for Harbor Survey Station E14, which is located outside of Flushing Bay in the East River, near Hunts Point. Station E14 results were included to give a sense of how the DO concentration changes through the confluence of the Bay with East River. For each station, the top, middle, and bottom horizontal lines represent the maximum, median, and minimum values, respectively. In addition, the top and bottom breaks in the vertical lines represent the 75th and 25th percentile values, respectively. The calculated model results in Figure 4-10 indicate that under Baseline conditions, the DO concentrations are consistently calculated to be greater than the 4.0 mg/L standard only at the stations north of the finger dike. For stations 2 and E15, the model calculates DO concentrations lower than the 4.0 mg/L standard, but less than 25 percent of the time.

In addition, the portion of the time the model calculates DO concentrations lower than 4.0 mg/L is plotted as a function of distance in Figure 4-11, for June, July, and August. For each of the three months, the smaller graph on the left presents the calculated DO along the dashed transect axis as shown in Figure 4-9, starting where it reads “0 k”. Likewise, the larger graph on the right presents the calculated DO along the solid transect axis as shown in Figure 4-9, starting at the upstream end of Flushing Creek.



Baseline Condition Summertime Dissolved Oxygen Percentiles

FIGURE 4-10



Environmental Protection

Baseline Bottom DO by Distance

July is by far the most critical month in terms of DO with calculated concentrations less than 4.0 mg/L 40 percent of the time.

4.4.2 Total and Fecal Coliform Bacteria

DEP currently collects fecal coliform data at Station S65 in Flushing Bay (See Figure 4-1). The quantity of data available from this location is limited compared to similar data collected along the main axis of the East River. Quarterly data measured at station S65 is summarized in Table 4-5 below. Note that compliance for fecal coliforms is based on a monthly geometric mean, so a single high value is inadequate for compliance assessment. During the 1992 dry weather surveys, total coliform counts occasionally exceeded the standard in the bottom waters of the Flushing Bay station (LMS,1993).

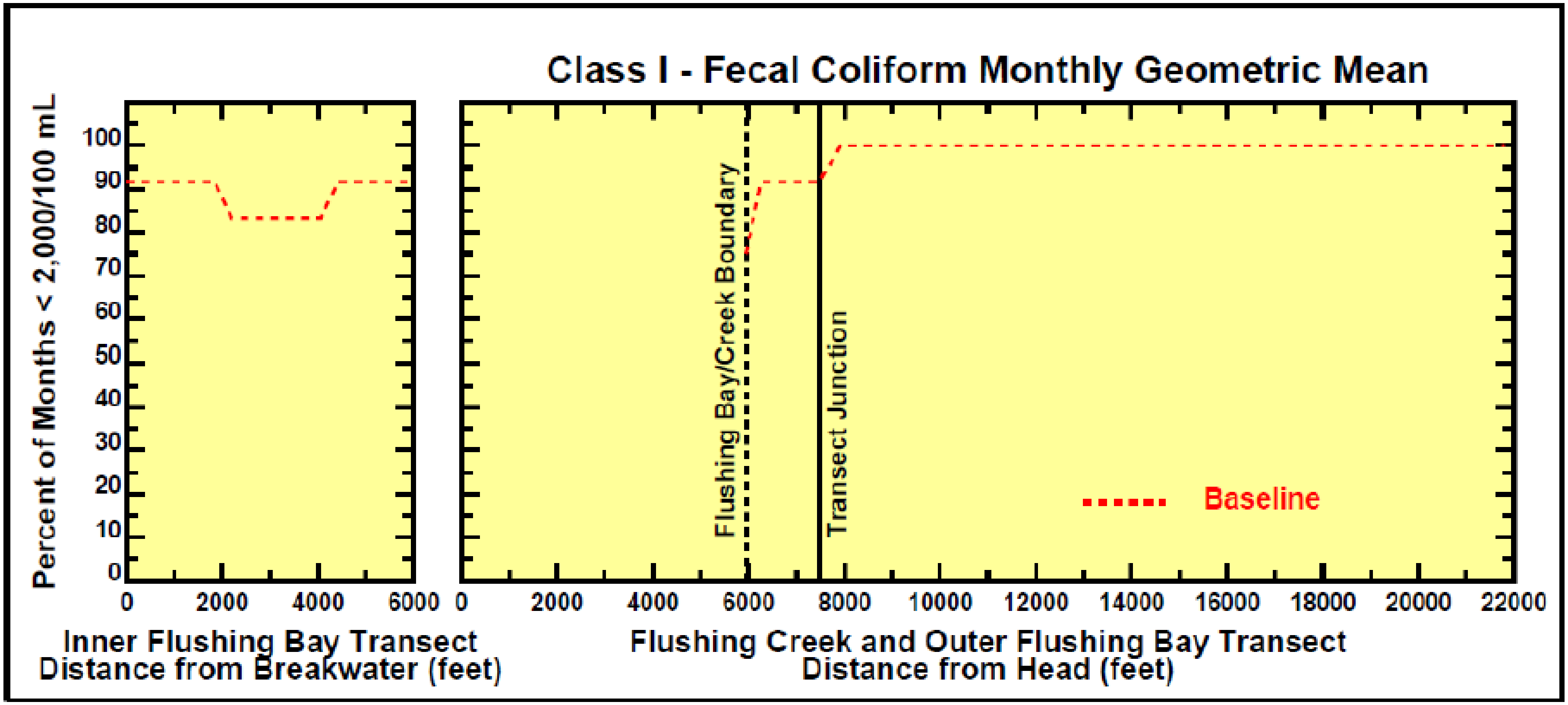
Table 4-5. Fecal Coliform Concentrations at Sentinel Station S65 (Water Year 2002-2003)

Date	Waterbody	Fecal Coliform MPN (count/100mL)
10/2/2002	Flushing Bay	80
4/16/2003	Flushing Bay	2
7/14/2003	Flushing Bay	21
10/2/2002	Flushing Bay	110
4/21/2003	Flushing Bay	220
7/14/2003	Flushing Bay	1700

Figures 4-12 and 4-13 present graphic displays of ERTM model results for total and fecal coliform levels for Flushing Bay and Flushing Creek under Baseline conditions. Figure 4-12 shows the percentage of months where the calculated monthly fecal coliform geometric mean is below the Class I standard of 2,000 per 100 mL as a function of distance along the transect axes shown in Figure 4-9. Similarly, Figure 4-13 shows the percentage of months where the calculated monthly total coliform geometric mean is below the Class I standard of 10,000 per 100 mL

As shown on Figure 4-12, fecal coliform concentrations in Flushing Bay comply with Class I standards more than 90 percent for the time in the Inner Bay and 100 percent of the time in the Outer Bay. Near the confluence of Flushing Bay and Flushing Creek fecal coliform concentrations comply with the current Flushing Bay water quality standards (Class I standards) between 75 percent and 100 percent of the time, steadily improving further into the Bay.

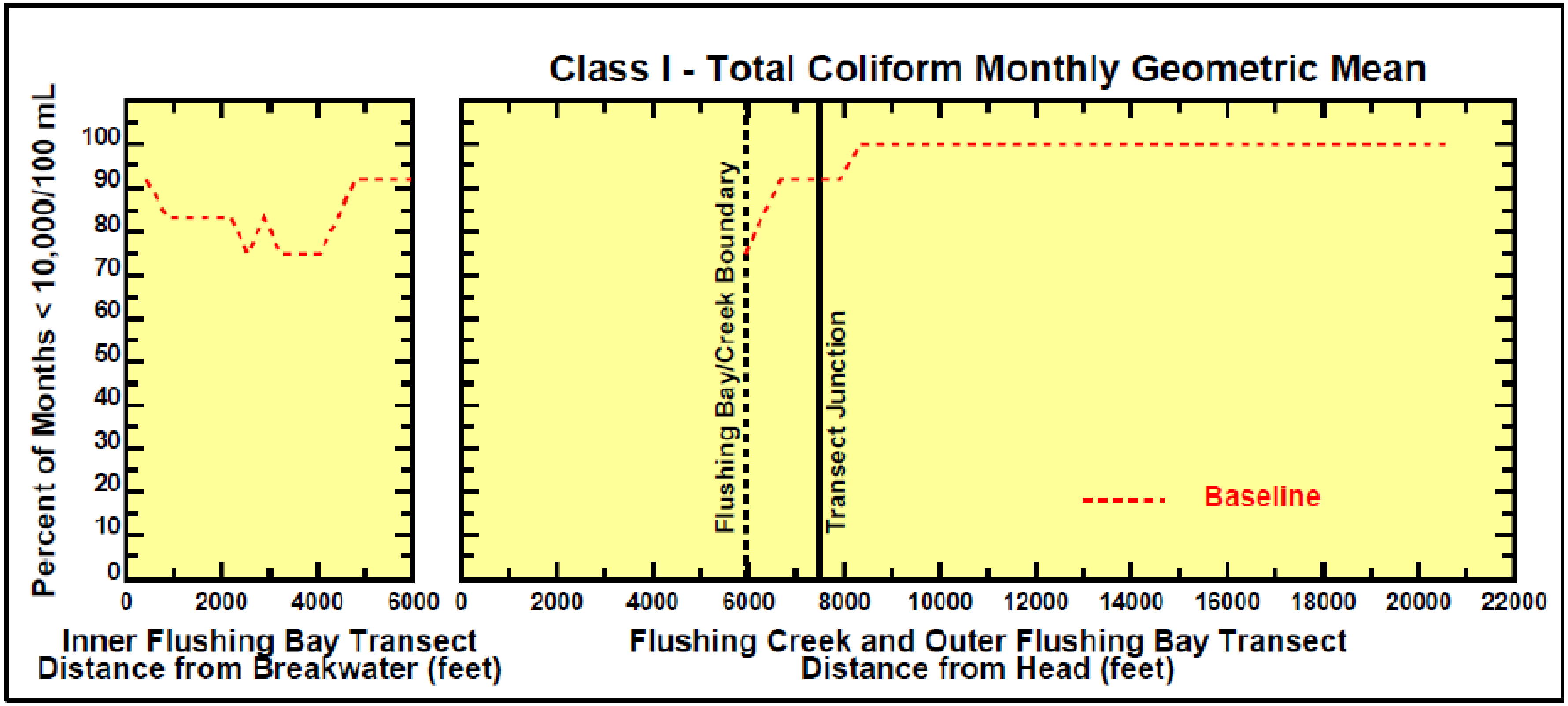
Total coliform concentration in Flushing Bay comply with Class I standards more than 80 percent of the time in Inner Flushing Bay and 100 percent of the time throughout the majority of Outer Flushing Bay (See Figure 4-13). Near the confluence of Flushing Bay and Flushing Creek compliance for total coliform ranges between 70 and 90 percent of months.



NYC Environmental Protection

Baseline Fecal Coliform Percent of Months Within Numerical Criteria

FIGURE 4-12



Environmental Protection

Baseline Total Coliform Percent of Months Within Numerical Criteria

FIGURE 4-13

4.4.3 Odors

There have been efforts since the 1980's to abate the unpleasant odors originating from Flushing Bay. Three reports released in the 1980's addressed the issue of unpleasant odors:

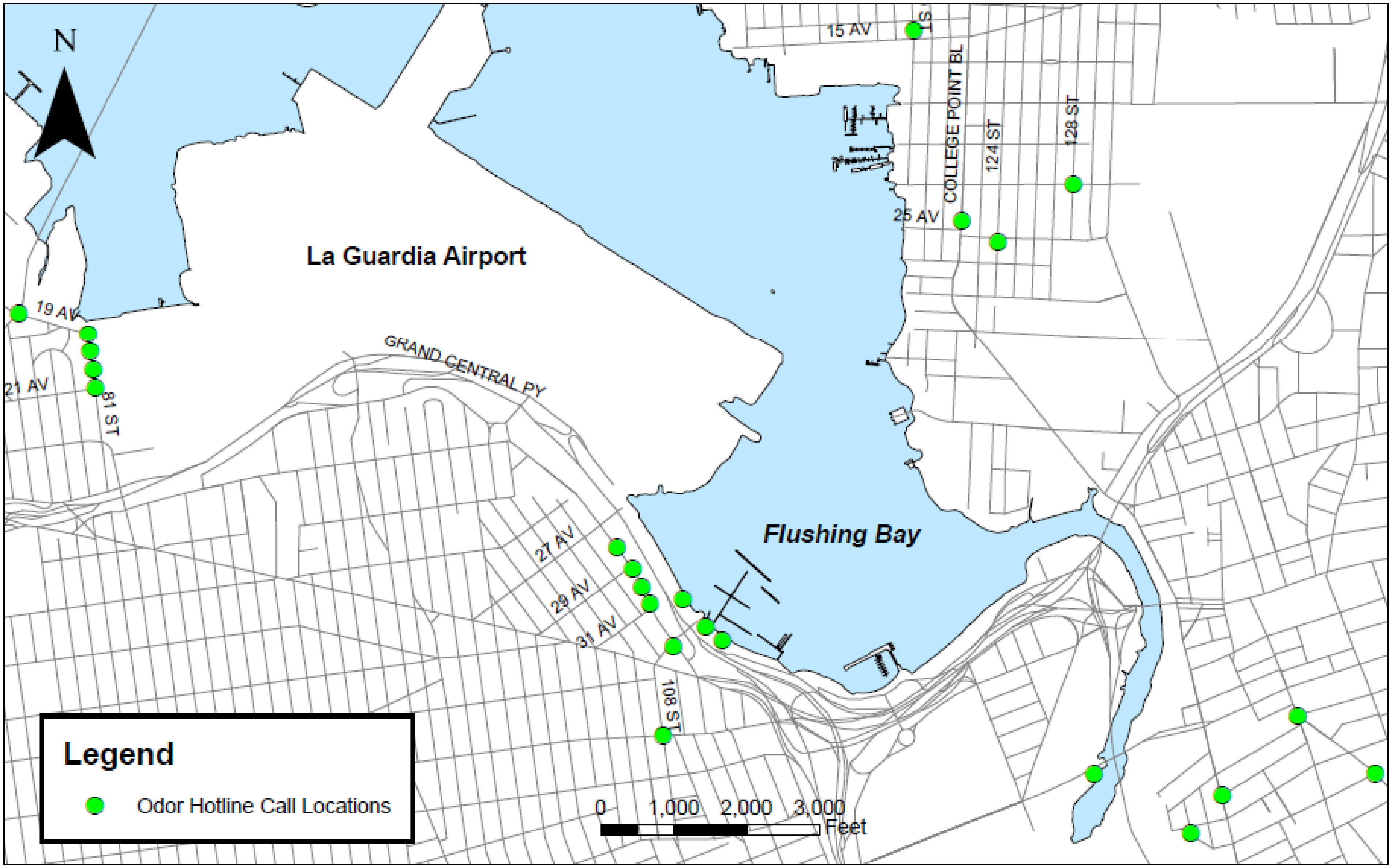
- 1984 Flushing Bay and Creek Odor Abatement Feasibility Study (H2M 1984): During the summer of 1984, DEP operated an odor hotline. When a citizen called to report an unpleasant odor, DEP mobilized a crew to the location with instruments to identify and quantify the odor-causing substance. The odor hotline response call locations are shown in Figure 4-14. Based on the collected data, it was concluded that the odors were caused by H_2S in the exposed sediments in Flushing Bay and Creek. Six locations were identified as the primary sources of the odors, with four of these sites located in Flushing Bay as shown in Figure 4-15. The final recommendation of this report was to dredge at three sites to remove the mud flats that were exposed at low tides. Two of the sites (Sites 1, and 3) were located in Flushing Bay as shown in Figure 4-15.

- 1986 Preliminary Engineering Report: Dredging of Flushing Bay and Creek for Odor Abatement (URS 1986a): Based on the data in the 1984 Feasibility Study, areas to be dredged to three feet below Mean Low Water (MLW) were delineated as shown in Figure 4-16. The quantity to be dredged was estimated to be 55,500 cubic yards total for Flushing Bay and Flushing Creek.

- 1989 Post-Dredging Evaluation (LMS 1989): Dredging operations of Flushing Bay and Creek began in September 1987 and ended in May 1988. H_2S levels in the ambient air at various locations in the watershed were measured both before and after the dredging, in order to evaluate the effects of the dredging. It was concluded that the dredging was "moderately effective" at abating odors, that dredging should be considered a short-term solution only, and that the long-term solution should be to control the CSOs, as they are the source of the odors.

4.5 BIOLOGY

The aquatic biological resources of NY/NJ Harbor are important components of the aquatic ecosystem because their collective health is a measure of how humans are managing natural resources and because fish and invertebrates can have substantial recreational and commercial value. The biological resources in tributaries and embayments receiving CSO discharges provide a basis for assessing the effectiveness of control technology alternatives which cover a wide range of costs. In the complex process of establishing a balance between ecosystem health and the cost of providing environmental protection, a biological baseline is needed to predict future conditions. Because the health of biological communities is an integration of the many factors which influence aquatic organisms, one can make judgments about the relative importance of various factors and how they may interact. A foundation of biological information is needed to advance the management of CSOs in NY/NJ Harbor.

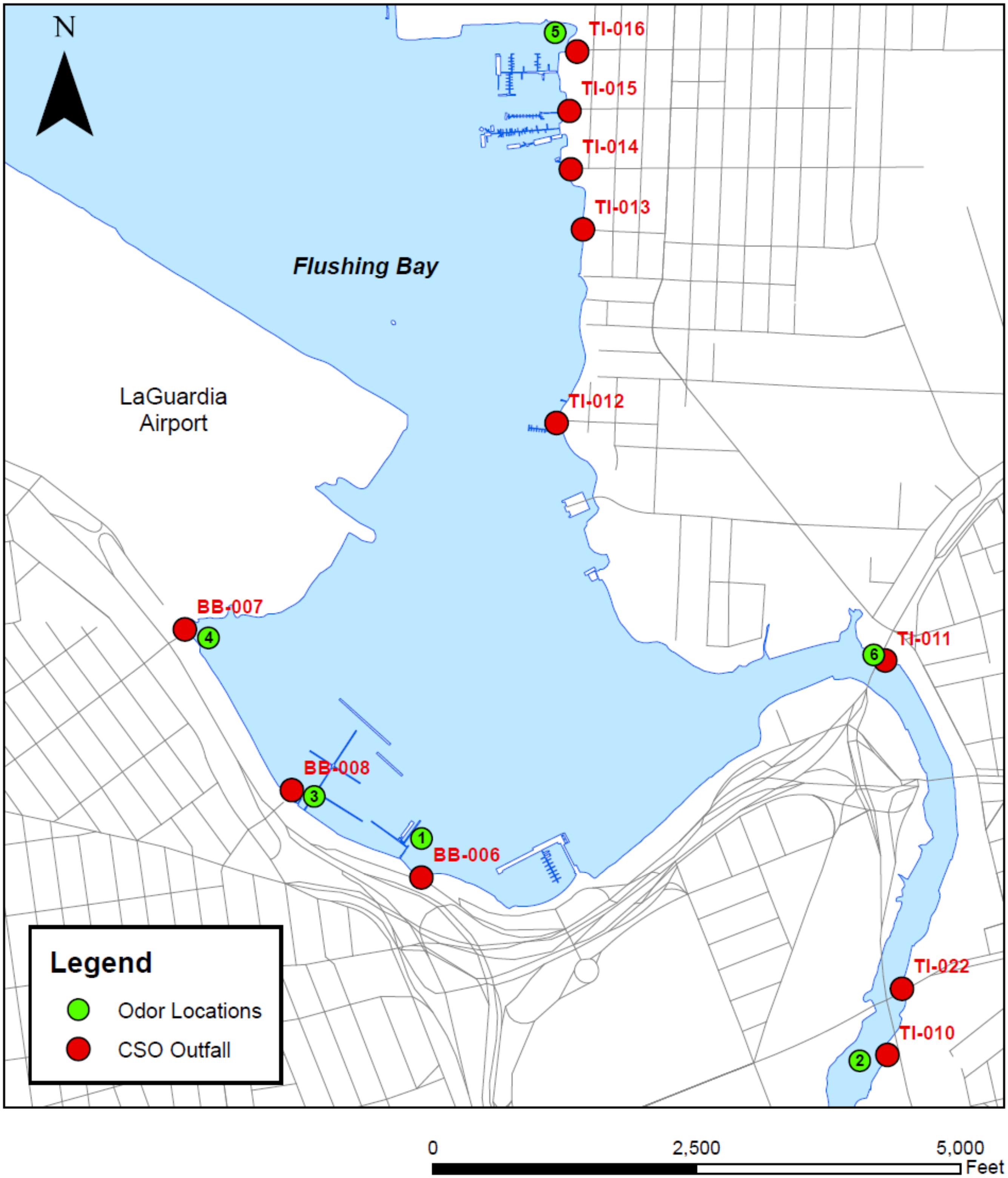


NYC Environmental Protection

Flushing Bay Waterbody/Watershed Facility Plan

Odor Hotline Response Call Locations (1984)

FIGURE 4-14

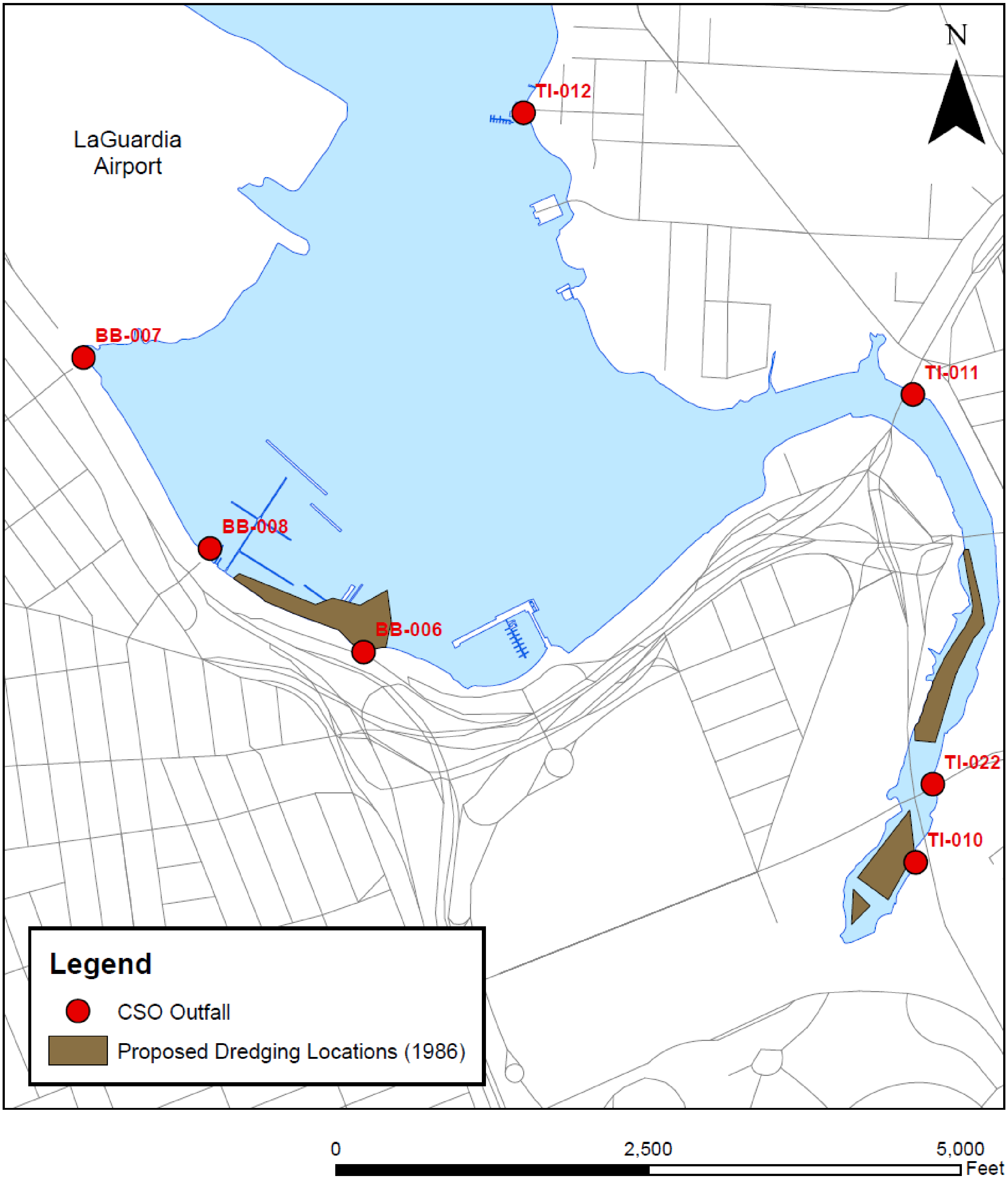


Environmental Protection

Flushing Bay Waterbody/Watershed Facility Plan

Odor Source Locations (1984)

FIGURE 4-15



Proposed Flushing Bay and Creek Dredging Locations (1986)

Flushing Bay supports aquatic communities which are similar to those found throughout the NY/NJ Harbor in areas of similar water quality and sediment type. The aquatic communities of Flushing Bay contain typical estuarine species but has been highly modified by physical changes to the original watershed, shoreline, and to water and sediment quality. These changes represent constraints on Flushing Bay from reaching its full potential to support a diverse aquatic life community and to provide a fishery resource for anglers.

Adverse physical effects on aquatic habitats interact with water and sediment quality to limit the diversity and productivity of aquatic systems. Water and sediment quality limit aquatic life when they are below thresholds for survival, growth and reproduction, but when these thresholds are reached or exceeded, physical habitat factors tend to be limiting to diversity and productivity. Improvements to both water and sediment quality, and to physical habitat can enhance aquatic life use in degraded areas such as Flushing Bay, but major irreversible changes to the watershed and the waterbody place limits on the extent of these enhancements. In addition, because Flushing Bay is part of a much larger modified estuarine/marine system, which is a major source of recruitment of aquatic life to Flushing Bay, its ability to attain use standards is closely tied to overall ecological conditions in NY/NJ Harbor.

This section describes existing aquatic communities in Flushing Bay and provides comparison to those found in the nearby Little Neck Bay, Manhasset Bay, and the open waters of the East River. This baseline information, in conjunction with projections of water and sediment quality from modeling, technical literature on water quality and habitat tolerances of aquatic life, long term baseline aquatic life sampling data from the Harbor and experience with the response of aquatic life to water quality and habitat restoration in the Harbor provides the foundation for assessing the response of aquatic life to CSO treatment alternatives for Flushing Bay.

Many of the biotic communities associated with Flushing Bay have been considerably altered over the centuries. For example, Flushing Bay has been heavily channelized and the marshes that formerly lined the natural shorelines have been almost entirely replaced with bulkheading. With the depletion of marshes there is a predictable reduction in wildlife. However, Flushing Bay supports a diverse ecosystem despite it being situated within a major metropolitan area.

The area surrounding Flushing Bay is almost entirely urbanized. Open space and recreational parkland is limited to the World's Fair Marina and Promenade. Shoreline uses include commercial, industrial, and institutional activity. Much of the bay consists of channelized and dredged areas, particularly in the middle of the bay. Flushing Bay has been repeatedly dredged and channelized to support its continued use for commercial navigation. Nevertheless, vast areas of shallow tidal flat shorelines exist ranging, on average, from four to eight feet deep. There are no known endangered, protected or threatened species in the area.

To document the more subtle effects of urbanization on the estuarine ecosystem, sampling is required to understand the temporal and spatial distribution of aquatic life and seasonal patterns in habitat use. Few such studies have been conducted in Flushing Bay. While numerous inventories of fish and benthic invertebrates have been completed for the East River proper, none of these past studies has extended to Flushing Bay. Project specific studies to address the lack of tributary data were conducted to provide a baseline. The descriptions of fish and aquatic life uses to follow draw primarily upon data generated by HydroQual (2002) for the

USA Project. The goals of USA Project were to define specific and comprehensive long-term beneficial use goals for New York City's waterbodies including habitat, wetlands, riparian and recreational goals, in addition to water quality goals. The Project Field Sampling and Analysis Programs (FSAPs) and Standard Operating Procedures manuals provide literature reviews and detailed information on methods and materials used in this report (HydroQual 2003d, 2002, 2001e, 2001c, 2001b).

4.5.1 Tidal Wetlands Habitat

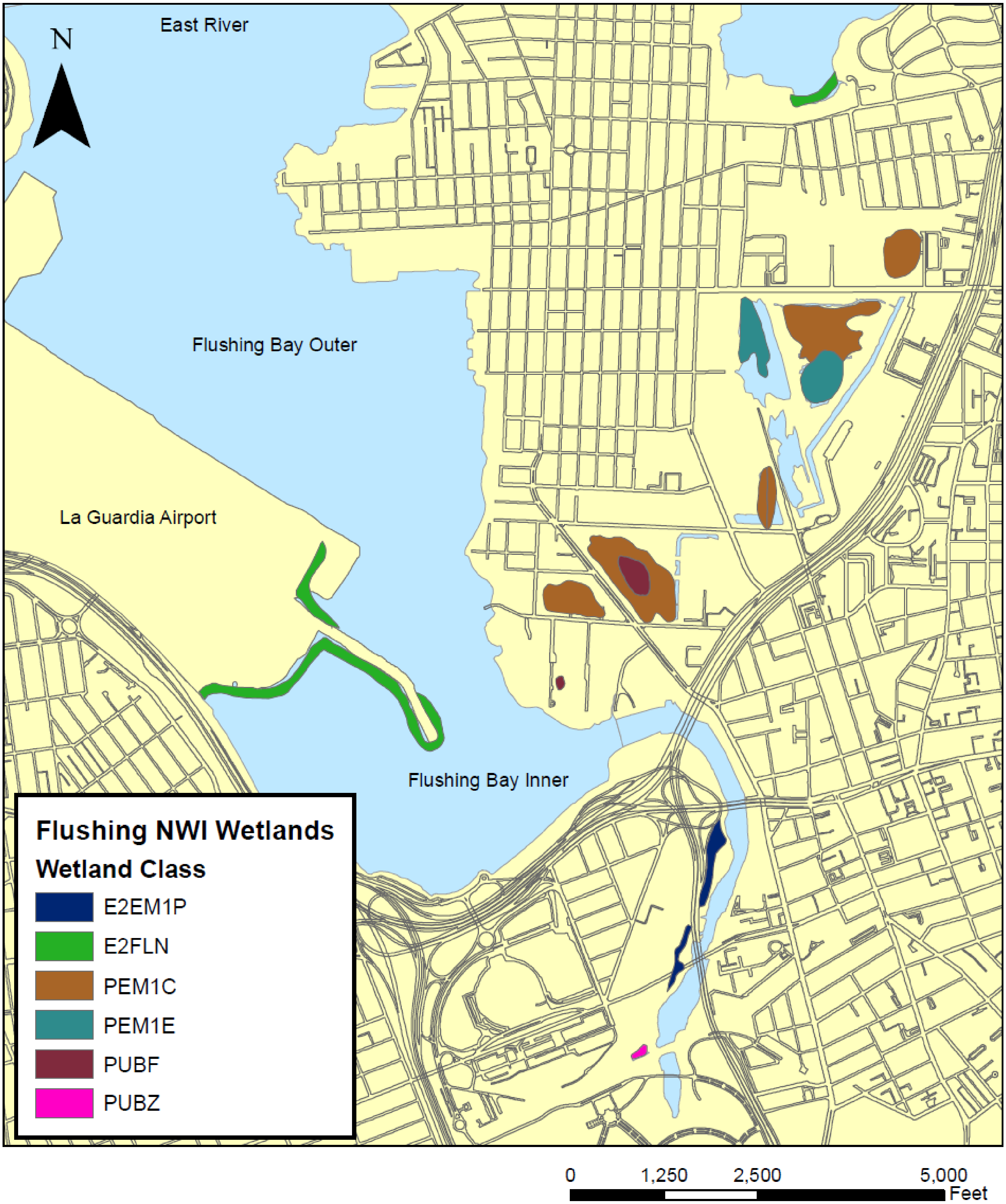
Current information on wetlands along Flushing Bay is based on a review of United States Fish and Wildlife Service National Wetland Inventory (NWI) wetland maps, as shown in Figure 4-17. The abbreviations for the wetland classes are as follows:

- E2EM1P: Estuarine, Intertidal, Emergent, Persistent, Irregularly Flooded.
- E2FLN: Estuarine, Intertidal, Flat, Regularly Flooded.
- PEM1C: Palustrine, Emergent, Persistent, Seasonally Flooded.
- PEM1E: Palustrine, Emergent, Persistent, Seasonally Flooded/Saturated.
- PUBF: Palustrine, Unconsolidated Bottom, Semipermanently Flooded.
- PUBZ: Palustrine, Unconsolidated Bottom, Intermittently Exposed/ Permanent.

Emergent vegetation of estuaries is characterized by erect, rooted, herbaceous hydrophytes (excluding mosses and lichens), dominated by perennial plants. Estuaries are typically highly productive ecological systems characterized by vegetated shorelines, sunlit shallows and tidal marshes. Cowardin (1979) developed the classification scheme used for these wetlands. The vast majority of the area immediately surrounding Flushing Bay is urbanized and therefore contains no wetlands. However, portions of the southern and western shores are characterized as wetlands. These wetlands, along the wavebreak and LaGuardia Airport shoreline, are classified as estuarine, intertidal, flat, regularly flooded wetlands (E2FLN). This area encompasses approximately 17.4 acres (7.0 ha) total. To the east in Flushing Airport, there are a number of palustrine wetlands that are not contiguous with the Flushing Bay shoreline. Two of these wetlands are greater than 12.4 acres and therefore are regulated by the DEC. All tidal wetlands present are similarly regulated.

4.5.2 Benthic Invertebrates

The benthic community consists of a wide variety of small aquatic invertebrates which live burrowed into or in contact with bottom sediments, such as worms and snails. Benthic organisms cycle nutrients from the sediment and water column to higher trophic levels through feeding activities. Suspension feeders filter particles out of the water column and deposit feeders consume particles on or in the sediment. The sediment is modified by the benthos through bioturbation and formation of fecal pellets (Wildish and Kristmanson, 1997). Grain size, chemistry, and physical properties of the sediment are the primary factors determining which organisms inhabit a given area of the substrate. Because benthic organisms are closely associated with the sediment and have limited mobility, the benthic community structure reflects local water and sediment quality.



Environmental Protection

Flushing Bay and Creek NWI Wetlands

FIGURE 4-17

Benthic inventories have been conducted in Flushing Bay as part of the East River Field Sampling and Analysis Program (HydroQual 2001e). Benthos sampling was conducted in July 2001 using a modified Young Ponar Grab with five replicate samples collected at one station (FLSHB01) located in Flushing Bay, as shown previously in Figure 4-6. In addition to benthic sampling, sediment samples were collected at the Flushing Bay station for analysis of sediment grain size and total organic carbon (TOC) content.

The benthic fauna collected at the Flushing Bay station (FLSHB01) consisted primarily of the polychaete worm *Haploscoloplos robustus* ($576/m^2$). The molluscs *Mulinia lateralis* ($8/m^2$), and *Mya arenaria* ($8/m^2$) and the arthropod *Crangon sp.* ($8/m^2$) were also present. *Nereis* sp. (polychaete) was the second most abundant species collected ($16/m^2$). Polychaete worms are generally pollution tolerant organisms and as such, they serve as important indicators of pollution levels because of their tolerance to organic enrichment (Gosner 1978, Weiss 1995).

Overall, the benthic community in Flushing Bay was low in abundance and diversity compared to similar areas of the East River (Table 4-6). The abundance, diversity, and composition of benthic species, in combination with their relative pollution tolerance, are indicators of habitat quality. While the total diversity and abundance of benthic organisms was higher in Flushing Bay than in other stations (e.g. Little Neck Bay), the relative proportion of pollution tolerant polychaetes collected (95 percent) was second only to Manhasset Bay. Polychaete density ranged from 51 percent to 97 percent at the East River stations. The low species diversity and high proportion of pollution tolerant organisms indicates degraded benthic habitat quality in Flushing Bay and other areas of the East River.

The low number of taxa at Flushing Bay is consistent with the relation between benthic community diversity and percent Total Organic Carbon (TOC) found to exist in NY Harbor areas. The sediments at the Flushing Bay station had a percent TOC of 4.93 percent. The area is dominated by fine-grained sediments and had high percent silt and clay (95.4 percent), and a total percent solids of 26.0 percent. The percentage of solids in sediment infers the amount of water retained, *i.e.*, a higher percentage of solids retains less water. Of the seven areas compared in Table 4-6, the Flushing Bay station had the second lowest percent solids (Manhasset Bay was slightly lower at 25 percent) and similarly, the second highest percent silt and clay (second only to Manhasset Bay’s 98.1 percent).

The benthic community structure in Flushing Bay is similar to that described in studies of the effects of organic pollution on the benthos. In areas of high levels of organic enrichment benthic communities are composed of a few small, rapidly breeding, short-lived species with high genetic variability (Pearson and Rosenberg 1978). The Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational Scientific and Cultural Organization (UNESCO) suggested that stress to the benthic community will be greatest in sediment with TOC greater than 3 percent (Hyland *et al.* 2000). The Flushing Bay sampling location had sediment TOC greater than 3 percent and the degree of impairment of the benthic community compared to other areas of the East River is apparent where sediment TOC was the highest.

In 2001, as part of the U.S. Army Corps of Engineers Flushing Bay and Creek Ecological Restoration Project, Northern Ecological Associates, Inc (NEA) performed a preliminary investigation and inventory of the benthic macroinvertebrate fauna of tidally influenced sites in Flushing Bay (NEA 2002a). The study will be incorporated into a more comprehensive ecosystem restoration program. Sampling sites (Figure 4-18) were chosen for their proximity near potential restoration or shoreline stabilization areas. Sampling locations from this study differed slightly from those of the FSAP program and included some sample locations that are not within Flushing Bay and Creek proper. A total of 16 sites were within Flushing Bay and Creek, with Flushing Bay accounting for 12 of the sites. Of the sample locations in Flushing Bay a total of 29 invertebrate taxa were identified and compiled into a presence-absence table (Table 4-7). Of these 30 taxa, 29 were found in Flushing Bay. Results of the NEA study showed that the average number of taxa for the Flushing Bay sampling locations was 9, with the highest number of taxa located near the breakwater (14 taxa at station BW1E and 13 taxa at station BW4W). Oligochaeta (LPIL) and *Polydura cornuta* were the most abundant taxa and were found in all of the 12 sites sampled. Nematoda (LPIL) and *Streblospio benedicti,* were found in 11 of the 12 sites. *Streblospio benedicti,*, a species of polychaete worm, is relatively tolerant to high levels of sediment organics and low oxygen concentrations, and is indicative of pollution (NEI 2002a). The taxonomic dominance of Oligochaete worms in these samples concurs with the results of the FSAP and other studies that the benthic habitat is polluted and the overall benthic habitat quality is poor.

Another study of the benthic habitats of NY/NJ harbor, conducted in 1995 by NOAA and the U.S. Army Corps of Engineers, used sediment profile imagery and grab samples to survey Jamaica, Upper, Newark, Bowery, and Flushing Bays (Iocco *et al.* 2000). Benthic habitats in Flushing Bay consisted predominantly of silty-bottomed communities; the presence of subsurface methane pockets indicated organic contamination in Flushing Bay. One element of their study was to measure the depth of the apparent Redox Potential Discontinuity (RPD). RPD depth, the depth to which sediments are oxidized, is useful in assessing habitat quality for epifauna and infauna from both physical and biological perspectives. The depth of the RPD from profile images is directly correlated to the quality of the benthic habitat in polyhaline and mesohaline estuarine zones (Iocco *et al.* 2000). Shallow RPD depths (<1 cm) tend to be associated with environmental stress, whereas deeper RPD depths (>= 3cm) usually indicate flourishing epibenthic and infaunal communities. Notable temporal shifts, seen in all the bays from June to October, included increases in infaunal polychaete density, general deepening of the apparent RPD, and changes in species dominance within communities.

In the 1995 NOAA study, Flushing Bay stations were located in three major areas: (1) the northwestern region, west of the main channel, (2) the northeastern region, east of the main channel, and (3) the lower basin. All stations in Flushing Bay were composed of silty sediments with one exception in October. This station was located near the shore in the lower basin and was composed of rock and shell hash. Soft sediment habitats were observed only in June and at 60 percent of stations distributed throughout the three regions of the bay. Oyster beds occupied the northwestern corner of the sampling area west of the channel and stations closest to the coast consisted of silty habitats with faunal communities in June. The presence of epifauna and infauna increased in this region of Flushing Bay in October, and RPD depths ranged <1cm (93 percent) and 1-2.9 cm (7 percent) in June and <1 cm (8 percent), 1-2.9cm (84 percent) and >=3cm (8 percent) in October. Stations on the eastern side of the channel mainly were composed of soft sediments and few gas voids in June, and these habitats shifted to shallow sediment communities with infaunal worms and some gas voids in October. RPD depths were <1 cm in June and <1 cm (18 percent) and 1-2 cm (82 percent) in October. Gas voids were

Environmental Protection

NEA 2001 Benthic Sampling Locations

FIGURE 4-18

Table 4-6. Abundance of Benthic Organisms

		Station Location						
Phylum	**Taxonomic Order**	**Flushing Bay (FLSHB01)**	**Little Neck Bay (ALLYB01)**	**Manhasset Bay (MABAB01)**	**East River (EASTB05)**	**East River (EASTB06)**	**East River (EASTB03)**	**East River (EASTB04)**
Nema-toda	Unidentified Nematoda sp.	0	0	0	0	0	0	0
Annelida	*Polygordius trieslinus*	0	0	0	0	0	0	0
	Ampharetidae	0	0	0	0	0	0	0
	Arabella iricolor	0	0	0	0	0	0	0
	Capitellidae	0	0	8	392	696	200	488
	Capitella capitata	0	0	0	0	0	0	0
	Eteone sp.	0	0	0	0	0	0	0
	Eulalia sp.	0	0	0	0	0	0	0
	Glycera sp.	0	0	0	16	0	8	8
	Haploscoloplosus sp.	0	0	0	0	0	0	0
	Haploscoloplos robustus	576	0	0	56	72	56	56
	Lumbrineris acuta	0	0	0	0	0	0	0
	Nephtys sp.	0	72	16	56	0	48	64
	Nephtys incisa	0	0	16	0	0	0	0
	Nereis sp.	16	0	0	0	0	8	0
	Nereis succinea	0	0	0	0	0	0	0
	Orbiniidae	0	0	0	0	0	0	0
	Pectinaria gouldii	0	0	0	0	8	0	0
	Phyllodocidae	0	0	0	0	0	0	0
	Polychaeta	0	0	8	0	0	8	0
	Polydora Iigni	0	0	0	0	0	0	0
	Polydora sp.	0	0	0	0	0	0	0
	Sabella microphthalma	0	0	0	0	0	0	0
	Scolecolepides viridis	0	0	0	0	0	0	0
	Scoloplos sp.	0	0	0	0	0	0	0
	Spionidae sp.	0	0	0	16	0	0	0
	Streblospio benedicti	0	0	0	0	0	0	0
	Tharyx sp.	0	0	0	120	104	0	0
	Tharyx acutus	0	0	0	0	0	0	0
	Oligochaeta	0	0	0	0	0	0	0
Mollusca	*Mulinia lateralis*	8	8	480	48	16	56	0

Table 4-6. Abundance of Benthic Organisms

		Station Location						
Phylum	**Taxonomic Order**	**Flushing Bay (FLSHB01)**	**Little Neck Bay (ALLYB01)**	**Manhasset Bay (MABAB01)**	**East River (EASTB05)**	**East River (EASTB06)**	**East River (EASTB03)**	**East River (EASTB04)**
	Spisula solidissima	0	0	0	0	0	0	0
	Tellina sp.	0	0	0	0	24	0	0
	Tellina agilis	0	0	0	0	0	0	0
	Yoldia sp.	0	0	0	0	0	0	0
	Melampus bidentatus	0	0	16	0	0	0	0
	Crepidula fornicata	0	0	0	8	0	0	0
	Gastropoda	0	0	0	224	0	200	16
	Bivalvia	0	0	8	8	0	0	0
	Mya arenaria	8	0	32	0	16	24	0
	Acteocina canaliculata	0	0	0	0	0	8	0
	Pandora gouldiana	0	0	0	0	16	0	0
	Nassarius trivittatus	0	0	0	0	88	16	0
	Nassarius obsoletus	0	120	0	0	0	8	0
Arthro-poda	*Ampelisca sp.*	0	0	0	0	0	0	0
	Amphipoda	0	0	0	0	0	0	0
	Corophium sp.	0	0	0	0	0	0	0
	Lysianopsis alba	0	0	0	0	0	0	0
	Lysianassidae	0	0	0	0	0	0	0
	Microdeutopus gryllotalpa	0	0	0	0	0	0	0
	Paraphoxus epistomus	0	0	0	0	0	0	0
	Crangon septemspinosa	0	8	0	0	8	0	0
	Crangon sp.	8	0	0	0	0	0	0
	Crago septemspinosus	0	0	8	0	0	0	0
	Pagurus sp.	0	0	0	0	0	0	0
	Sesarma sp.	0	0	0	0	0	0	0
	lnsecta sp.	0	0	0	0	0	0	0
Echino-dermata	*Asteroidea*	0	0	0	0	0	0	0
	NUMBER OF SPECIES	**5**	**4**	**9**	**10**	**10**	**12**	**5**
	TOTAL INDIVIDUALS/m^2	**616**	**208**	**592**	**944**	**1048**	**640**	**632**

Table 4-7. NEA 2001 Benthic Organisms

	Station																
Taxon	**BW1E**	**BW2E**	**BW3E**	**BW4E**	**BW1W**	**BW2W**	**BW3W**	**BW4W**	**FC1**	**FC2**	**FC3**	**FC4**					**Total**
*Edwardsia (*LPIL)	P																**1**
Leptoplanidae: *Euplana gracilis*	P																**1**
Nematoda (LPIL)	P	P	P		P	P	P	P	P	P	P	P					**11**
Nemertea (LPIL)		P							P								**2**
Annelida: Oligochaeta (LPIL)	P	P	P	P	P	P	P	P	P		P	P					**11**
Ampharetidae (LPIL)			P														**1**
Capitella capitata	P							P	P	P	P	P					**6**
Mediomastus (LPIL)	P																**1**
Cirratulidae (LPIL)			P														**1**
Chaetozone (LPIL)	P				P		P	P		P							**5**
Microphthalmus aberrans	P		P				P	P	P	P		P					**7**
Praxillella praetermissa								P									**1**
Neanthes succinea									P	P	P	P					**4**
Leitoscoloplos robustus	P	P	P	P	P	P	P	P									**8**
Lepidonotus squamatus	P																**1**
Polydora cornuta	P	P	P	P	P	P	P	P			P						**9**
Streblospio benedicti		P	P	P	P	P	P	P	P	P	P	P					**11**
Syllidae (LPIL)																	**0**
Eteone heteropoda	P		P	P			P	P	P			P					**7**
Ilyanassa obsolete								P									**1**
Mya arenaria							P										**1**
Macoma tenta			P														**1**
Macoma (LPIL)								P									**1**
Gemma gemma		P					P										**2**
Copepoda: Harpacticoida (LPIL)							P	P	P								**3**
Idoteidae: *Edotea triloba*																	**0**
Ampeliscidae*: Ampelisca* (LPIL)							P										**1**
Corophium insidiosum	P																**1**
Melitidae*: Melita* (LPIL)																	**0**
Melita nitida	P																**1**
Total taxa present:	**14**	**7**	**10**	**5**	**6**	**5**	**12**	**13**	**9**	**6**	**6**	**7**					**100**

observed at 7 percent and 21 percent of stations in June and October, respectively, and were most concentrated in the lower basin. In June, the lower basin contained soft sediments and bacteria habitats. June grab data taken at one station on the eastern side of the main channel, showed highest abundances of *Oligochaeta* (>1,500 individuals/m^2) and *M. lateralis* (>1,250 individuals/m^2). Grab data from October, taken from nine stations distributed in each region, showed high average abundances of *S. benedicti* (>1,700 individuals/m^2), *Leitoscoloplos robustus* (>590 individuals/m^2), *M. lateralis* (>400 individuals/m^2) and *Asabellides oculata* (>360 individuals/m^2).

4.5.3 Epibenthic Communities

Epibenthos live on or move over the substrate surface. Epibenthic organisms include sessile suspension feeders (mussels and barnacles), free swimming crustaceans (amphipods, shrimp, and blue crabs) and tube-dwelling polychaete worms found around the base of attached organisms.

Epibenthic organisms require hard substrate, they cannot attach to substrates composed of soft mud and fine sands (Dean and Bellis 1975). In general, the main factors that limit the distribution of epibenthic communities are: the amount of available hard surface for settlement, species interactions, and water exchange rates. In Flushing Bay, pier piles and bulkheads provide the majority of underwater substrates that can support epibenthic communities. The epibenthic communities living on underwater structures impact the ecology of the nearshore zone. Suspension feeding organisms continuously filter large volumes of water, removing seston (particulate matter which is in suspension in the water) and releasing organic particles to the sediment. This flux of organic particles (from feeding and feces) enriches the benthic community living in the sediment below piers and bulkheads (Zappala, 2001).

The epibenthic, or "fouling", community was studied as part of the USA Project by suspending multiple-plate arrays of 8" X 8" synthetic plates in the water column (HydroQual 2003d, 2001c). This method was selected in order to eliminate the effect of substrate type on community composition since not all places of interest around the harbor have the same kinds of hard substrates (to which organisms cling or forage about). Epibenthic arrays were deployed three feet below mean low water level in April 2001 at two stations in Flushing Bay (south station FLSHP01 and north station FLSHP02, as shown in Figure 4-6). Plates were retrieved after three and six months of exposure for the south station, and after three months for the north station. Upon retrieval, the arrays were inspected and weighed and motile organisms clinging to or stuck in the arrays (*i.e*., crabs and fish) were counted and identified.

In Flushing Bay, a total of 22 taxa were identified on the top epibenthic array for both three and six month exposure times combined (Table 4-8). A total of 14 taxa were identified from both stations combined after three months exposure and eight taxa were identified after six months exposure from the south station (FLSHP01). The major groups found were tunicates (*Botryllus schlosseri*) after three months exposure and sea grapes (*Molgula manhattensis*) and barnacles (*Balanus eburneus*) after nine months exposure at the south station (FLSHP01). The north station (FLSHP02) was dominated by tunicates after three months exposure. Overall, after three months exposure, the south station had a greater diversity and biomass of species. Some annelids, molluscs, chordates and other arthropods were also collected to a lesser degree. The golden star tunicate, *Botryllus schlosseri*, was the most abundant species collected.

Typically, epibenthic communities in the NY/NJ Harbor exhibit a vertical distribution on pier piles and bulkheads (Zappala 2001). This vertical distribution coincides with changes in water level, salinity and dissolved oxygen associated with the tides and water stratification. Because bottom plates were not collected at the Flushing Bay stations, it is impossible to determine if any vertical stratification exists.

4.5.4 Phytoplankton

As part of the New York Harbor Water Quality Survey, DEP collected plankton samples at one station within Flushing Bay (Station E15 as shown in Figure 4-1) in the spring, summer and fall from 1991 to 2000 (DEP 1997b, 1998, 1999, 2000). Ninety-six samples were collected during this time period. In addition, the phytoplankton and zooplankton communities of the lower East River were investigated in the 1980s (Hazen and Sawyer 1981). By definition, planktonic community structure is governed by water movement (tides and wind), thus plankton communities of the East River and Western Long Island Sound should be comparable to those found in Flushing Bay.

Phytoplankton are the dominant primary producers in the East River. Factors that affect phytoplankton community structure include: temperature, light, nutrients, and grazing by other organisms. Phytoplankton are also affected by all hydrodynamic forces in a waterbody. Resident times of phytoplankton species within the New York harbor are short and these organisms move quickly through the system, limiting the time they are available to grazers (NYS DOT and MTA 2004).

A total of 86 species of phytoplankton were collected at the Flushing Bay sampling station over the course of the DEP (DEP 1997a, 1998, 1999, 2000) sampling (Table 4-9). Diatoms were the dominant class of phytoplankton, followed by dinoflagellates and green algae. The most frequently collected species were *Nannochloris atomus* (green algae), *Skeletonema costatum* (diatom), *Rhizosolenia delicatula* (diatom), *Peridinium sp.* (dinoflagellate), *Thalassiosira nordenskioldii* (diatom), and *Prorocentrum redfieldii* (dinoflagellate).

Two toxic species of phytoplankton were collected in Flushing Bay over the course of the DEP sampling. *Pseudo nitzchia pungens* (diatom) is associated with amnesic shellfish poisoning and was collected three times. *Prorocentrum micans* (dinoflagellate) is associated with diarrhetic shellfish poisoning and was collected eight times. The fact that some toxic species were collected, however, is not a sufficient indicator of habitat degradation per se. These species are generally always present in low abundance and only become problematic when conditions exist to promote their unmitigated growth (i.e. a bloom).

4.5.5 Zooplankton

A total of 16 species of zooplankton were collected at the Flushing Bay sampling station over the course of the DEP sampling (Table 4-10). Protozoans and copepods comprised the zooplankton community. *Tintinnopsis* sp. (Protozoa) and copepod nauplii were the most frequently collected forms.

Table 4-8. Epibenthic Organisms

		Flushing Bay (FLSHP01)		**Manhasset Bay (MABAP01)**		**Flushing Bay (FLSHP02)**	**Alley Creek (ALLYP01)**
	Exposure Time:	**3 month**	**6 month**	**3 month**	**6 month**	**3 month**	**3 month**
Phylum	**Lowest Taxonomic Level**						
Cnidaria	Hydroida	5.9	0.0	17.7	0.0	1.3	3.4
Annelida	*Sabella microphthalma*	0.0	8.4	0.1	0.0	0.0	0.0
	Nereis succinea	0.7	0.2	0.3	0.2	0.0	0.2
Mollusca	*Mytilus edulis*	0.0	2.2	0.0	0.0	0.0	0.2
	Onchidorididae	0.0	0.4	0.1	0.0	0.0	0.0
	Crepidula plana	0.3	1.0	0.0	0.0	0.0	0.0
	Mya arenaria	0.0	0.0	0.0	0.0	0.0	0.1
Arthropoda	*Balanus eburneus*	2.7	37.6	6.2	2.6	0.8	2.6
	Ampithoidae	0.0	0.0	0.0	0.0	0.0	0.1
	Gammarus oceanicus	0.3	0.0	0.1	0.0	0.0	0.1
	Panopeus herbstii	1.0	0.1	0.0	0.1	0.0	0.0
	Leptocheirus pinguis	0.1	0.0	0.0	0.0	0.0	0.0
	Pleustidae	0.1	0.0	0.0	0.0	0.0	0.0
Chordata	*Molgula manhattensis*	3.1	46.1	0.4	0.5	0.0	0.0
	Botryllus schlosseri	118.5	0.0	0.0	0.0	48.5	0.0
Crustacea	*Jassa falcata*	0.1	0.0	0.0	0.0	0.0	0.0
Total number of species		**11**	**8**	**7**	**4**	**3**	**7**

Table 4-9. Phytoplankton Species Collected in Flushing Bay

Phylum	Species	Frequency of Collection (%)	Phylum	Species	Frequency of Collection (%)
Bacillariophyta (Diatoms)	*Skeletonema costatum*	90.63	Bacillariophyta (Diatoms)	*Nitzschia bilobata*	1.04
	Rhizosolenia delicatula	45.83		*Bacteriastrum sps*	1.04
	Thalassiosira nordenskioldii	39.58		*Diatoma sps*	1.04
	Thalassionema nitzchoides	37.50		*Grammatophora sps*	1.04
	Pleorosigma sps	29.17		*Hemiaulus sinensis*	1.04
	Chaetoceros sps	28.13		*Biddulphia sps*	1.04
	Nitzschia closterium	26.04		*Planktoniella sps*	1.04
	Nitzschia longissima	17.71		*Rhizosolenia fragilissima*	1.04
	Asterionella japonica / Asterionella glaciallis	17.71		*Fragillaria sps*	1.04
	Melosira sulcata	17.71		*Hemiaulus hauckii*	1.04
	Synedra sps	14.58		*Chaetoceros debilis*	1.04
	Nitzschia sps	14.58	Chlorophyta (Green Algae)	*Nannochloris atomus*	93.75
	Eucampia zoodiacus	13.54		*Chlorella sps*	11.46
	Ditylum brightsellii	12.50		*Ankistrodesmus sps*	6.25
	Cyclotella sps	10.42		*Volvox sps*	3.13
	Coscinodiscus sps	7.29		*Desmidium sps*	2.08
	Thalassiosira rotula	7.29		*Scenedesmus caudatus*	2.08
	Schroderella delicatula	6.25		*Hydrodictyon sps*	2.08
	Leptocylindrus danicus	5.21		*Oocystis sps*	1.04
	Biddulphia aurita	5.21		*Pediastrum sps*	1.04
	Lithodesmium undulatum	5.21		*Phytoconis sps*	1.04
	Thalassiosira decipiens	5.21		*Crucigenia sps*	1.04
	Lauderia borealis	5.21	Cyanobacteria (Blue-green Algae)	*Anabaena sps*	17.71
	Amphirora sps	4.17		*Anacystis sps*	7.29
	Thalassiothrix frauenfeldii	3.13		*Oscillatoria sps*	1.04
	Nitzschia pungens / Pseudo nitzchia	3.13		*Arthrospira sps*	1.04
	Rhizosolenia alata	3.13		*Gomphophaeria sps*	1.04
	Chaetoceros vistualae	3.13		*Coccomyxis sps*	1.04
	Ceratulina bergonii / Certaulina pelagica	3.13	Dinoflagellata (Dinoflagellates)	*Peridinium sps*	42.71
	Guinardia flaccida	3.13		*Prorocentrum redfieldii*	38.54
	Melosira moniliformis	3.13		*Peridinium trochoideum*	22.92
	Navicula sps	3.13		*Prorocentrum scutellum*	10.42
	Nitzschia delicatissima	2.08		*Prorocentrum minimum*	10.42
	Surirella sps	2.08		*Prorocentrum micans*	8.33
	Rhizosolenia robusta	2.08		*Massartia roundata / Katodinium rotundatum*	5.21
	Rhizosolenia setigera	2.08		*Peridinium palatonium*	5.21
	Biddulphia longicruris	2.08		*Prorocentrum sps*	3.13
	Hemiaulus sps	2.08		*Olisthodiscus luteus*	1.04
	Thalassiothrix longissima	2.08		*Ceratium minutum*	1.04
	Stephanodiscus sps	1.04		*Gyrodinium aureolum*	1.04
	Asterionella kariana	1.04		Ceratium macroceros	1.04
	Hemiaulus hauckii	1.04	Chrysophyta (Golden Algae)	*Chroomonas sps*	4.17
	Biddulphia alternans	1.04		*Pyramimonas micron*	1.04

Table 4-10. Zooplankton Species Collected in Flushing Bay

Phylum	Species	Frequency of Collection (%)
Protozoa	*Tintinnopsis sps*	27.08
	Eutreptia sps	17.71
	Flavella sps	11.46
	Tintinnids sps	11.46
	Acanthostomelia norvegica	7.29
	Strombilidium sps	6.25
	Helicostomella sps	5.21
	Euglena sps	5.21
	Thalassicolla sps	3.13
	Hetrocapsa triquetra	3.13
	Strombidium sps	1.04
	Parafevella sps	1.04
	Un spec. ciliate	1.04
Arthropoda	*Nauplius of copepods*	18.75
	Pseudocalanus minutus	1.04
	Oithona similes	1.04

4.5.6 Ichthyoplankton

Because the issue of fish propagation is integral to defining use classifications and attainment of associated water quality standards and criteria, ichthyoplankton sampling was conducted to identify fish species spawning in Flushing Bay or using its waters during the planktonic larval stage (HydroQual 2003d, 2001e, 2001b). Ichthyoplankton sampling was conducted at one station (FLSHI01) in the southern portion of Flushing Bay in March, May, July, and August 2001, and at a northern station (FLSHI02) in March, May and July. March and May were chosen based on spawning times of a variety of important species, and July and August were chosen to observe activity during anticipated worst case DO conditions.

The ichthyoplankton community found in Flushing Bay varied seasonally. There was a shift from Fourbeard rockling eggs and sculpin larvae in March, to a community of Atlantic menhaden, herrings, tautog, cunner, and bay anchovy in May and July. This shift in community structure follows species spawning activity (Table 4-11). Atlantic menhaden eggs and anchovy larvae were most abundant in May and July, respectively. Overall, ichthyoplankton abundances were highest in May and July, when the majority of estuarine species are spawning. A total of 14 taxa were collected from the south station and 15 taxa from the north station (Table 4-12). The north sampling station had a high concentration of herring (2690/100m^3), which is an economically important species. In addition, both Flushing Bay sampling stations had a high concentration of Atlantic menhaden, another commercially and ecologically important species.

Table 4-11. Seasonal Occurrence of Fish Eggs and Larvae in Flushing Bay

Lowest Taxonomic Level	Common Name	Date							
		March		May		July		August	
		FLSHI01	FLSHI02	FLSHI01	FLSHI02	FLSHI01	FLSHI02	FLSHI01	FLSHI02
Ammodytes americanus	American sand lace		L						
Anchoa	Anchovies								
Brevoortia tyrannus	Atlantic menhaden			E	E		L		
Menidia menidia	Atlantic silverside				L				
Anchoa mitchelli	Bay anchovy					L	E, L	L	
Tautogolabrus adspersus	Cunner				E	E, L	E	E	
Enchelyopus cimbrius	Fourbeard rockling	E	E	L	L				
Clupeidae	Herrings			L	E, L	L	L		
Myoxocephalus	Sculpin	L	L						
Tautoga onitis	Tautog			E	E	E	E	E	
Gobiidae	True Gobies					L	L	L	
Scophthalmus aquosus	Windowpane	L		E, L	L		E, L	E	
Hypsoblennius hentzi	Feather Blenny					L			
Syngnathus fuscus	Northern Pipefish						L	L	
Stenotomus chrysops	Scup						E		
Prionotus sp.	Searobins					E	E	E	
Pseudopleuronectes americanus	Winter flounder	L	L						

Table 4-12. Number of Fish Eggs and Larvae Collected in East River Tributaries

Species	Common Name	Flushing Bay (FLSHI01)	Flushing Bay (FLSHI02)	Little Neck Bay (ALLYI01)	Manhasset Bay (MABAI01)
Ammodytes americanus	American sand lance	22	10	24	62
Anchoa	Anchovies	0	0	8	0
Anchoa mitchelli	Bay anchovy	48	38	36	60
Brevoortia tyrannus	Atlantic menhaden	15872	1342	70	38
Clupeidae	Herrings	90	2690	9190	4256
Enchelyopus cimbrius	Fourbeard rockling	8	10	1586	624
Gobiidae	True gobies	84	56	2	6
Menidia menidia	Atlantic silverside	0	6	56	0
Myoxocephalus	Sculpin	20	2	28	0
Pseudopleuronectes americanus	Winter flounder	22	70	316	122
Scophthalmus aquosus	Windowpane	72	10	54	48
Tautoga onitis	Tautog	734	776	148	108
Tautogolabrus adspersus	Cunner	108	442	120	32
Hypsoblennius hentzi	Feather blenny	4	0	0	0
Prionotus	North American searobins	6	22	0	0
Syngnathus fuscus	Northern pipefish	4	2	0	2
Stenotomus chrysops	Scup	0	4	0	0
Pholis gunnellus	Rock gunnel	0	0	0	4
Total # of Taxa		**14**	**15**	**13**	**12**
Total Number		**17094**	**5480**	**11638**	**5362**

Ichthyoplankton drift in the water column thus their presence in Flushing Bay could be due to spawning in the Bay or in the East River with their eggs and larvae transported into the Bay by the tides. Because the duration of the egg stage is short (about two days after fertilization) compared to the larval stage (2-3 months, depending on species) there is a relatively higher degree of confidence that an egg found in the Flushing Bay may have been spawned there. The majority of the eggs collected in Flushing Bay were of structure oriented species such as cunner, tautog and fourbeard rockling. The occurrence of rip-rap shorelines is probably responsible for the abundance of these species.

4.5.7 Adult and Juvenile Fish

The fish community of Flushing Bay was sampled in July and August 2001, when bottom water DO concentrations are at their lowest, and in April and August 2002. Sampling was conducted with an otter trawl to catch bottom oriented species and a gill net suspended in the water column to capture pelagic species.

A total of 17 taxa and 837 individuals were collected from both Flushing Bay stations combined (14 taxa, 797 individuals from the south station; 3 taxa, 40 individuals from the north station; Table 4-13). Weakfish and Bluefish were the most abundant species at the south (FLSHF01) station in July and August 2001, respectively. Striped bass dominated the catch in April 2002 and weakfish and winter flounder were the most abundant species in August 2002. The north station (FLSHF02) catch was dominated by weakfish in July 2001. No fish were caught in August 2001 and sampling was not conducted in 2002.

4.5.8 Fish and Aquatic Uses

Fish and aquatic life use of Flushing Bay has been impaired since development in the watershed permanently modified virtually all of the factors that can have a major influence on the ecological health of an estuarine waterbody. The improvement in water quality conditions through CSO abatement will enhance aquatic life uses, but other factors, primarily physical habitat, may become limiting. Enhanced aquatic life use will reach a threshold that cannot be exceeded due to irreversible alterations to the physical environment. In addition, most of the adjacent waterbodies and tributary watersheds have undergone similar physical impairments.

Long-term sampling for aquatic life throughout the NY/NJ Harbor has shown how fish and benthic life are distributed with regard to a range of DO and physical habitat conditions. Aquatic life use of existing habitats when DO is near the regulatory limit involves many desirable fish and invertebrates which are not regarded as pollution tolerant.

Table 4-13. Number of Fish Collected in East River Tributaries

Species	Common Name	Flushing Bay (FLSHF01)	Flushing Bay (FLSHF02)	Little Neck Bay (ALLYF01)	Manhasset Bay (MABAF01)
Anguilla rostrata	American eel	2	0	0	0
Brevoortia tyrannus	Atlantic menhaden	73	0	27	3
Menidia menidia	Atlantic silverside	0	0	4	0
Anchoa mitchelli	Bay anchovy	12	0	0	0
Alosa aestivalis	Blueback herring	3	0	0	0
Pomatomus saltatrix	Bluefish	18	1	9	12
Peprilus triacanthus	Butterfish	1	2	0	0
Tautogolabrus adspersus	Cunner	1	0	0	0
Clupeidae	Herrings	6	0	0	0
Brevoortia	Menhaden	3	0	0	0
Prionotus carolinus	Northern searobin	0	0	0	3
Urophycis regia	Spotted hake	2	0	0	0
Morone saxatilis	Striped bass	67	0	0	0
Prionotus evolans	Striped searobin	0	0	3	0
Paralichthys dentatus	Summer flounder	0	0	2	0
Cynoscion regalis	Weakfish	308	37	6	39
Pseudopleuronectes americanus	Winter flounder	298	0	9	41
Brevoortia smithi	Yellowfin menhaden	3	0	12	15
Total # of Taxa		**14**	**3**	**8**	**6**
Total Number of Individuals		**797**	**40**	**72**	**113**

The use of Flushing Bay by aquatic life is partially limited by its degraded physical habitat. Even with DO near or above the regulatory limit, the loss of extensive fringing wetlands, diverse natural shorelines, and benthic habitat suitable for colonization have substantially reduced biological diversity. Improvement in DO and a reduction in the discharge of organic matter will result in an improvement in the sediments through reduction of the percentage of sediment TOC. A reduction in TOC has been shown to correlate well with an increase in benthic diversity in the substrate (DEP 2004). A review of organic enrichment of estuaries and marine waters by Pearson and Rosenberg (1978) and a recent review by Hyland *et al.* (2000) under the auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO) confirm the general applicability of the relationship of TOC to benthic diversity. However, as long as the substrate is dominated by fine grain material; many invertebrate species will be excluded. Although the productivity of soft sediments can be high, because of a lack of diversity in the benthic community, many fishes will make limited use of the habitat due to a lack of their preferred prey.

A comparison of the upper East River tributaries supports the position that physical habitat diversity is important for biological diversity. For example, the abundance of the eggs/larvae of cunner, tautog and fourbeard rockling in the upper East River suggests that these species could increase in number if desirable physical habitat were more abundant. These species prefer structure with irregularities and interstices. Vertical bulkhead walls and piles provide some of this habitat, but man-made bulkheads tend to be smooth and regular over extensive lengths. The high productivity among a few pollution tolerant species in fine-grained sediments represents another example of poor ecological conditions. The attainment of enhanced aquatic life usage in Flushing Bay is contingent upon a diverse physical habitat to support a variety of fish and benthic life. If such conditions could be attained, reproduction and growth would probably be enhanced which would contribute to a more balanced estuarine community than under existing conditions. The potential gain in aquatic life usage in Flushing Bay diminishes rapidly above the regulatory DO limit of 4.0 mg/l, due to the limitations of physical habitat.

Currently, there is a strong interest in waterfront amenities harbor-wide which, in part, reflects the public recognition that water quality has improved over past conditions and that the aquatic resources can be used with some limitations. The cumulative effects of improving conditions for water quality and physical habitat throughout the NY/NJ Harbor minimizes the residual effects of small areas with temporary seasonal declines in water quality on the ecosystem scale. There are continuing trends of improving water quality in adjacent waterbodies such as major tributaries of the Upper East River. While these trends in water quality improvement continue, the significance of small areas of non-compliance with water quality standards will be minimized.

The extensive development of the shorelines for industrial, commercial and residential uses in the Bay and the upstream watershed is a factor which places limits on both water quality and aquatic habitat availability and quality. A reduction in the TOC levels in the vicinity of the CSO outfalls would improve sediment and water quality in these areas. The benefits of this reduction in sediment TOC would include a more diverse benthic community. However, these benefits would be limited to the treatment area and would make a small contribution to the overall Harbor ecosystem.

Water quality in Flushing Bay is near its practical limit for improvement with respect to real gains in aquatic life use. In a highly modified system such as Flushing Bay, the protection and use of aquatic resources need to reflect that water quality and habitat will always be less than ideal due to irreversible changes in the watershed.

4.6 SENSITIVE AREAS

4.6.1 CSO Policy Requirements

Federal CSO Policy requires that the long-term CSO control plan give the highest priority to controlling overflows to sensitive areas. For such areas, the CSO Policy indicates the LTCP should: (a) prohibit new or significantly increased overflows; (b) eliminate or relocate overflows that discharge to sensitive areas if physically possible, economically achievable, and as protective as additional treatment, or provide a level of treatment for remaining overflows adequate to meet standards; and (c) provide reassessments in each permit term based on changes in technology, economics, or other circumstances for those locations not eliminated or relocated (USEPA, 1995a). The policy defines sensitive areas as:

- Waters designated as Outstanding National Resource Waters (ONRW);
- National Marine Sanctuaries;
- Public drinking water intakes;
- Waters designated as protected areas for public water supply intakes;
- Shellfish beds;
- Waters with threatened or endangered species and their habitat;
- Water with primary contact recreation; and
- Additional areas determined by the Permitting Authority (i.e., DEC).

The last item in the list was addressed by consulting the Natural Resources Division of DEC during the development of the assessment approach, and additional sensitive areas were provided for CSO abatement prioritization based on local environmental issues. Their response listed the following: Jamaica Bay; Bird Conservation Areas; Hudson River Park; 'important tributaries' such as the Bronx River in the Bronx, and Mill, Richmond, Old Place, and Main Creeks in Staten Island; the Raritan Bay shellfish harvest area; waterbodies targeted for regional watershed management plans (Newtown Creek and Gowanus Canal).

4.6.2 Assessment

An assessment was performed to identify any areas within Flushing Bay that may be candidates for consideration as sensitive areas. The assessment was limited to a review of relevant regulatory designations, publicly-available information accessed through Freedom of Information Act (FOIA) requests, and direct communication with the permitting authority. It was determined that there are no sensitive areas in Flushing Bay.

5.0 WATERBODY IMPROVEMENT PROJECTS

New York City is served primarily by a combined sewer system. Approximately 70 percent of the City is comprised of combined sewers totaling 4,800 miles within the five boroughs. The sewer system drains some 200,000 acres and serves a population of approximately 8 million New Yorkers. Approximately 460 outfalls are permitted to discharge during wet-weather through CSOs to the receiving waters of the New York Harbor complex. These discharges result in localized water-quality problems such as periodically high levels of coliform bacteria, nuisance levels of floatables, depressed DO, and, in some cases, sediment mounds and unpleasant odors.

The City of New York is committed to its role as an environmental steward of the New York Harbor and began addressing the issue of CSO discharges in the 1950s. To date, DEP has spent or committed over $2.9 billion in its Citywide CSO abatement program. As a result of this and other ongoing programs, water quality has improved dramatically over the past 30 years (DEP Harbor Survey Annual Reports). Implementation of many of these solutions within the current DEP 10-year capital plan will continue that trend as DEP continues to address CSO-related water quality issues through its Citywide CSO Floatables program, pump station and collection system improvements, and the ongoing analysis and implementation of CSO abatement solutions. The following sections present the history of DEP CSO abatement and describe the current and ongoing programs in detail.

5.1 CSO PROGRAMS 1950 TO 1992

Early CSO assessment programs began in the 1950s and culminated with the Spring Creek Auxiliary WWTP, a 12-million gallon CSO retention facility constructed on a tributary to Jamaica Bay. Completed in 1972, this project was one of the first such facilities constructed in the United States. Shortly thereafter, New York City was designated by the USEPA to conduct an Area-Wide Wastewater Management Plan authorized by Section 208 of the then recently enacted CWA. This plan completed in 1979 identified a number of urban tributary waterways in need of CSO abatement throughout the City. During the period from the mid-1970s through the mid-1980s New York City's resources were devoted to the construction of wastewater treatment plant upgrades.

In 1983, DEP re-invigorated its CSO facility-planning program in accordance with DEC-issued SPDES permits for its WWTPs with a project in Flushing Bay and Creek. In 1985, a Citywide CSO Assessment was undertaken which assessed the existing CSO problem and established the framework for additional facility planning. From this program, the City was divided into eight areas, which together cover the entire harbor area. Four area-wide projects were developed (East River, Jamaica Bay, Inner Harbor and Outer Harbor) and four tributary project areas were defined (Flushing Bay, Paerdegat Basin, Newtown Creek, and the Jamaica tributaries). Detailed CSO Facility Planning Projects were conducted in each of these areas in the 1980s and early 1990s and resulted in a series of detailed, area-specific plans.

In 1989, DEP initiated the Citywide Floatables Study in response to a series of medical waste and floating material wash-ups and resulting bathing beach closures in New York and New

Jersey in the late 1980s. This comprehensive investigation determined that medical wastes were a small component of the full spectrum of material found in metropolitan area waters and beach wash-ups and that the likely source of the medical wastes was illegal dumping. The study also found that, aside from natural materials and wood from decaying piers and vessels, the primary component of the floatable material is street litter in surface runoff that is discharged to area waters via CSOs and storm sewers. The Floatables Control Program is discussed in Section 5.4.

5.2 CITYWIDE CSO ABATEMENT ORDERS (1992, 1996, 2005, 2008, 2009)

In 1992, DEC and DEP entered into the original CSO Administrative Consent Order (1992 ACO). As a goal, the 1992 ACO required DEP to develop and implement a CSO abatement program to effectively address the contravention of water quality standards for coliforms, DO, and floatables attributable to CSOs. The 1992 ACO contained compliance schedules for the planning, design and construction of the numerous CSO projects in the eight CSO planning areas. The 1992 ACO was modified in 1996 to add a program for catch basin cleaning, construction, and repair to further control floatables.

The Flushing Bay and Paerdegat Basin CSO Retention Tanks were included in the 1992 ACO. In addition, two parallel "tracks" were identified for CSO planning purposes. Track 1 addressed DO (aquatic life protection) and coliform bacteria (recreation) issues. Track 2 addressed floatables, settleable solids and other water-use impairment issues. The 1992 ACO also provided for an Interim Floatables Containment Program to be implemented consisting of a booming and skimming program in confined tributaries, skimming in the open waters of the harbor, and an inventory of street catch basins where floatable materials enter the sewer systems. Open waters are defined as the Inner and Outer Harbors as well as Jamaica Bay.

In accordance with the 1992 ACO, DEP continued to implement its work for CSO abatement through the facility-planning phase into the preliminary engineering phase. Work proceeded on the planning and design of eight CSO retention tanks located on confined and highly urbanized tributaries throughout the City. The number of planned retention tank facilities was reduced from eight to six during the CSO facility planning phase. The Interim Floatables Containment Program was fully developed and implemented. The Corona Avenue Vortex Facility (CAVF) pilot project for floatables and settleable solids control was designed and implemented. The City's 141,000 catch basins were inventoried and a re-hooding program for floatables containment was implemented and substantially completed. Reconstruction and re-hooding of the remaining basins were completed in 2009.For CSOs discharging to the open waters of the Inner and Outer Harbors areas, efforts were directed to the design of sewer system improvements and wastewater treatment plant modifications to increase the capture of combined sewage for processing at the plants. For the Jamaica Tributaries, efforts focused on correction of illegal connections to the sewer system and evaluation of sewer separation as control alternatives. For Coney Island Creek, attention was directed to corrections of illegal connections and other sewer system/pumping station improvements. These efforts and the combination of the preliminary engineering design phase work at six retention tank sites resulted in amendments to some of the original CSO Facility Plans included in the 1992 ACO and the development of additional CSO Facility Plans in 1999.

DEP and DEC negotiated a new Consent Order that was signed January 14, 2005 that supersedes the 1992 Order and its 1996 Modifications with the intent to bring all DEP CSO-related matters into compliance with the provisions of the Clean Water Act and Environmental Conservation Law. The new Order, noticed by DEC in September 2004, contains requirements to evaluate and implement CSO abatement strategies on an enforceable timetable for 18 waterbodies and, ultimately, for Citywide long-term CSO control in accordance with USEPA CSO Control Policy. DEP and DEC also entered into a separate Memorandum of Understanding to facilitate water quality standards reviews in accordance with the CSO Control Policy. The 2005 Consent Order was modified in 2008 and 2009. Table 5-1 presents the design and construction milestone dates for capital projects in the most current CSO Consent Order.

Table 5-1. CSO Consent Order Milestone Dates for Capital Projects(1)

Planning Area	Project	Design Completion	Construction Completion
Alley Creek	Outfall & Sewer System Improvements	Mar 2002	Dec 2006
	CSO Retention Facility	Dec 2005	Mar 2011
Outer Harbor	Regulator Improvements – Fixed Orifices	Apr 2005	Jul 2008
	Regulator Improvements – Automation	Nov 2006	Jun 2010
	Port Richmond Throttling Facility	Aug 2005	Nov 2009 as modified
	In-Line Storage (Deleted per 2008 CSO Consent Order)	Nov 2006	Deleted
Inner Harbor	Regulator Improvements – Fixed Orifices	Sep 2002	Apr 2006
	Regulator Improvements – Automation	Nov 2006	Jun 2010
	In-Line Storage	Nov 2006	Aug 2010
	Gowanus Flushing Tunnel Modernization	-	Sep 2014
	Gowanus Pumping Station Reconstruction	-	Sep 2014
	Dredging Gowanus Canal	Dec 2010	See Note 2
Paerdegat Basin	Influent Channel	Mar 1997	Feb 2002
	Foundations and Substructures	Aug 2001	Dec 2009
	Structures and Equipment	Nov 2004	May 2011
	Dredging Paerdegat Basin	See Note 2	See Note 3
Flushing Bay/Creek	CS4-1 Reroute & Construct Effluent Channel	Sep 1994	Jun 1996
	CS4-2 Relocate Ball fields	Sep 1994	Aug 1995
	CS4-3 Storage Tank	Sep 1996	Aug 2001
	CS4-4 Mechanical Structures	Feb 2000	Sep 2009
	CS4-5 Tide Gates	Nov 1999	Apr 2002
	CD-8 Manual Sluice Gates	May 2003	Jun 2005
	Tallman Island WWTP 2xDDWF	Dec 2010	Jul 2015
Jamaica Tributaries	Meadowmere & Warnerville DWO Abatement	May 2005	Jul 2009 as modified
	Expansion of Jamaica WWTP Wet Weather Capacity	Jun 2011	Jun 2015
	Destratification Facility	Dec 2007	Mar 2012
	Laurelton & Springfield Stormwater Buildout Drainage Plan	May 2008	-
	Regulator Automation	Nov 2006	Jun 2010
Coney Island Creek	Avenue V Pumping Station Upgrade	Jan 2005	Apr 2011
	Avenue V Force Main	Sep 2006	Jun 2012
Newtown Creek	Aeration Zone I	Dec 2004	Dec 2008
	Aeration Zone II	Jun 2010	Jun 2014
	Relief Sewer/Regulator Modification	Jun 2009	Jun 2014
	Throttling Facility	Jun 2008	Dec 2012
	CSO Storage Facility	Nov 2014	Dec 2022

Table 5-1. CSO Consent Order Milestone Dates for Capital Projects(1)

Planning Area	Project	Design Completion	Construction Completion
Westchester Creek	Phase 1 (Influent Sewers)	Jun 2010	Jun 2015
	CSO Storage Facility	-	Dec 2022
Bronx River	Floatables Control	Jul 2008	Jun 2012
Hutchinson River	Phase I of Storage Facility	Jun 2010	Jun 2015
	Future Phases	-	Dec 2023
Jamaica Bay	Spring Creek AWWTP Upgrade	Feb 2002	Apr 2007
	26th Ward Drainage Area Sewer Cleaning & Evaluation	Jun 2007	Jun 2010
	Hendrix Creek Dredging	Jun 2007	Feb 2012
	26th Ward Wet Weather Expansion	Jun 2010	Dec 2015
	Rockaway WWTP 2xDDWF	-	Dec 2017

Notes: 1) DEP and DEC are negotiating replacing some of the existing mandates with more cost effective CSO controls that will attain equivalent water quality benefits
2) Dredging must be completed with 5 years of final permit issuance.
3) Design Completion = Permit + 18 months; Construction Completion = Permit + 60 months.

5.3 BEST MANAGEMENT PRACTICES (BMPS)

The SPDES permits for all 14 WWTPs in New York City require the DEP to report annually on the progress of 14 BMPs related to CSOs. The BMPs are equivalent to the Nine Minimum Controls (NMCs) required under the USEPA National Combined Sewer Overflow policy, which were developed by USEPA to represent best management practices that would serve as technology based CSO controls. They were intended to be “determined on a best professional judgment basis by the NPDES permitting authority” and to be the best available technology based controls that could be implemented within two years by permittees. USEPA developed two guidance manuals that embodied the underlying intent of the NMCs (USEPA 1995a, 1995b) for permit writers and municipalities, offering suggested language for SPDES permits and programmatic controls that may accomplish the goals of the NMCs.

A list of BMPs excerpted directly from the most recent SPDES permits follows, along with brief summaries of each BMP and their respective relationships to the federal NMCs. In general, the BMPs address operation and maintenance procedures, maximum use of existing systems and facilities, and related planning efforts to maximize capture of CSO and reduce contaminants in the combined sewer system, thereby reducing water quality impacts. Through the CSO BMP Annual Reports, which were initiated in 2004 for the reporting year 2003, DEP provides brief descriptions of the Citywide programs and any notable WWTP drainage area specific projects that address each BMP.

5.3.1 CSO Maintenance and Inspection Program

This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and NMC 9 (Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls). Through regularly scheduled inspection of the

CSOs and the performance of required repair, cleaning, and maintenance, dry weather overflows and leakage can be prevented and maximization of flow to the WWTP can be ensured. Specific components of this BMP include:

- Inspection and maintenance of CSO tide gates;
- Telemetering of regulators;
- Reporting of regulator telemetry results;
- Recording and reporting of rain events that cause dry weather overflows; and
- DEC review of inspection program reports.

DEP reports on the status of the Citywide program components and highlights specific maintenance projects such as the Enhanced Beach Protection Program, where additional inspections of infrastructure in proximity to sensitive beach areas were performed. Table 5-2 lists all of the maintenance preformed on regulators within the Flushing Bay service area in the 2010 calendar year.

Table 5-2. CSO Maintenance and Inspection Programs in Flushing Bay (2010)

Regulator	Description of Work[1]
TI - 12	Chopped and removed heavy grease from walls, measured duckbill for replacement flapper, replaced duckbill with flapper and chain
[1] As listed in the SPDES Permit for the 14 Wastewater Treatment Plants, CY2010 CSO BMP Annual Report Attachment A, 2011	

5.3.2 Maximum Use of Collection System for Storage

This BMP addresses NMC No. 2 (Maximum Use of the Collection System for Storage) and requires the performance of cleaning and flushing to remove and prevent solids deposition within the collection system as well as an evaluation of hydraulic capacity so that regulators and weirs can be adjusted to maximize the use of system capacity for CSO storage and thereby reduce the amount of overflow. DEP provides general information describing the status of Citywide SCADA, regulators, tide gates, interceptors, and collection system cleaning in the CSO BMP Annual Report. Several interceptors in the Flushing Bay service area were cleaned as part of the NMC 2 requirement. Table 5-3 summarizes interceptor cleaning preformed in 2010.

Table 5-3. Interceptor Cleaning in Flushing Bay (2010)

Description	Size (ft)	Length (ft)	Task completed
Bowery Bay WWTP	Various	Various	Removed 100 cubic yards of debris
Linden Place PS	Various	Various	Removed 14 cubic yards of debris
Park Drive East PS	Various	Various	Removed 34 cubic yards of debris

5.3.3 Maximize Flow to WWTP

This BMP addresses NMC No. 4 (Maximizing Flow to the Publicly Owned Treatment Works) and reiterates the WWTP operating targets established by the SPDES permits with regard to the ability of the WWTP to receive and treat minimum flows during wet weather. The collection systems are required to deliver and the WWTPs are required to accept the following flows for the associated levels of treatment:

- Receipt of flow through the headworks of the WWTP: 2xDDWF;
- Primary treatment capacity: 2xDDWF; and
- Secondary treatment capacity: 1.5xDDWF.

The 2008 Modified Consent Order states, "The Tallman Island WWTP and associated sewer system are capable of delivering, accepting and treating influent at or above twice the plant's design flow during any storm event," with milestones including construction completion by July 2015. During 2007, the Tallman Island WWTP attained a flow rate of 160 MGD (2xDDWF) for a total of 5 hours. Recent hydraulic analyses and sewer system modeling projects have indicated that additional interceptor capacity and modifications to a few regulators are required to improve the ability of the interceptors to deliver 160 MGD on a sustained basis. DEP completed facility planning activities in 2005. In 2004 and 2005, DEP developed plans for and designed modifications to Regulator TI-R09 that could allow it to deliver more wet-weather flow to the WWTP. The construction work for this action was completed in mid-2006. A contract for the design of additional collection system conveyance capacity (interceptor capacity) was registered in 2007. Design work was completed in 2010.

The BMP also refers to the establishment of collection system control points in the system's WWOP as required in BMP #4, and requires the creation of a capital compliance schedule within six months of the DEC approval of the WWOP should any physical limitations in flow delivery be detected.

In addition to describing WWTP upgrades and efforts underway to ensure appropriate flows to all 14 WWTPs, the CSO BMP Annual Report provides analysis of the largest 10 storms of the year and WWTP flow results for each of these storms at least during the peak portions of the events.

According to the CY2010 Annual BMP Report, while the Tallman Island WWTP was able to achieve their permitted 2XDDWF capacity the Bowery Bay WWTP did not during the top ten storm events of 2010. A summary of each plant's performance during the top ten storm events is summarized in Table 5-4 below.

Table 5-4. WWTP 2010 Performance

		Top-Ten Storm Maximum			Top-Ten Storm Average		
Plant	Permitted Capacity(1)	Reported Capacity(2)	Sustained Flow(3)	Peak Flow(4)	Reported Capacity(5)	Sustained Flow(6)	Peak Flow(7)
Bowery Bay	300	220	253	296	200-220	234	262
Tallman Island	160	160	141	158	160	126	143

(1) **Permitted Capacity** represents the design wet-weather capacity of the WWTP, except as noted. The design wet-weather capacity is typically equal to two times design dry-weather flow (2xDDWF). The design capacity is applicable when all process units are in service. Construction and repair activities can temporarily reduce capacity.

(2) **Maximum Reported Capacity** represents the single largest WWTP capacity reported by the WWTP for any of the top ten storms. Capacities reported by the WWTP are based on the process units in service during each storm and area in accordance with each WWTP's approved wet-weather operating plan. Process units may be taken out of service during construction for upgrades mandated by Consent Orders or

for other reasons such as emergency repairs. If all process units are in service during a storm, the reported capacity equals the design capacity.

(3) **Maximum Sustained Flow** is the largest wet-weather "sustained flow" that occurred during any of the top ten storms. Sustained flows represent the average hourly WWTP flow during WWTP throttling periods, or for events with no throttling, the average hourly flow over at least 3 hours including the peak wet-weather flow.

(4) **Maximum Peak Flow** represents the highest hourly flow observed during the top ten storms.

(5) **Average Reported Capacity** represents the average of the capacities reported by the WWTP for all top ten storms. Capacities reported by the WWTP are based on the process units in service during each storm and are in accordance with each WWTP's approved wet-weather operating plan. Process units may be taken out of service during construct for upgrades mandated by Consent Orders or for other reason such as emergency repairs. If all process units are in service during a storm, the reported capacity equals the design capacity.

(6) **Average Sustained Flow** represents the average of the largest, multi-hour flows that occurred during each of the top ten storm periods. Sustained flows represent the average hourly WWTP flow during WWTP-throttling periods or, for events with no throttling, the average hourly flow over at least 3 hours including the peak wet-weather flow.

(7) **Average Peak Flow** represents the average of the highest hourly flows observed during each of the top ten storms.

5.3.4 Wet Weather Operating Plan

In order to maximize treatment during wet weather events, WWOPs are required for each WWTP drainage area. Each WWOP should be written in accordance with the DEC publication entitled *Wet Weather Operations and Wet Weather Operating Plan Development for Wastewater Treatment Plants*, and should contain the following components:

- Unit process operating procedures;
- CSO retention/treatment facility operating procedures, if relevant for that drainage area; and
- Process control procedures and set points to maintain the stability and efficiency of biological nutrient removal (BNR) processes, if required.

This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and NMC 4 (Maximizing Flow to the Publicly Owned Treatment Works). The DEP provides a schedule of plan submittal dates as part of the CSO BMP Annual Report. The submittal dates listed in the CY2010 CSO BMP Annual Report for facilities in Flushing Bay are provided in Table 5-5.

Table 5-5. Flushing Bay Wet Weather Operating Plans

Facility	Original Submissions to DEC	Revisions Submitted to DEC	DEC Approval Status
Bowery Bay WWTP	July 2003	Sept. 2004, March 2009	March 2009 version Conditionally Approved (May 2009)
Tallman Island WWTP	July 2003	Sept. 2004, May 2007, Oct. 2007, Aug. 2009, July 2010	July 2010 version approved September 2010
Corona Avenue Vortex Facility	December 2003	NA	NA

5.3.5 Prohibition of Dry Weather Overflow

This BMP addresses NMC 5 (Elimination of CSOs During Dry Weather) and NMC 9 (Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls) and requires that any dry weather flow event be promptly abated and reported to DEC within 24 hours. A written report must follow within 14 days and contain information per SPDES permit requirements. The status of the shoreline survey, the Dry Weather Discharge Investigation report, and a summary of the total bypasses from the treatment and collection system are provided in the CSO BMP Annual Report.

5.3.6 Industrial Pretreatment

This BMP addresses three NMC: No. 3 (Review and Modification of Pretreatment Requirements to Determine Whether Nondomestic Sources are Contributing to CSO Impacts); No. 7 (Pollution Prevention Programs to Reduce Contaminants in CSOs); and No. 9 (Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls). By regulating the discharges of toxic pollutants from unregulated, relocated, or new SIUs tributary to CSOs, this BMP addresses the maximization of persistent toxics treatment from industrial sources upstream of CSOs. Specific components of this BMP include:

- Consideration of CSOs in the calculation of local limits for indirect discharges of toxic pollutants;
- Scheduled discharge during conditions of non-CSO, if appropriate for batch discharges of industrial wastewater;
- Analysis of system capacity to maximize delivery of industrial wastewater to the WWTP, especially for continuous discharges;
- Exclusion of non-contact cooling water from the combined sewer system and permitting of direct discharges of cooling water; and
- Prioritization of industrial waste containing toxic pollutants for capture and treatment by the POTW over residential/commercial service areas.

The CSO BMP Annual Report addresses the components of the industrial pretreatment BMP through a description of the Citywide program.

5.3.7 Control of Floatable and Settleable Solids

This BMP addresses NMC 6 (Control of Solid and Floatable Material in CSOs), NMC 7 (Pollution Prevention Programs to Reduce Contaminants in CSOs), and NMC 9 (Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls) by requiring the implementation of four practices to eliminate or minimize the discharge of floating solids, oil and grease, or solids of sewage origin which cause deposition in receiving waters, i.e.:

- Catch Basin Repair and Maintenance: This practice includes inspection and maintenance schedules to ensure proper operation of basins;
- Catch Basin Retrofitting: By upgrading basins with obsolete designs to contemporary designs with appropriate street litter capture capability, this program is intended to increase the control of floatable and settleable solids, Citywide;

- Booming, Skimming and Netting: This practice establishes the implementation of floatables containment systems within the receiving waterbody associated with applicable CSO outfalls. Requirements for system inspection, service, and maintenance are established, as well; and
- Institutional, Regulatory, and Public Education - A one-time report must be submitted examining the institutional, regulatory, and public education programs in place Citywide to reduce the generation of floatable litter. The report must also include recommendations for alternative City programs and an implementation schedule that will reduce the water quality impacts of street and toilet litter.

The CSO BMP Annual Report provides summary information regarding the status of the catch basin and booming, skimming, and netting programs Citywide.

Several catch basin cleaning and hooding activities took place in the Flushing Bay service area in 2010 as described in the CY2010 CSO BMP Annual Report. An average of 1,725 catch basins were cleaned in Queens each month. In 2010, hoods were replaced in 113 and 67 of the catch basins within the Bowery Bay and Tallman Island service areas, respectively.

As part of its floatables plan, the DEP maintains two floatables containment booms in Flushing Bay, one downstream of Outfall BB-006 (CS2) and one downstream of Outfall BB-008 (CS1). The DEP has these facilities inspected and serviced after significant rainstorms. Table 5-6 summarizes the quantity of floatables retrieved from the Flushing Bay containment facilities in 2010, as reported in the CY2010 CSO BMP Annual Report.

Table 5-6. Floatable Material Collected in Flushing Bay (2010)

Month of Year	**Flushing Bay CS1 at BB-008(1) (cy)**	**Flushing Bay CS2 at BB-006(2) (cy)**
January	0.0	0.5
February	0.0	0.0
March	2.5	0.5
April	0.0	0
May	0.0	2.5
June	0.0	0.0
July	0.0	1.0
August	0.0	2.0
September	0.0	0.0
October	1.0	0.0
November	0.0	0.0
December	0.0	0.0
Total	**3.5**	**0.0**

(1) Formerly known as Flushing Bay CS2
(2) Formerly known as Flushing Bay CS3

5.3.8 Combined Sewer System Replacement

This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls), requiring all combined sewer replacements to be approved by the New York State Department of Health (NYSDOH) and to be specified within the DEP Master Plan for Sewage and Drainage. Whenever possible, separate sanitary and storm sewers should be used to replace combined sewers. The CSO BMP Annual Report describes the general, Citywide plan and addresses specific projects occurring in the reporting year. DEP plans to separate a portion of the College Point area as described in section 5.8. No work associated with this project was performed in 2010.

5.3.9 Combined Sewer/Extension

In order to minimize storm water entering the combined sewer system, this BMP requires combined sewer extensions to be accomplished using separate sewers whenever possible. If separate sewers must be extended from combined sewers, analysis must occur to ensure that the sewage system and treatment plant are able to convey and treat the increased dry weather flows with minimal impact on receiving water quality.

This CSO BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and a brief status report is provided in the CY2010 CSO BMP Annual Report, although no combined sewer extension projects were completed in 2010.

5.3.10 Sewer Connection & Extension Prohibitions

This BMP addresses NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and prohibits sewer connections and extensions that would exacerbate recurrent instances of either sewer back-up or manhole overflows. Wastewater connections to the combined sewer system downstream of the last regulator or diversion chamber are also prohibited. The CSO BMP Annual Report contains a brief status report for this BMP and provides details pertaining to chronic sewer back-up and manhole overflow notifications submitted to DEC when necessary.

For the calendar year 2010, no letter of notification was received from DEC concerning chronic sewer backups or manhole overflows which would prohibit additional sewer connections or sewer extensions.

5.3.11 Septage and Hauled Waste

The discharge or release of septage or hauled waste upstream of a CSO (i.e., scavenger waste) is prohibited under this BMP. Scavenger wastes may only be discharged at designated manholes that never drain into a CSO, and only with a valid permit. This BMP addresses NMC No. 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls). The CSO BMP Annual Report summarizes the three scavenger waste acceptance facilities controlled by DEP, all of which are downstream of CSO regulators, and the regulations governing discharge of such material at the facilities.

5.3.12 Control of Run-off

This BMP addresses NMC 7 (Pollution Prevention Programs to Reduce Contaminants in CSOs) by requiring all sewer certifications for new development to follow DEP rules and regulations, to be consistent with the DEP Master Plan for Sewers and Drainage, and to be permitted by DEP. This BMP ensures that only allowable flow is discharged into the combined or storm sewer system. The CSO BMP Annual Report refers to the DEP permit regulations required of new development and sewer connections.

5.3.13 Public Notification

This BMP requires easy-to-read identification signage to be placed at or near CSO outfalls with contact information for DEP to allow the public to report observed dry weather overflows. All signage information and appearance must comply with the Discharge Notification Requirements listed in the SPDES permit. This BMP also requires that a system be in place to determine the nature and duration of an overflow event, and that potential users of the receiving waters are notified of any resulting, potentially harmful conditions. The BMP does allow New York City Department of Health and Mental Hygiene (NYCDHMH) to implement and manage the notification program.

BMP # 13 addresses NMC 8 (Public Notification) as well as NMC 1 (Proper Operations and Maintenance of Combined Sewer Systems and Combined Sewer Overflow Outfalls) and NMC 9 (Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls). DEP provides the status of the CSO signage program in the CSO BMP Annual Report and lists those former CSO outfalls that no longer require signs. DEP is currently developing improvements to the CSO signs to increase their visibility and to include information relative to wet-weather warnings as required by the EPA CSO Policy. In addition, descriptions of new educational signage and public education-related partnerships are described. The NYCDHMH CSO public notification program is also summarized.

5.3.14 Annual Report

This BMP requires an annual report summarizing implementation of the BMPs, including lists of all existing documentation of implementation of the BMPs, be submitted by April 1st of each year. This BMP addresses all nine minimum controls. As of August 2011, the most recent BMP Annual Report submitted was for calendar year 2010.

5.4 CITYWIDE CSO PLAN FOR FLOATABLES ABATEMENT

In the late 1980s, New York City initiated the Citywide Floatables Study, a multi-year investigation of floatables in New York Harbor (HydroQual 1993, 1995). In addition to examining floatables characteristics, this study investigated potential sources of floatables, floatables circulation and beach-deposition patterns throughout the Harbor, and potential structural and non-structural alternatives for floatables control. Findings of the study showed that the primary source of floatables (other than natural sources) in the Harbor was urban street litter carried into waterways along the rainfall runoff.

DEP developed a floatables abatement plan (Floatables Plan) for the CSO areas of New York City in June 1997 (HydroQual, 1997). The Floatables Plan was updated in 2005 (HydroQual, 2005c, 2005d) to reflect the completion of some proposed action elements and the addition of a monitoring program, as well as changes appurtenant to SPDES permits and modifications of regional WB/WS Facility Plans and CSO Facility Plans. The DEC approved the updated Floatables Plan on March 17, 2006.

The objectives of the Floatables Plan are to provide substantial control of floatables discharges from CSOs throughout the City and to provide for compliance with appropriate DEC and IEC requirements pertaining to floatables.

5.4.1 Program Description

The Citywide CSO Floatables Plan consists of the following action elements:

- Monitor Citywide street litter levels and inform the New York City Department of Sanitation (DSNY) and/or the New York City Mayor's Office of Operations when changes in litter levels at or in City policies would potentially result in increased discharges of CSO floatables;
- Continue the three-year cycle to inspect catch basins Citywide for missing hoods and to replace missing hoods to prevent floatables from entering the sewer system. In addition, proceed with the retrofit, repair, or reconstruction of catch basins requiring extensive repairs or reconstruction to accommodate a hood;
- Maximize collection system storage and capacity;
- Maximize wet weather flow capture at WWTPs;
- Capture floatables at wet-weather CSO storage/treatment facilities;
- Capture floatables at end-of-pipe and in-water facilities, including the Interim Floatables Containment Program (IFCP);
- Continue the Illegal Dumping Notification Program (IDNP) in which DEP field personnel report any observed evidence of illegal shoreline dumping to the Sanitation Police section of DSNY, who have the authority to arrest dumpers who, if convicted, are responsible for proper disposal of the material;
- Engage in public outreach programs to increase public awareness of the consequences of littering and the importance of conserving water;
- As new floatables-control technologies emerge, continue to investigate their applicability, performance and cost-effectiveness in New York City;
- Provide support to DEC to review and revise water quality standards to provide for achievable goals; and
- Develop a floatables monitoring program to track floatables levels in the Harbor and inform decisions to address both short- and long-term floatables-control requirements.

Overall, implementation of the Floatables Plan is expected to control approximately 96 percent (HydroQual, 1997) of the floatable litter generated in New York City. The Floatables Plan is a living program that will undergo various changes over time in response to ongoing assessment of the program itself as well as changing facility plans associated with other ongoing programs. A key component of the Floatables Plan is self-assessment, including a new Floatables Monitoring Program to evaluate the effectiveness of Plan elements and to provide for actions to address both short- and long-term floatables-control requirements (see Section 8). Evidence of increasing floatables levels that impede uses could require the addition of new floatables controls, expansion of BMPs, and modifications of WB/WS Facility Plans and/or drainage-basin specific LTCPs, as appropriate.

5.4.2 Pilot Floatables Monitoring Program

In late 2006, work commenced to develop the Floatables Monitoring Program to track floatables levels in New York Harbor (HydroQual, 2007a). This pilot work which was performed to develop a monitoring procedure and an associated visual floatables rating system based on a five-point scale (very poor, poor, fair, good, very good), involved observations at a number of different sites. At each site, observations were made for up to three categories: on the shoreline, in the water near the shoreline; and in the water away from the shoreline.

5.4.3 Interim Floatable Controls in Flushing Bay

There are booms installed at outfalls BB-006, and BB-008. Photos of the installations are shown in Figure 5-1. The volume of floatables contained from those locations is provided in Table 5-6 above.

5.4.4 Shoreline Cleanup Pilot Program

As part of the Environmental Benefits Projects (EBP) program established under the Consent Judgment, DEP has implemented a beach clean-up program to clean up shorelines in areas where floatables are known to occur due to CSO overflows and stormwater discharges as well as careless behavior and illegal dumping. This project was undertaken in connection with the settlement of an enforcement action taken by New York State and the DEC for violations of New York State law and DEC regulations. DEP has conducted cleanups at several areas deemed to benefit from these efforts including:

- Coney Island Creek, Brooklyn
- Kaiser Park, Brooklyn
- Sheepshead Bay (Kingsborough Community College) Brooklyn
- Cryders Lane (Little Bay Park), Queens

Boom at BB-006

Boom at BB-008

NYC Environmental Protection

Booms at BB-006 and BB-008

- Flushing Bay, Queens
- Owls Head, Brooklyn

These cleanup efforts will include the following methods:

- WorkboatAssisted Cleanup – Mechanical Cleanup: Where debris is caught up in riprap on the shoreline, a high-pressure pump will be used to spray water onto the shoreline to dislodge and flush debris and floatables from the riprap back into the water. A containment boom placed in the water around the site will allow a skimmer vessel to collect the material for proper disposal.
- Workboat-Assisted Cleanup: At a few locations where the shoreline is not readily accessible from the land side, a small work boat with an operator and crewmembers collects debris by hand or with nets and other tools. The debris will be placed onto the work boat for transport to a skimmer boat for ultimate disposal.
- Manual Cleanup: At some locations, simply raking and hand cleaning will provide the most efficient clean up method. Debris will then be removed and placed into plastic garbage bags, containers, or dumpsters and then loaded onto a pickup truck for proper disposal.

On average, DEP will generally be performing three cleanups per site each year for a four-year period at each of the above locations. Pending the outcome of this program, as well as the findings of the floatables monitoring program, an evaluation will be made of how DEP will proceed in the future.

Flushing Bay was visited on July 19, 2006 and July 24, 2006. A bicycling and walking path stretches for several miles along the Promenade. The shoreline adjacent to the walking path consists of tightly placed stones and boulders forming a well developed riprap. Access to the shoreline is blocked by a decorative fence to prevent pedestrians from walking on the slippery rocks or accessing debris. Easily retrievable debris was found along a two to three foot swath at the high water line. Debris that would not be as easy to recover mechanically was located in the spaces between the rocks comprising the riprap. One possible technique to remove this debris is to use pressurized water to dislodge the debris and flush it into the water within the confines of the redeployed containment boom. At low tide, a work boat with an operator and two crew members collect debris and transport it to the skimmer vessel, which will dispose of all collected debris at the most appropriate site. This technique can remove a large amount of debris and is not labor intensive. Photos of the debris and shoreline, are shown in Figure 5-2.

5.5 LONG-TERM CSO CONTROL PLANNING

In June 2004 DEP authorized the LTCP Project. This work integrates all Track I and Track II CSO Facility Planning Projects and the Comprehensive Citywide Floatables Abatement Plan, incorporates on-going USA Project work in the remaining waterbodies, and develops WB/WS Facility Plan reports and the LTCP for each waterbody area. The LTCP Project monitors and assures compliance with applicable Administrative Consent Orders. This document is a work product of the LTCP Project.

5.6 EVALUATION OF CSO TECHNOLOGIES

DEP also has a demonstrated commitment to evaluating state-of-the-art alternatives that have the potential to provide cost effective solutions with maximum water quality benefits. The Corona Avenue Vortex Facility has been constructed in the Corona section of Queens to evaluate the effectiveness of three different vortex technologies for settleable solids and floatables removal. DEP has installed inflatable dams in the Soundview section of the Bronx for the purpose of demonstrating this technology for real time control and in-line storage. The DEP is also investigating in-stream supplemental aeration as a method of improving DO conditions. At the time of the writing of this report, in-stream air bubbling systems were being designed for construction in Shellbank Basin (for inducing destratification) and in-stream aeration system have been constructed for testing in Newtown Creek (for DO enhancement). The DEP has been in the forefront of abating floatables discharges by conducting several floatables investigations, pilot testing floatables controls, and implementing control programs in catch basins, sewer systems, at the ends of pipes, and in receiving waters. The DEP is also piloting "green projects" BMPs to reduce stormwater run-off and contaminant loadings from land surfaces.

5.7 CORONA AVENUE VORTEX FACILITY

The DEP developed the Flushing Bay CSO Facility Plan in November 1989 (URS, 1989). This plan proposed CSO abatement for the 10 outfalls discharging to Flushing Bay. The largest outfall, in Flushing Bay is located on the southwest shoreline of the bay at the World's Fair Marina, and accounts for approximately 72 percent of the total CSO discharge to Flushing Bay. This discharge was seen to be the source of floatables and settleable organic matter that accumulated in sediment mounds by the outfall, which were noted to be the source of objectionable odors. The facility planning study recommended that an end-of-pipe treatment facility to remove floatables and settleable materials be constructed on the sewer tributary to this outfall. This recommended treatment process consisted of screening and the use of vortex technology for removal of settleable solids.

The concentrated underflow from the facility would be directed to the 108th Street Pump Station, which pumps to the Bowery Bay High Level Interceptor for treatment at the Bowery Bay WWTP. The location of the CAVF and the tributary area for outfall BB-006 are shown in Figure 5-3. The configuration of the facility with respect to the Bowery Bay collection system, including depiction of the upstream regulators replaced and the connection to the 108th Street Pump Station, is shown schematically in Figure 3-9.

The CAVF was envisioned as a prototype facility to test and demonstrate the effectiveness of the vortex removal technology, with the intention that if proved successful it might be applied to other New York City CSO discharges. To fully test the technology, three different variants of the vortex technology were constructed in parallel to afford comparative assessment. A plan view of the facility is shown in Figure 5-4. The three vortex concentrators, each 43 feet in diameter with a design peak hydraulic capacity of 130 MGD, are:

- the USEPA Swirl Concentrator,
- the British Storm King hydrodynamic separator, and
- the German FluidSep vortex separator.

Close-up Photo of Debris

Shoreline

Environmental Protection

Shoreline Cleanup Pilot Program Photos

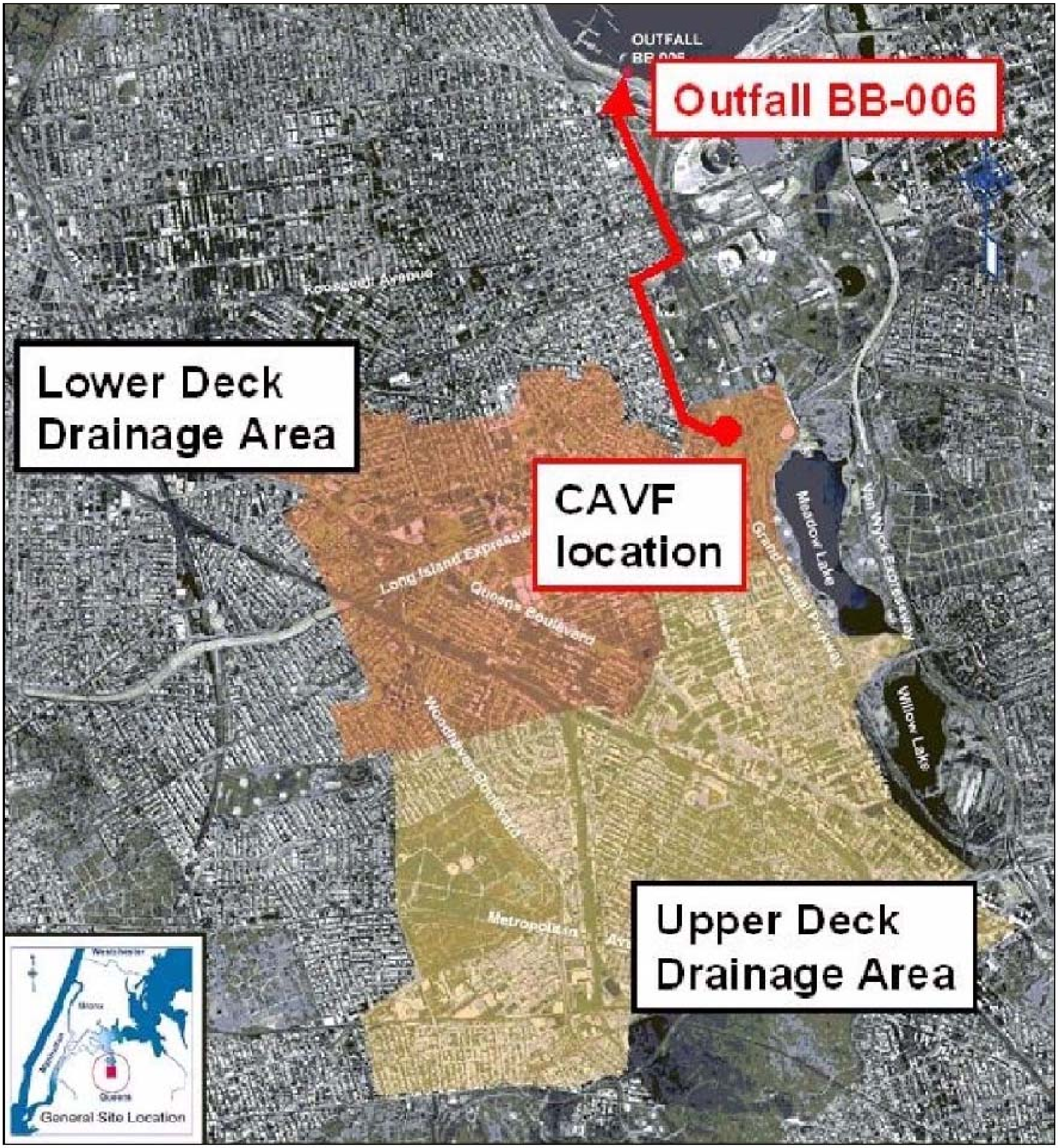
FIGURE 5-2

Testing of the facility (was conducted from December 6, 1999, to October 3, 2002 (HydroQual, 2003). During the field program, a total of 24 wet-weather events were successfully sampled for floatables and 22 events for water sampling. The results of the CAVF testing program indicated limited removal of CSO pollutants from the flow entering the facility. Overall performance of the USEPA, German and British vortex units were similar for removals of floatables, TSS, BOD_5, oil and grease, and settleable solids. Floatables removal ranged between 40 percent and 70 percent at hydraulic loadings ranging from 4 to 21 gallons per minute per square foot (gpm/ft^2). Average floatables removal was about 60 percent. The average overall removal of TSS and BOD_5 was about 50 percent to 55 percent. However, actual removal by the vortex unit was 0 percent to 20 percent, with the remaining removal associated with the diversion of flow. Similar observations were made for oil and grease and settleable solids removal. The average overall oil and grease removal was 65 percent with floatation removal of 30 percent. The average overall settleable solids removal was 60 percent of which 50 percent was associated with the diversion.

The findings noted above indicate that the majority of the pollutant removal is associated with the diversion of flow out of the overflow rather than with treatment by the vortex unit. Diversion can be accomplished in a number of much simpler and cheaper ways such as regulators and weirs.

Another limitation of this facility discovered during the evaluation was associated with the retention of the diverted underflow from the facility in the downstream collection system. Field observations indicated that a significant portion of the CAVF underflow was subsequently lost from the system in overflows from downstream regulators on the Bowery Bay High Level Interceptor, discharging at BB-006 and BB-008 (HydroQual, 2005). DEP evaluated a number of modifications that might be made to the collection system to improve the CAVF underflow retention (including raising weirs, new force mains and parallel interceptors, and prioritized pumping operations); however, none showed significant improvements relative to CSO load reduction commensurate with the cost.

It had been proposed that should the CAVF project prove to be successful, that similar vortex units would be built at many of the other outfalls that discharge to Flushing Bay. However, based on the results documented in the evaluation study these plans have been dropped and the vortex technology would not be used further within New York City.

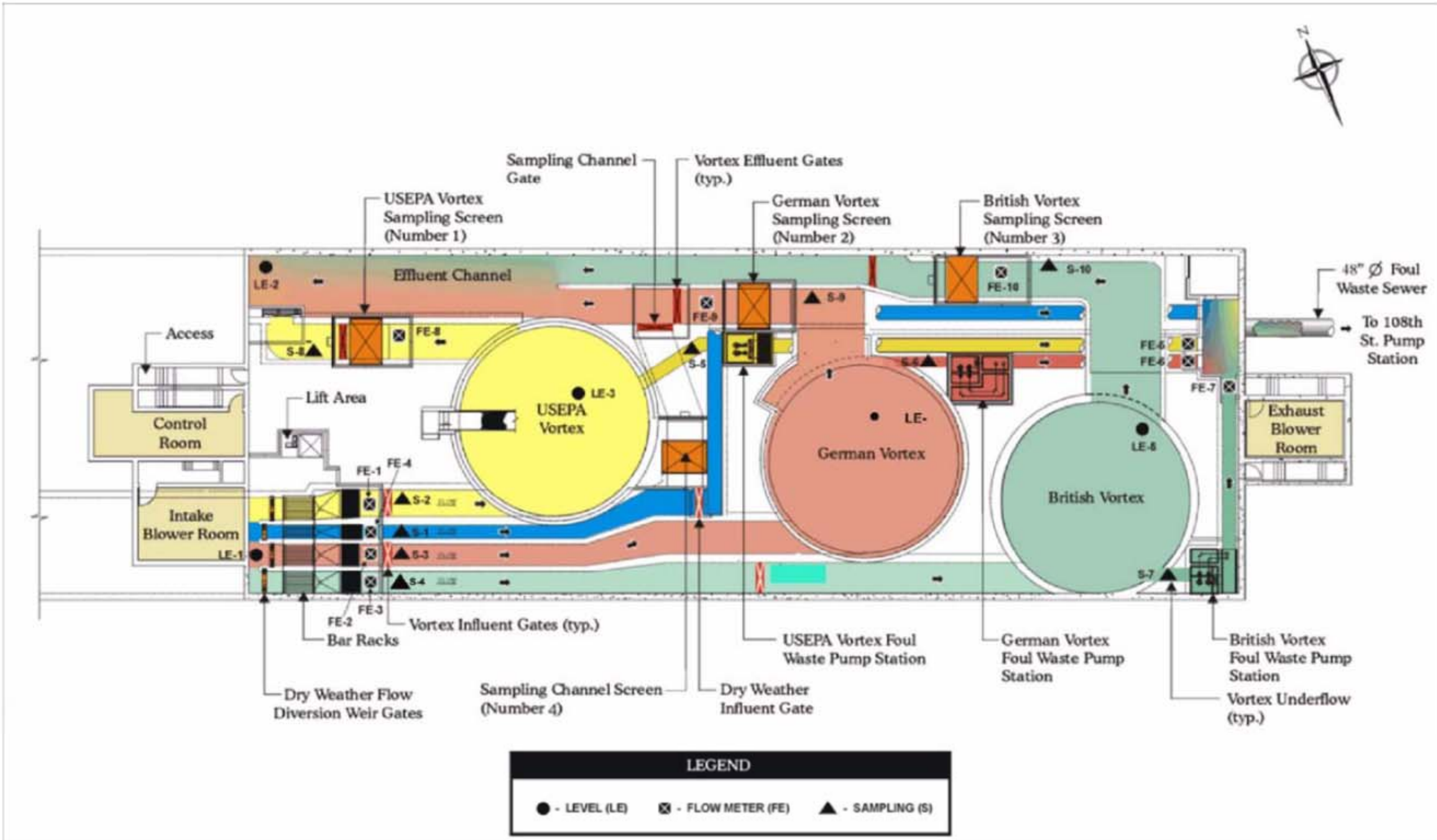


Environmental Protection

CAVF Drainage Area

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE 5-3



Flushing Bay Waterbody/Watershed Facility Plan

CAVF Plan View

FIGURE 5-4

5.8 COLLEGE POINT SEWER SEPARATION PROJECT

The DEP has adopted capital projects to separate the currently combined sewered areas in the College Point Interceptor area. There are four capital projects to accomplish this, however, final schedules for construction have not yet been established. These projects generally involve the construction of a new storm sewer drainage system serving the area, bulkheading the existing CSO diversion structure, and leaving the existing sewerage to carry sanitary wastewater. This sanitary sewage is introduced into the College Point Interceptor for conveyance to and treatment at the Tallman Island WWTP. The discharge outfalls affected are located in the northeast shoreline of the outer Flushing Bay and one directly discharging into the East River, a short distance west of the Tallman Island WWTP. Separation of outfalls TI-012 and TI-013 has been completed. Information on remaining projects is summarized in Table 5-7, below.

Table 5-7. College Point Interceptor Area Separation Projects

Outfalls	Regulators	Project Numbers	Estimated Cost	
TI-020	1	SEQ 200463; WM-1	$4,962,000	
TI-019	2	SEQ 200464; WM-1	$3,485,000	
TI-018, 017, 015, 014	3,4,6 & 7	SEQ 200467; WM-1	$7,417,000	
TI-016	5	SE-807; WM-1	$10,433,000	
Source: DEP, January 9, 2009.				

5.9 US ARMY CORPS OF ENGINEERS ECOSYSTEM RESTORATION PROJECT

Concurrent to the DEP's waterbody/watershed assessment of Flushing Bay, the USACE is conducting its Flushing Bay Ecosystem Restoration Feasibility Study. The DEP and the Port Authority of New York and New Jersey are the study's non-federal sponsors, funding fifty percent of the study. The feasibility study assesses environmental problems and potential solutions in Flushing Bay and Creek related to ecosystem restoration. A reconnaissance report was completed in April 1996 (USACE, 1996), which demonstrated a federal interest of a feasibility study. The draft feasibility report and public review period was completed in 2008. It identified six measures which might be taken in the interest of ecosystem restoration:

- tidal wetlands restoration,
- freshwater wetlands restoration,
- dredging of parts of the bay
- removal of part or all of the earthen dike,
- reorientation of the federal navigation channel, and
- shoreline bank stabilization, site cleanup and debris removal.

In 2003 the USACE issued a "P-7 Milestone Report" entitled <u>Preliminary Formulation of Alternatives</u> (USACE, 2003), in which the determination was made if the earlier identified measures would be retained for further development. The screening of the alternative projects is summarized below.

1. <u>Tidal wetlands restoration</u> - Based on review of aerial photography taken in 1994, it was assessed that there remains approximately 21 acres of tidal wetlands in the

Flushing Bay and Creek watershed, a reduction of 87 percent from the 157 acres assessed to have been present in the early 1900s. The current wetlands are located along Flushing Creek, the Inner Bay shoreline, and the southeast corner of the College Point shoreline. Tidal wetlands projects in the Flushing Bay and Creek watershed that were recommended for full feasibility evaluation were:

- Inner Flushing Bay: creation and/or rehabilitation of approximately 6 acres of low marsh and another 6 acres of new tidal shore mud flat;
- College Point northern shoreline: creation of up to 6 acres of tidal marsh and about 8 acres of transitional and upland woody habitat;
- Lower Flushing Creek: restoration of about 6.5 acres of low tidal marsh and forest along 2,000 linear feet of Creek between the mouth of the Creek at the Van Wyck Expressway crossing to the tide gates at Porpoise Bridge.

Tidal wetland restoration projects that were considered and rejected were:

- College Point western shore: rejected because the project would require construction of a new breakwater for wave protection, which USACE believes would be unacceptable to the public, and because ongoing residential development is precluding the option;

- Upper Flushing Creek: rejected because it would conflict with current heavy recreational use of the area.

2. Freshwater wetlands restoration - Freshwater wetlands were identified on the fringes of Willow and Meadow Lakes. Restoration projects were considered for these areas, but were rejected because they would conflict with current heavy recreational use of the area. Freshwater wetlands restoration in the vicinity of the former Flushing Airport (site now the responsibility of the NYC Economic Development Corporation [EDC]) remains an option, but was deferred to a new study to be initiated by a request from the EDC. Reconstruction and day lighting of Flushing Creek (i.e., the 2,400 linear feet of underground section in culvert) was rejected for the same reasons.

3. Dredging of parts of the Bay and Creek - The study reviewed dredging options including re-contouring of the Bay bottom to improve circulation patterns and water quality, removal of fine grained organics rich sediments and capping with clean material to improve benthic habitat, and lowering the elevation of existing mudflats to reduce odorous hydrogen sulfide flux. Primary considerations raised in the report were related to the likely duration of the beneficial impacts of such dredging if the existing organic loadings, specifically those from the CSOs, were to continue. It was recommended that review of the benefits of restoration dredging, and configuration of areas which might be dredged, be continued in concert with review of options for abating future organic loadings.

4. Removal of part or all of the earthen dike - On the basis of hydrodynamic modeling conducted for the project, it was concluded that removal of the breakwater dike would not improve DO levels in the Bay or the Creek nor would it decrease the deposition of

fine grained organic-rich sediments in the Inner Bay. The report recognized sentiment by the local public in favor of removal of the dike in order to abate odor problems. The report stated, "After many model refinements, reviews, and reassessments the conclusion is that breakwater removal will not provide ecological benefits." However, it was noted that although the breakwater removal would not be included, consideration would be given to improvement of the substrate characteristics and to modification of the breakwater elevation to increase habitat value of the structure.

5. Reorientation of the federal navigation channel - The hydrodynamic model was used to assess whether deepening or widening the navigation channel would improve water quality conditions. The channel is normally maintained to a depth of 14 feet and a width of 150 feet. It was found that increasing the cross-section of the dredged navigation channel would increase transfer of East River water into the Inner Bay; however, this would be counterproductive as DO conditions in the Inner Bay are better than those in the East River. So channel modification for this purpose was rejected. (Under a separate program, USACE does maintenance dredging of the channel. The last dredging operations for this purpose were in the Creek in 2003. Additional dredging of accumulated mounds in the Bay or the Creek is dependent on budgetary funding. [USACE, 2005])

6. Shoreline bank stabilization, site cleanup and debris removal - The study considered cleanup and debris removal in association with wet restoration sites along the west side of the College Point shoreline. However, as indicated above, the tidal wetland restoration project in this area was rejected, and this associated work was also rejected since a substantial and continuing enforcement effort would have to be implemented in order to prevent illegal debris placement and to maintain site cleanliness.

5.10 NYC GREEN INFRASTRUCTURE PLAN

On September 28, 2010, Mayor Bloomberg and DEP Commissioner Cas Holloway unveiled the NYC Green Infrastructure Plan which presents a "green strategy" for CSO drainage areas that includes cost-effective grey infrastructure strategies, reduced flows to the WWTP, and 10 percent capture of impervious surfaces with green infrastructure. The green infrastructure component of the plan builds upon and reinforces strong support for green approaches to address water quality concerns. A key goal of the NYC Green Infrastructure Plan is to manage the first inch of runoff from 10 percent of the impervious surfaces in combined sewer watersheds through detention and infiltration source controls over the next 20 years.

The *NYC Green Infrastructure Plan* builds upon and extends the commitments made previously in Mayor Bloomberg's PlaNYC to create a livable and sustainable New York City and, specific to water quality, open up 90 percent of the City's waterways for recreation. PlaNYC included initiatives to promote green infrastructure implementation, including the formation of an Interagency BMP Task Force, development of pilot projects for promising strategies, and providing incentives for green roofs toward these goals.

The Sustainable Stormwater Management Plan (SSMP) released in December 2008 was developed as a result of the Interagency BMP Task Force's efforts to identify promising BMPs for New York City. The SSMP provided a framework for testing, assessing, and implementing pilot installations to control stormwater at its source as well as strategies to promote innovative and cost-effective source controls and secure funding for future implementation. A key conclusion of the SSMP was that green infrastructure is feasible in some areas and could be more cost-effective than certain large infrastructure projects such as CSO storage tunnels.

Based on the evaluations completed for the development of the *NYC Green Infrastructure Plan*, preventing one inch of precipitation from becoming runoff that surges into the sewers over 10 percent of each combined sewer watershed's impervious area will reduce CSOs by approximately 1.5 billion gallons per year. Green infrastructure technologies currently in use and being piloted throughout the City include green roofs, blue roofs, enhanced tree pits, bioinfiltration, vegetated swales, pocket wetlands, and porous and permeable pavements. The monitoring data collected from the pilots will improve our understanding of performance, costs and maintenance requirements under New York City's environmental conditions, and our modeling methods and assumptions will continue to be refined based on this information. Table 5-8 summarizes the opportunities available to achieve the 10 percent goal Citywide.

Table 5-8. Citywide Green Infrastructure Opportunities, Strategies, and Technologies

Land Use	% of Citywide Combined Sewer Watershed Areas	Potential Strategies and Technologies
New development and redevelopment	5.0%	- Stormwater performance standard for new and expanded development - Rooftop detention; green roofs; subsurface detention and infiltration
Streets and sidewalks	26.6%	- Integrate stormwater management into capital program in partnership with DOT, DDC, and DPR - Enlist Business Improvement Districts and other community partners - Create performance standard for sidewalk reconstruction - Swales; street trees; Greenstreets; permeable pavement
Multi-family residential complexes	3.4%	- Integrate stormwater management into capital program in partnership with NYCHA and HPD - Rooftop detention; green roofs; subsurface detention and infiltration; rain barrels or cisterns; rain gardens; swales; street trees; Greenstreets; permeable pavement
Parking lots	0.5%	- Sewer charge for stormwater - DCP zoning amendments - Continue demonstration projects in partnership with MTA and DOT - Swales; permeable pavement; engineered wetlands
Parks	11.6%	- Partner with DPR to integrate green infrastructure into capital program - Continue demonstration projects in partnership with DPR - Swales; permeable pavement; engineered wetlands
Schools	1.9%	- Integrate stormwater management into capital program in partnership with DOE - Rooftop detention; green roofs; subsurface detention and infiltration
Vacant lots	1.9%	- Grant programs - Potential sewer charge for stormwater

Table 5-8. Citywide Green Infrastructure Opportunities, Strategies, and Technologies

Land Use	% of Citywide Combined Sewer Watershed Areas	Potential Strategies and Technologies
		- Rain gardens; green gardens
Other public properties	1.1%	- Integrate stormwater management into capital programs - Rooftop detention; green roofs; subsurface detention and infiltration; rain barrels; permeable pavement
Other existing development	48.0%	- Green roof tax credit - Sewer charges for stormwater - Continue demonstration projects and data collection - Rooftop detention; green roofs; subsurface detention and infiltration; rain barrels or cisterns; rain gardens; swales; street trees; Greenstreets; permeable pavement

To begin implementation, the City has already created a Green Infrastructure Task Force to design and build stormwater controls into planned roadway reconstructions and other publicly funded projects. In addition, the City recognizes that partnerships with numerous community and civic groups and other stakeholders will be necessary to build and maintain green infrastructure throughout the City. DEP will provide resources and technical support so that communities can propose, build, and maintain green infrastructure projects.

Over the next year, the City will take on a number of other concrete steps to begin early implementation of the *NYC Green Infrastructure Plan* such as demonstrating green infrastructure installations on a variety of land uses (see Table 5-9); launching a comprehensive program to increase optimization of the existing system; piloting sewer charges for stormwater for stand-alone parking lots; refining DEP models by including new impervious cover data and extending predictions to ambient water quality; identifying alternative funding for additional elements of the plan; and replacing all CSO outfall signs to reduce potential exposure.

Table 5-9. DEP Retrofit Demonstration Projects

Green Infrastructure Pilot	Location	Type	Status	Construction Completion
Rain Barrel give-away program	Jamaica Bay	1,000 rain barrels	Completed	2008-2009
5 tree pits/5 swales*	Jamaica Bay	Tree pits and streetside swales in the right-of-way	Completed	Fall 2010
MTA constructed wetland/parking lot*	Jamaica Bay	Biofiltration	In Construction	Spring 2011
Blue roof/green roof comparison*	Jamaica Bay	Blue/green roofs	Completed	August 2010
DEP rooftop detention	Newtown Creek	Various Blue roof technologies	Design	Fall 2010
High Density residential retrofit	Bronx River	Variety of on-site BMPs at a New York City Housing Authority development	In Construction	Spring 2011
DOT parking lots*	Jamaica Bay	Detention/bioinfiltration/porous pavement	Design	Spring 2011

North/South Conduit	Jamaica Bay	Detention/bioinfiltration in roadway median	In construction	Spring 2011
Shoelace Park	Bronx River	Detention/bioinfiltration	Redesign underway	Spring 2011

* This project was undertaken in connection with the settlement of an enforcement action taken by New York State and DEC for violations of New York State Law and DEC Regulations.

5.11 DEP ENVIRONMENTAL BENEFIT PROJECTS

In connection with the settlement of an enforcement action taken by New York State and DEC for violations of New York State law and DEC regulations, DEP submitted a Nitrogen Consent Judgment Environmental Benefit Project (EBP) Plan to DEC in January 2007 that proposed a stormwater pilot study in the Jamaica Bay drainage area. This project will use Nitrogen Consent Judgment EBP funds to conduct a three year pilot study program to implement and monitor several stormwater treatment technologies and volume reduction stormwater BMPs for potential application within the Jamaica Bay watershed. The goals of Jamaica Bay Watershed Stormwater Pilot Project include documenting the quality of New York City stormwater and refining the specific capture rates and treatment efficiencies that may be expected locally. Once this information has been gathered, effective stormwater strategies would be developed for potential future applications.

The project is expected to cost approximately $1.75 million and will include infiltration swales for street-side and parking lot applications, parking lot curb water capture systems, enhanced tree pits, and a commercial green roof and a blue roof comparison installation (see Table 5-9. The EBP is being conducted through an innovative collaborative effort between DEP and the Gaia Institute. DEP entered into a contract with the Gaia Institute to complete the pilot study. The Gaia Institute is a 501(c)3 not-for-profit corporation, located on City Island in the Bronx, that explores how human activities can be attenuated to increase ecological productivity, biodiversity, environmental quality, and economic well being.

In connection with the settlement of an enforcement action taken by New York State and DEC for violations of New York State law and DEC regulations, DEP also submitted a CSO EBP Work Plan in March 2008 (approved by the DEC in April 2008) that is expected to partially mitigate the impacts of stormwater and CSO discharges in the New York Harbor Estuary through stormwater BMP implementation. Practices such as bio-infiltration swales, enlarged street tree pits with underground water storage, constructed wetlands, and others would be evaluated. The CSO EBP Work Plan proposes pilots in the Bronx River, Flushing Bay and Creek, and Gowanus Canal watersheds using the $4 million which has been placed in an EBP Fund.

6.0 PUBLIC PARTICIPATION AND AGENCY INTERACTION

One of the nine elements of a long-term control plan is a public participation and agency interaction process that actively involves the affected public and regulators in decision-making to select long-term CSO controls. USEPA guidance states that establishing early communications with both the public and regulatory agencies is an important first step in the long-term planning approach and crucial to the success of a CSO control program (USEPA, 1995a). The DEP is committed to involving the public and regulators early in the planning process by describing the scope and goals of its facility planning projects and continuing public involvement during its development, evaluation, and selection of plan elements.

The CSO Control Policy emphasizes that state water quality standards authorities, permitting authorities, USEPA regional offices and permittees should meet early and frequently throughout the long-term planning process. It also describes several issues involving regulatory agencies that could affect the development of the long-term control plan, including the review and appropriate revision of water quality standards and agreement on the data, analyses, monitoring, and modeling necessary to support the development of the long-term control plan toward that end. A Harbor-Wide Government Steering Committee was convened by the DEP consisting of city, state, interstate, and federal stakeholders representing regulatory, planning, and public concerns in the New York Harbor watershed.

The DEP has also formed local and city-wide citizen advisory committees, has involved other municipal officials, local community government representatives, permitting agencies, and the general public in its planning process. Public meetings were conducted to present technical information and obtain input from interested individuals and organizations. Potential CSO alternatives, costs (to the DEP and to the public via water usage rates) and benefits were discussed before completing engineering evaluations. Comments were sought regarding the selection of a recommended plan. This process has been executed by the DEP during the Flushing Bay and Creek Facility Planning Project. The DEP regularly met with its Advisory Committee on Water Quality to discuss the goals, progress and findings of its ongoing planning projects such as the waterbody/watershed assessment of Flushing Bay and Creek. A local stakeholder team was specifically convened by the DEP to participate in the waterbody/watershed assessment of Flushing Bay and Creek.

The following section describes the formation and activities of the DEP's Harbor-Wide Government Steering Committee, its Citizen's Advisory Committee on Water Quality, and the Flushing Bay and Creek Waterbody/Watershed Stakeholder Team that represented the DEP's public participation and agency interaction components of its waterbody/watershed assessment of Flushing Bay.

6.1 HARBOR-WIDE STEERING COMMITTEE

The DEP convened a Harbor-Wide Government Steering Committee to ensure overall program coordination and integration of management planning and implementation activities by holding quarterly meetings, exploring regulatory issues, prioritizing planning and goals, developing strategies, reviewing and approving assessment-related work plans and coordinating actions. A Steering Committee was comprised of city, state, interstate and federal stakeholders representing regulatory, planning and public concerns in the New York Harbor Watershed. The Citizens Advisory Committee on Water Quality (CAC), which reviews and comments on DEP water quality improvement programs is represented on the Steering Committee and separately monitors and comments on the progress of CSO projects, among other DEP activities.

Federal government members of the Harbor-Wide Government Steering Committee included representatives of the USEPA, USACE and the National Park Service. USEPA Region 2 was represented by its Deputy Director and its Water Quality Standards Coordinator. The USACE was represented by its Chief of the Technical Support Section, Planning Division, New York District. The National Park Service member was a representative of its Division of Natural Resources at the Gateway National Recreational Area.

The State of New York was represented by the central and regional offices of the DEC. The Central Office of the DEC in Albany was represented by its Associate Director of the Division of Water, the Director of the Bureau of Water Assessment and Management Branch of the Division of Water and the Director of the Bureau of Water Compliance in the Division of Water. The Region II office of the DEC was represented by the Regional Engineer for the Region II Water Division.

Several departments of the City of New York were represented on the Harbor-Wide Government Steering Committee. The Deputy Commissioner of the Bureau of Engineering Design and Construction and its Director of Planning and Capital Budget represented the DEP. The Department of City Planning was directed by its Director of Waterfront/Open Space. The New York City Department of Parks and Recreation was represented by the Chief of its Natural Resources Group.

Public interests were represented on the Steering Committee by the General Counsel of Environmental Defense at the New York headquarters and the Real Estate Board of New York. These two members also co-chaired the Citizens Advisory Committee on Water Quality. In 2006 these positions have been changed after a few years' hiatus of the CAC.

Interstate interests were represented by the Executive Director and Chief Engineer of IEC. The IEC is a joint agency of the states of New York, New Jersey and Connecticut. The IEC was established in 1936 under a Compact between New York and New Jersey and approved by Congress. The State of Connecticut joined the IEC in 1941. The mandates of the IEC are governed by the Tri State Compact, Statutes, and the IEC's Water Quality Regulations. Its responsibilities and programs include activities in areas such as air pollution, resource recovery facilities and toxics; however, the IEC's continuing emphasis is on water quality, an area in which the IEC is a regulatory and enforcement agency. The IEC's area of jurisdiction runs west from Port Jefferson and New Haven on Long Island Sound, from Bear Mountain on the Hudson River down to Sandy Hook, New Jersey (including Upper and Lower New York Bays, Newark Bay, Arthur Kill and Kill Van Kull), the Atlantic Ocean out to Fire island Inlet on the southern shore of Long Island, and the waters abutting all five boroughs of New York City.

The Steering Committee was responsible for reviewing the methodology and findings of DEP water quality-related projects, and to offer recommendations for improvement. The

Steering Committee reviewed and approved the waterbody work plan developed by the USA Project (HydroQual, 2001), and was fully briefed on the on-going assessments and analyses for each waterbody. Among the recommendations provided by the Steering Committee was the investigation of cost-effective engineering alternatives that improve water quality conditions to remove harbor waters from the State of New York 303(d) List, to pursue ecosystem water quality restoration actions with USACE, and to coordinate use attainment evaluations with the DEC. Representatives of the DEC reported that its agency was awaiting the results of the DEP waterbody/watershed assessment before completing the 303(d) evaluations.

6.2 WATER QUALITY FACILITY PLAN (Existing Facility Plan)

Public participation in the Water Quality Facility Plan extends back to the 1980's (URS, 1989). Table 6-1 lists the dates of the meetings that were held prior to the draft facility plan of January 21, 1987. The concept of a Flushing Creek CSO Retention Facility was first presented in this draft facility plan. In addition, several meetings regarding alternate locations for CSO control facilities were held, as shown in Table 6-2.

Table 6-1. Public Participation Activities Prior to Draft Facility Plan

Mechanisms	Dates
Public Meetings (Responsiveness Summaries and Public Notices)	11/14/85 1/21/87
Citizens Advisory Committee (CAC) Meetings	11/6/85 2/26/86 4/30/86 9/10/86 11/19/86
Press Releases	Several over Project Period
Project Depository Materials Delivered	10/21/85 7/14/86
CAC Mailings	2/26/86 4/16/86 9/18/86
Major Mailing List Distributions	10/21/85 2/2/87
Tallmans Island CAC Tour	4/10/86
American Small Craft Associations (TASCA) Presentation	7/17/86
Community Board Briefing Papers Distributed	12/10/87
Flushing Bay Task Force Meeting Presentations	4/18/86 9/25/86
Parks Department Presentation	9/26/86
Progress Reports and Progress Meeting Minutes Mailed to: All Community Boards in Study Area Queens Borough President	22 monthly reports and minutes through January 1987

Table 6-2. Meetings Regarding Alternate Locations for CSO Control Facilities

Date	Meeting
February 9, 1987	Parks Department at Olmstead Center, Queens
May 6, 1987	Parks Department at Olmstead Center, Queens
June 3, 1987	Parks Department at Olmstead Center, Queens
June 30, 1987	Parks Department at Olmstead Center, Queens
July 27, 1987	Parks Department at Olmstead Center, Queens
October 1, 1987	Parks Commissioner Stern at Armory at Central Park
December 28, 1987	Claire Shulman, Queens Borough President at Queens Borough Hall
February 2, 1988	Parks Department at Olmstead Center, Queens
February 4, 1988	Flushing Bay Advisory Council at Queens Borough Hall
February 8, 1988	Queens Borough Board at Queens Borough Hall
February 22, 1988	Flushing Meadow Development Corp. at Queens Borough Hall
March 21, 1988	Parks Council at NYC Urban Center, 457 Madison Avenue, New York City
October 18, 1988	Flushing Bay Task Force at Queens Borough Hall
December 12, 1988	Queens Borough Board at Queens Borough Hall
January 9, 1989	Queens Borough Board at Queens Borough Hall
January 23, 1989	Flushing Meadow Corona Park Advisory Council
January 25, 1989	Dept. of Parks, Dept. of Environmental Protection, Queens Borough President Claire Shulman, Deputy Mayor Esnard at City Hall
January 31, 1989	Claire Shulman, Queens Borough President at Queens Borough Hall
May 25, 1989	Political representatives, various parks groups and others at Queens Borough Hall, gathered by Claire Shulman, Queens Borough President

6.3 WATER QUALITY CITIZENS ADVISORY COMMITTEE

In April 1989, the Citizens Advisory Committee issued a statement announcing its unanimous support for the building of a 40 MG underground storage tank (URS, 1989). It should be noted that the location of the proposed storage tank was later changed from the Avery Ball Fields within Flushing Meadow Park to the Parks Maintenance Area at Fowler Ave and Avery Ave.

6.4 WATERBODY/WATERSHED STAKEHOLDER TEAM

A stakeholder team for Flushing Bay and Flushing Creek, consisting of community and environmental leaders from Queens Community Boards 3 and 7 (CB3 and CB7), was assembled in 2006. The stakeholder meetings were held on April 5, 2006, June 6, 2006, August 1, 2006, March 28, 2007, and June 6, 2007 at the Parks Department Olmsted Center. The full minutes for all the stakeholder meetings are in Appendix C.

6.4.1 Stakeholder Meeting No 1

The main topics presented at the first stakeholder meeting held on April 5, 2006, were as follows:

- The purpose of the LTCP project is to improve the quality of the city's open waters and tributaries by developing a long-term plan to invest in infrastructure that will reduce the number and volume of combined sewer overflow (CSO) events.

- The 2005 Consent Order with NY State Department of Conservation that defined the scope of the LTCP.
- The primary water quality issues in the study area include nuisance odor generation, floatables, coliform, and low dissolved oxygen.
- A brief overview of DEP's current water quality improvement projects include the Corona Ave Vortex Facility, Flushing Creek CSO Retention Facility, College Point sewer separation, the COE "Flushing Bay Restoration Project", and Floatables Containment, including catch basin hooding affecting all outfalls.
- An extensive water quality survey was performed in the summer of 2000 that gathered data on Flushing Bay and Creek's hydrodynamics, and water quality parameters such as dissolved oxygen levels, temperature, nitrogen, photosynthesis/respiration, and hydrogen sulfide.

The stakeholders' main concerns at this first meeting centered around the odor problems and the issue of dredging.

6.4.2 Stakeholder Meeting No 2

The main topics presented at the second stakeholder meeting held on June 6, 2006 were as follows:

- The fourteen Best Management Practices (BMPs) contained in New York State SPDES permits for New York City WWTPs.
- A more detailed presentation of the Corona Ave Vortex Facility, Flushing Creek CSO Retention Facility, and the Interim Floatables Containment Program.
- The landside models for the Bowery Bay and Tallman Island sewer systems.
- The ERTM and SWEM water quality models.
- Baseline DO and fecal coliform data.

The stakeholders' main concerns and comments at this second meeting were as follows:

- The first flush of stormwater from a separate stormwater system, if untreated, would have a significant, negative impact on water quality.
- One stakeholder suggested that open public records on CSO's would promote public involvement.
- One participant asked why previous plans for chlorination in the Flushing Creek CSO Retention Facility were not carried forward. The response was that the water quality risks of potentially over-chlorinating were too great, but that the facility retains space for future disinfection equipment.
- A stakeholder asked whether tidal water flows would help to move unwanted sediment away from the shoreline if they moved at higher velocity. He suggested that removing the submerged breakwater or contouring the bottom would aid in the removal of sediment. DEP representatives responded that a more effective approach to improving water quality is by controlling CSO events, and that it is unlikely that contouring would help the problem.

6.4.3 Stakeholder Meeting No 3

The main topics presented at the third stakeholder meeting held on August 1, 2006 were as follows:

- The main categories of CSO control alternatives: source control, inflow control, sewer system optimization, sewer separation, storage, treatment, receiving water improvement, and solids and floatables controls.
- A short list of leading alternatives being considered for Flushing Bay and Flushing Creek, including tunnel alternatives.
- A tabular summary of the CSO reductions from the leading alternatives.
- An example of the cost versus percent CSO reduction and cost versus DO quality plots that will be developed.

The stakeholders' main concerns and comments at this third meeting were as follows:

- Litter in storm sewers is a continuing problem.
- Stenciling of storm drains would deter residents from disposing of trash in storm drains.
- BMP implementation in other cities, such as Seattle could be used as guideline for implementation in New York City.
- Tunnels may result in groundwater contamination, as was the case in Milwaukee. The response was that lining the tunnels could prevent this problem.
- According to USGS projections, groundwater flows may double over the next ten years.
- Removing the breakwater from Flushing Bay may improve water quality. The response was that several studies have shown that removing the breakwater would not improve water quality.

6.4.4 Stakeholder Meeting No 4

The main topics presented at the fourth stakeholder meeting held on March 28, 2007 were as follows:

- The results of a hydrodynamic analysis demonstrate that the breakwater, or "finger dike" in Flushing Bay does not have a detrimental impact on the water quality in the Bay.
- DEP is conducting pilot projects, through the Jamaica Bay Watershed Protection Plan, which will allow them to analyze the impact of source control, or Low Impact Development (LID) in the specific context of New York City. When the pilot project data is collected and analyzed, a program will be put together for a more widely implemented source control program.
- A short list of leading alternatives being considered for Flushing Bay and Flushing Creek, including tunnel alternatives, was presented.

The stakeholders' main concerns and comments at this fourth meeting were as follows:

- Source control should be an integral part of the WB/WS plans.
- A stakeholder asked whether the team had considered separating the combined sewer system. The response was that separation had been considered, but it did not provide significant water quality benefits and therefore was discarded as an alternative.
- A stakeholder expressed concern that storage tunnels are very expensive and perform poorly, citing the example of the storage tunnel constructed in Milwaukee, where groundwater infiltrated into the tunnel, and thus diminished the capacity to store combined sewage. The response was that building a reliable tunnel is a challenge, but if designed and built properly, tunnels are an effective technology for abating CSOs.

6.4.5 Stakeholder Meeting No 5

The main topics presented at the fifth stakeholder meeting held on June 6, 2007 were as follows:

- A DEP representative gave a presentation on stormwater management pilot projects within the Jamaica Bay watershed. Successful stormwater projects would later be implemented throughout the City, including the Flushing Bay watershed.
- The most effective CSO abatement alternatives for Flushing Bay and Flushing Creek were formed into Water Quality Improvement Plans (WQIPs).
- The percent CSO reduction and DO quality of all the WQIPs were plotted with respect to project cost.
- The recommended WB/WS Plans for both Flushing Bay and Flushing Creek were presented, including the anticipated water quality benefits and costs.

The stakeholders' main concerns and comments at this fifth meeting were as follows:

- The recommended tunnel for Flushing Bay will not be effective due to groundwater infiltration. Green solutions such as LIDs and BMPs would be far more cost effective in reducing CSOs.
- The source of funding and schedule of implementation for the recommended WB/WS plan and the stormwater projects should be determined.
- The proposed area for the dredging of Flushing Bay should be expanded.

6.5 PUBLIC OPINION SURVEY SUMMARY

The DEP conducted a telephone survey in order to assess and measure the use of waterbodies in New York City, and obtain feedback from New York City residents about their attitudes towards the water resources in their community and elsewhere. Surveys addressed city-wide issues as well as those for local waterbodies. Primary and secondary waterbody survey results (dependent on residential location within watersheds) were analyzed discretely and summarized to provide additional insight into the public's waterbody uses and goals in addition to those identified via other public participation programs run by the DEP.

Survey interviews were conducted using Computer Assisted Telephone Interviews (CATI) among residents of the five New York City boroughs that were 18 years or older. Residents were asked about specific waterways depending on their zip code. A total of 7,424 interviews with New York City residents were conducted during these telephone surveys and a total of 8,031 primary waterway responses were recorded. Questionnaire development involved a pre-test prior to the full field application of the survey to ensure that the survey covered all relevant issues and it was presented in a way that would be clear to all respondents. The pre-test was conducted via a series of five focus groups representing residents of each of the five New York City boroughs. Final presentation of results involved editing, cleaning, and weighting collected data. The weights were applied to the data to correct for unequal probability of household selection due to households with more than one telephone number, and different numbers of individuals available to be interviewed at different households. Post-stratification weighting was also applied for each waterbody to balance the sample data to 2000 U.S. Census population data that takes into account household composition, age, gender, and race/ethnicity. The survey data was then projected to actual population counts from the 2000 U.S. Census so that areas could easily be combined to yield an appropriate weighted sample for all five boroughs of New York City.

The telephone survey included 7,424 interviews with New York City residents. A minimum of 300 interviews for each of the 26 watersheds was included within the scope of the USA project. The survey was analyzed to quantify the extent of existing uses of the waterbody and riparian areas, and to record interest in future uses. Elements of the survey focused on awareness of the waterbody, uses of the waterbody and riparian areas, recreational activities involving these areas and how enjoyable these activities were, reasons why residents do not partake in recreational activities in or around the waterbody, overall perceptions of New York City waterbodies; and what improvements have been recognized or are desired.

6.5.1 Waterbody Awareness

Approximately 71 percent of the Flushing Bay area residents that participated in the survey were aware of Flushing Bay but only 11 percent could identify Flushing Bay as their primary waterbody without prompting or aid in their response. On an unaided basis, area residents most often mentioned the East River as the waterway closest to their home.

6.5.2 Water and Riparian Uses

Approximately 15 percent of the Flushing Bay area residents that participated in the survey visit waterbodies in their communities or elsewhere in New York City on a regular basis and 43 percent occasionally visit waterbodies. The remaining percentage of area residents rarely visit waterbodies (27 percent) or not at all (16 percent). This is about the same as New York City residents in general. Fifty-eight percent of the Flushing Bay area residents regularly or occasionally visit city waterbodies while 60 percent of all New York City residents regularly or occasionally visit city waterbodies. Only 21 percent of area residents have visited Flushing Bay at some point and 12 percent have done so in the prior 12 months. Those who have visited the Bay within the prior 12 months responded that they visit the Bay a median of two times. This is lower than the city-wide median of four visits per year. Among those area residents who are aware of Flushing Bay but have never visited the Bay, 39 percent responded that there was no particular reason for not doing so, 29 percent cited waterbody conditions and 24 percent cited riparian conditions.

The number of area residents that have participated in water-related activities at Flushing Bay represents 16 percent of those who have ever visited the bay. This equates to three percent of the area residents surveyed (those that have visited and those that have not). The most common activity cited by those that have visited Flushing Bay was fishing (9 percent). This was followed by on-water activities (4 percent) such as boating, canoeing, kayaking and sailing. Among the respondents who have never participated in water-activities while visiting Flushing Bay, seven percent responded that garbage or the water being dirty was the reason for not participating. Seven percent also cited not being able to see through the water as the reason for not participating in water activities.

Riparian-based activities appear to be more popular in general than in-water activities. Fifty-one percent of area residents that have visited Flushing Bay (equivalent to eleven percent of all residents) surveyed responded that they have participated in land-based activities along the bay. In comparison to all New York City residents who have ever visited their primary waterway, riparian activities at Flushing Bay is a slightly less popular activity than at other primary waterways in New York City. The most popular land activity at Flushing Bay among area visitors is sports (23 percent), followed by eating or dining (20 percent).

6.5.3 Improvements Noted

Approximately forty percent of area residents indicated that they have noticed improvements in New York City waterways in general in the past five years and 4 percent have noticed improvements specifically at Flushing Bay. Improvements in the water (quality, appearance and color) of New York City waterways were most frequently noted by area residents (19 percent). If funds were available, area residents would most like to see improvements to the water (quality, appearance and odor) at Flushing Bay. Eighty-five percent of the area residents responding indicated that water quality was extremely important (42 percent) or somewhat important (43 percent).

Approximately forty-two percent of the area residents who identified any improvement reported that they would be willing to pay between $10 and $25 a year for that improvement while 17 percent indicated they would not be willing to pay anything for improvements. For those that specifically cited water quality improvements as the most important improvement, thirty-eight percent indicated they would be willing to pay between $10 and $25 a year for that improvement and twenty-one percent were not willing to pay anything.

When asked which waterway should be improved if funds were available to improve only one New York City waterway, 27 percent of area residents cited Flushing Bay as the waterway to be improved. In comparison, approximately 18 percent of New York City residents cited the waterbody in their own assessment area as the one that should be improved.

6.6 ADMINISTRATIVE CONSENT ORDER

The Administrative Consent Order was published for public comments on September 8, 2004, as part of the overall responsiveness effort on behalf of the DEC. The public comment period, originally limited to 30 days, was extended twice to November 15, 2004, to allow for additional commentary. Comments were received from public agencies, elected officials, private and non-profit organizations, and private individuals. In total, DEC received in excess of 600 official comments via letter, facsimile, or e-mail during the comment period. All comments received were carefully reviewed and evaluated, then categorized by thematic elements deemed similar in nature by DEC. Each set of similar comments received a specific focused response. Many of the comments received, although differing in detail, contained thematic elements similar in nature regarding DEC and DEP efforts toward CSO abatement, water quality issues, standards, and regulatory requirements.

None of the comments received changed the terms of the Order, but the volume of commentary was interpreted by DEC to indicate that "NYC citizenry places CSO abatement as a high ongoing priority" (DEC, 2005). The terms of the Order offer numerous opportunities for public participation and input for future CSO abatement measures and regulatory decisions, such as the requirement to comply with federal CSO policy with regard to public participation during the plan development.

6.7 SPDES PERMITTING AUTHORITY

Dedicated CSO facilities built as part of this Waterbody/Watershed Facility Plan or water quality standards revision would be subject to conditions added to the Tallman Island and Bowery Bay WWTP SPDES permits. Stakeholders would then have the opportunity to make comments during the public review period associated with the SPDES modifications.

6.8 FINALIZATION OF PUBLIC OPINION

Following DEC review of this Waterbody/Watershed Facility Plan DEC and DEP will hold a public meeting and accept comments for the 30-day period following the meeting. Further, DEP will be required by the 2005 CSO Consent Order to produce a Long Term Control Plan for Flushing Bay, no later than 6-months after DEC approves this WB/WS Facility Plan. A final public meeting will be held by DEP to solicit public comment on the draft Long Term Control Plan prior to its approval by DEC. The DEP or the DEC may choose to solicit additional public comment through public notice and/or public meeting processes subsequent to this process.

7.0 EVALUATION OF ALTERNATIVES

As described in Section 1, Flushing Bay currently appears on the DEC "Section 303(d) List of Impaired Waters" for low DO associated with CSO and other urban inputs. The CSO Consent Order requires DEP to complete an approvable WB/WS Facility Plan for Flushing Bay by June 2007, which was submitted in combination with the Flushing Creek WB/WS at that time. The present document incorporates comments received from DEC on the June 2007 document as well as the June 2009 Flushing Bay WB/WS Facility Plan. Although a WB/WS Facility Plan does not necessarily require consistency with federal CSO Policy for CSO Long Term Control Plans, it is DEP's intention that this WB/WS Facility Plan satisfy the requirements of a CSO LTCP.

As previously discussed in Section 5, the DEP has been engaged for many years in water-quality improvement projects and CSO facility planning for the Flushing Bay waterbody and watershed. As noted in Section 5 of this report, a number of CSO controls have been proposed, constructed and/or partially constructed prior to the requirement of New York City to conduct Long Term CSO Control Planning. This section of the report assesses additional CSO controls that could be implemented to further improve water quality in Flushing Bay.

This section presents the evaluation of alternatives for CSO control, analyses that were performed in accordance with federal CSO LTCP guidance. Section 7.1 summarizes the regulatory framework for the evaluation of alternatives. Section 7.2 identifies and provides an initial screening of a full spectrum of successfully applied CSO control technologies. The CSO control technologies that pass through the initial screening are then examined in detail in Section 7.3 to create various alternatives that can be evaluated for effectiveness in mitigating CSOs in Flushing Bay. Section 7.4 presents a performance versus cost analysis of the feasible alternatives retained in 7.3, as well as a 100% reduction alternative, based on projected CSO volumes and frequencies and attainment of existing water quality standards. Section 7.5 describes the basis of selection and the costs and benefits of the Waterbody/ Watershed Facility Plan.

7.1 REGULATORY FRAMEWORK FOR EVALUATION OF ALTERNATIVES

The evaluation of alternatives to address CSO discharges and associated water quality impacts involves regulatory considerations in addition to those presented in Section 1. The following subsections present a summary of these considerations.

7.1.1 Water-Quality Objectives

As previously described in Sections 1.2.1, Flushing Bay appears on the 2010 DEC "Section 303(d) List of Impaired Waters" due to DO/Oxygen Demand from "urban/storm/CSO" inputs.

DEC has designated Flushing Bay as a Class I waterbody.

The New York State numerical and DEC narrative surface water quality standards for Class I waters are listed below in Table 7-1.

Table 7-1. New York State Numerical and Narrative Surface Water Quality Standards for Flushing Bay

Class	Class I (Saline)
Usage	Secondary contact recreation, fishing. Suitable for fish propagation and survival.
DO (mg/L)	$\geq$ 4.0
Total Coliform (#/100mL)	10,000 (4)
Fecal Coliform (#/100mL)	$\leq$ 2,000 (4)
Taste-, color-, and odor producing toxic and other deleterious substances	None in amounts that will adversely affect the taste, color or odor thereof, or impair the waters for their best usages.
Turbidity	No increase that will cause a substantial visible contrast to natural conditions.
Oil and floating substances	None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.
Garbage, cinders, ashes, oils, sludge and other refuse	None in any amounts.
Phosphorus and nitrogen	None in any amounts that will result in growth of algae, weeds and slimes that will impair the waters for their best usages.

(1) Daily avg. min for non-trout waters
(2) Monthly median value of five or more samples
(3) Monthly 80th percentile of five or more samples
(4) Monthly geometric mean of five or more samples

7.1.2 Range of Alternatives

The federal CSO Policy calls for LTCPs to consider a number of factors when evaluating CSO control alternatives, as described in Sections II.C.4 and II.C.5 of the Policy (40 CFR 122 [FRL-4732-7]). USEPA expects the analysis of alternatives to be sufficient to make a reasonable assessment of the expected performance and the cost of the alternatives. With regard to performance, USEPA expects the LTCP to "consider a reasonable range of alternatives" in the selection process. The LTCP should consider four or more alternatives, providing a range of control above the existing condition and extending to full elimination of CSOs, as measured in terms of CSO frequency or CSO capture.

7.1.3 "Presumption" and "Demonstration" Approaches

Whether a particular alternative provides sufficient control can be determined in two different manners. In the "Presumption Approach," alternatives that meet any of a number of discharge-based criteria may be "presumed" to provide sufficient CSO control to meet the water-quality based requirements of the CWA. These discharge-based criteria, which are applicable to an entire combined-sewer system (i.e., a WWTP drainage area) and not necessarily to the drainage area of a particular waterbody include:

i. No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year. For the purpose of this criterion, an overflow event is one or more overflows from a Combined Sewer System (CSS) as the result of a precipitation event that does not receive a minimum treatment specified below;
ii. The elimination or the capture for treatment of no less than 85 percent by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis; or
iii. The elimination or removal of no less than the mass of the pollutant […] for the volumes that would be eliminated or captured for treatment under item ii above.

Combined sewer flows remaining after implementation of the Nine Minimum Controls and within the criteria specified at II.C.4.a.i or ii, should receive a minimum of:

- Primary clarification (Removal of floatables and settleable solids may be achieved by any combination of treatment technologies or methods that are shown to be equivalent to primary clarification);

- Solids and floatables disposal; and

- Disinfection of effluent, if necessary, to meet WQS, protect designated uses and protect human health, including removal of harmful disinfection chemical residuals, where necessary

In the "Demonstration Approach," alternatives providing sufficient CSO control are those that, through modeling and/or other analyses, are expected to provide sufficient CSO control as to meet the water-quality based requirements of the CWA. The criteria associated with the Demonstration Approach are:

i. The planned control program is adequate to meet WQS and protect designated uses, unless WQS or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs;
ii. The CSO discharges remaining after implementation of the planned control program will not preclude the attainment of WQS or the receiving water's designated uses or contribute to their impairment. Where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a waste load allocation and a load allocation, or other means should be used to apportion pollutant loads;
iii. The planned control program will provide the maximum pollution reduction benefits reasonably attainable; and
iv. The planned control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS or designated uses.

7.1.4 Cost/Performance Consideration

USEPA expects the permittee to use the costs associated with each of these alternatives to demonstrate the relationships among a comprehensive set of reasonable control alternatives that correspond to the different ranges specified in Section II.C.4 of the federal CSO policy. This should include an analysis to determine where the increment of pollution reduction achieved in the receiving water diminishes compared to the increased costs. This analysis, often known as "knee of the curve," should be among the considerations used to help guide selection of controls.

7.1.5 Consideration of Non-CSO Inputs

Load sources other than CSOs were included in the receiving water modeling to assess water-quality conditions. These other inputs consist primarily of stormwater and tidal exchange with East River. Other sources of pollutants of concern were found to be insignificant.

7.1.6 Consideration of Other Parameters

Other parameters such as existing waterbody uses and stakeholder goals for waterbody use were taken into account when determining the necessary level of CSO control. Other parameters considered as part of the evaluations of alternatives for Flushing Bay include the following:

- Waterbody Use: As discussed in Section 2.2.5, Flushing Bay is entirely within the coastal zone boundary, and has been designated a Special Natural Waterfront Area (SNWA) through the Waterfront Revitalization Program (WRP), which promotes public investment to protect and enhance the city's natural resources.

- Aquatic Life Uses: Aquatic life in Flushing Bay was characterized as described in detail in Section 4.

- Sensitive Areas: As discussed in Section 4, the DEC, as the permitting authority, has not designated Flushing Bay as a sensitive area. There are no areas within the Bay that satisfy the CSO Control Policy criteria for sensitive areas. Therefore, prioritization of goals, selection of control alternatives, and scheduled implementation of these alternatives can be given to those alternatives that most reasonably attain the maximum benefit to water quality throughout the Bay.

- Stakeholder Goals: As discussed in Section 6, stakeholder goals for the waterbody include improved aesthetic conditions through the removal of sediment mounds and the reduction of odors and floatables. There was consensus among stakeholders that the water should be as clean as possible to support aquatic life and recreational use. Finally, stakeholders supported the use of green infrastructure technologies to mitigate CSOs.

7.2 SCREENING OF CSO CONTROL TECHNOLOGIES

A wide range of CSO control technologies was considered for application to New York City's Combined Sewer System (CSS). An effort was made to include all technologies that have been successfully applied to CSO control, and no technologies were excluded prior to initial screening. The technologies are grouped into the following general categories:

- Watershed-Wide Non-Structural Controls
- Inflow Control
- Green Infrastructure
- Sewer System Optimization
- Sewer Separation
- Storage
- Treatment
- Receiving Water Improvement
- Solids and Floatables Control

Each technology is described below, and a summary assessment is provided in Table 7-2.

Table 7-2. Preliminary Screening of Technologies

CSO Control Technology	Performance				Implementation and Operational Factors
	CSO Volume Reduction	Bacteria Removal	Floatables Control	Suspended Solids Reduction	
Watershed-Wide Non-Structural Controls (Section 7.2.1)					
Public Education	None	Low	Medium	Low	Cannot reduce the volume, frequency or duration of CSO overflows.
Street Sweeping	None	Low	Medium	Medium	Effective at floatables removal, cost-intensive O&M. Ineffective at reducing CSO volume, bacteria and very fine particulate pollution.
Construction Site Erosion Control	None	Low	Low	Medium	Reduces sewer sediment loading, enforcement required. Contractor pays for controls.
Catch Basin Cleaning	None	Very Low	Medium	Low	Labor intensive, requires specialized equipment.
Industrial Pretreatment	Low	Low	Low	Low	There is limited industrial activity in this sewer area.
Inflow Control (Sections 7.2.2)					
Storm Water Detention	Medium	Medium	Medium	Medium	Requires large area in congested urban environment, potential siting difficulties and public opposition, construction would be disruptive to affected areas, increased O&M.
Street Storage of Storm Water	Medium	Medium	Medium	Medium	Potential flooding and freezing problems, public opposition, low operational cost.
Water Conservation	Low	Low	Low	Low	Potentially reduces dry weather flow making room for CSO, ancillary benefit is reduced water consumption
Inflow/Infiltration Control	Low	Low	Low	Low	Infiltration usually lower volume than inflow, infiltration can be difficult to control
Green Infrastructure (see Sections 5.8 and 8.8)					
Sewer System Optimization (Section 7.2.4)					
Optimize Existing System	Medium	Medium	Medium	Medium	Low cost relative to large scale structural BMPs, limited by existing system volume and dry weather flow dam elevations.
Real Time Control	Medium	Medium	Medium	Medium	Highly automated system, increased O&M, increased potential for sewer backups.
Sewer Separation (Section 7.2.5)					
Complete Separation	High	Medium	Low	Low	Disruptive to affected areas, cost intensive, potential

CSO Control Technology	Performance				Implementation and Operational Factors
	CSO Volume Reduction	Bacteria Removal	Floatables Control	Suspended Solids Reduction	
					for increased stormwater pollutant loads, requires homeowner participation.
Partial Separation	High	Medium	Low	Low	Disruptive to affected areas, cost intensive, potential for increased stormwater pollutant loads.
Rain Leader Disconnection	Medium	Medium	Low	Low	Low cost, requires home and business owner participation, potential for increased storm water pollutant loads.
Storage (Section 7.2.6)					
Closed Concrete Tanks	High	High	High	High	Requires large space, disruptive to affected area, cost intensive, aesthetically acceptable.
Storage Pipelines/Conduits	High	High	High	High	Disruptive to affected areas, potentially expensive in congested urban areas, aesthetically acceptable, provides storage and conveyance.
Tunnels	High	High	High	High	Non-disruptive, requires little area at ground level, capital intensive, provides storage and conveyance, pump station required to lift stored flow out of tunnel.
Treatment (Section 7.2.7)					
Screening/Netting Systems	None	None	High	None	Controls only floatables.
Primary Sedimentation[1]	Low	Medium	High	Medium	Limited space at WWTP, difficult to site in urban areas.
Vortex Separator (includes Swirl Concentrators)	None	Low	High	Low	Variable pollutant removal performance. Depending on available head, may require foul sewer flows to be pumped to the WWTP and other flow controls, increased O&M costs.
High Rate Physical/Chemical Treatment[1]	None	Medium	High	High	Limited space at WWTP, requires construction of extensive new conveyance conduits, high O&M costs.
Disinfection	None	High	None	None	Cost Intensive/Increased O&M.
Expansion of WWTP	High	High	High	High	Limited by space at WWTP, increased O&M.
Receiving Water Improvement (Section 7.2.8)					
Outfall Relocation	High	High	High	High	Relocates discharge to different area, requires the construction of extensive new conveyance conduits.
In-stream Aeration	None	None	None	None	High O&M, only effective for increasing DO, limited effective area, may require dredging.
Maintenance Dredging	None	None	None	None	Removes deposited solids after build-up occurs.
Solids and Floatables Controls (Section 7.2.9)					
Netting Systems	None	None	High	None	Easy to implement, potential negative aesthetic impact.
Containment Booms	None	None	High	None	Simple to install, difficult to clean, negative aesthetic impact.
Skimming Vessels	None	None	High	None	Easy to implement but limited to navigable waters.
Manual Bar Screens	None	None	High	None	Prone to clogging, requires manual maintenance.
Weir Mounted Screens	None	None	High	None	Relatively low maintenance, requires suitable physical configuration, must bring power to site.
Fixed Baffles	None	None	High	None	Low maintenance, easy to install, requires proper hydraulic configuration.
Floating Baffles	None	None	High	None	Moving parts make them susceptible to failure.
Catch Basin Modifications/ Hooding	None	None	High	None	Requires suitable catch basin configuration and increases maintenance efforts.

1. Process includes pretreatment screening and disinfection.

7.2.1. Watershed-Wide Controls or Non-Structural Controls

To control pollutants at their source, management practices can be applied where pollutants accumulate. Source management practices are described below:

Public Education

Public education programs can be aimed at reducing (1) littering by the public and the potential for litter to be discharged to receiving waters during CSO events and (2) illegal dumping of contaminants in the sewer system that could be discharged to receiving waters during rain events. Public education programs cannot reduce the volume, frequency or duration of CSO overflows, but can help improve CSO quality by reducing floatable debris. Public education and information is an integral part of any LTCP. Public education is also an ongoing DEP program (DEP, 2005b).

Street Sweeping

The major objectives of municipal street cleaning are to enhance the aesthetic appearance of streets by periodically removing the surface accumulation of litter, debris, dust, and dirt, and to prevent these pollutants from entering storm or combined sewer systems. Common methods of street cleaning are manual, mechanical and vacuum sweepers, and street flushing. Studies on the effect of street sweeping on the reduction of floatables and pollutants in runoff have been conducted. New York City found that street cleaning can be effective in removing floatables. Increasing street cleaning frequency from two times per week to six times per week reduced floatables by approximately 42 percent on an item count basis at a very high cost. A significant quantity of floatables was found to be located on sidewalks that were not cleanable by conventional equipment (HydroQual, 1995). However, in spite of these limitations, the Department of Sanitation of New York City (DSNY) does have a regular street sweeping program targeting litter reduction. DSNY also has an aggressive enforcement program targeting property owners to minimize the amount of litter on their sidewalks. These programs are described in New York City's Citywide Comprehensive CSO Floatables Plan (DEP, 2005a).

Studies, funded by the National Urban Renewal Program (NURP) during the late 1970s to the early 1980s, reported that street sweeping was generally ineffective at removing pollutants and improving the quality of urban runoff (MWCOG, 1983; USEPA, 1983). The principal reason for this is that mechanical sweepers, employed at that time could not pick up the finer particles (diameter < 60 microns). Studies have shown that these fine particles contain a majority of the target pollutants on city streets that are washed into sewer systems (Sutherland, 1995). In the early 1990s, new vacuum-assisted sweeper technology was introduced that can pick up the finer particles along city streets. A recent study showed that these vacuum-assisted sweepers have a 70 percent pickup efficiency for particles less than 60 microns (Sutherland, 1995).

Street sweeping only affects the pollutant concentration in the runoff component of combined sewer flows. Thus, a street sweeping program is ineffective at reducing the volume and frequency of CSO events. Furthermore, the total area accessible to sweepers is limited. Areas such as sidewalks, traffic islands, and congested street parking areas cannot be cleaned using this method.

Although a street sweeping program employing high efficiency sweepers could reduce the concentrations of some pollutants in CSOs, bacteriological pollution originates primarily from the sanitary component of sewer flows. Thus, minimal reductions in fecal coliform and *E. coli* concentrations of CSOs would be expected.

Construction Site Erosion Control

Construction site erosion control involves management practices aimed at controlling the washing of sediment and silt from disturbed land associated with construction activity. Erosion control has the potential to reduce solids concentrations in CSOs and reduce sewer cleanout operation and maintenance (O&M) costs. For applicable projects, New York City's CEQR requirements addresses potential impacts associated with sediment runoff as well as required measures to be employed to mitigate any potential impacts.

Catch Basin Cleaning

The major objective of catch basin cleaning is to reduce conveyance of solids and floatables to the combined sewer system by regularly removing accumulated catch basin deposits. Methods to clean catch basins include manual, bucket, and vacuum removal. Cleaning catch basins can only remove an average of 1-to 2 percent of the five day biochemical oxygen demand (BOD_5) produced by a combined sewer watershed (USEPA, 1977). As a result catch basins cannot be considered an effective pollution control alternative for BOD_5 removal.

New York City has an aggressive catch basin hooding program to contain floatables within catch basins and remove the material through catch basin cleaning (Citywide Comprehensive CSO Floatables Plan, Modified Facility Planning Report, City of New York, Department of Environmental Protection, July 2005). While catch basins can be effective in reducing floatables in combined sewers, catch basin cleaning does not necessarily increase floatables retention in the catch basin. Results of a pilot scale study showed that floatables capture improves as material accumulates in the catch basin (HydroQual, 2001f). During a rain event, the accumulated floatables can dissipate the hydraulic load entering a catch basin, thereby reducing turbulence in the standing water and reducing the escape of floatables. Thus, while hooding of catch basins will improve floatables capture, the hooding program is not expected to results in a major increase in catch basin cleaning.

Industrial Pretreatment

Industrial pretreatment programs are geared toward reducing potential contaminants in CSO by controlling industrial discharges to the sewer system. DEP has an industrial pretreatment program in place as discussed in Section 3 of this report.

7.2.2 Inflow Control

Inflow control involves eliminating or retarding stormwater inflow to the combined sewer system, lowering the magnitude of the peak flow through the system, thereby reducing overflows. Methods for inflow control are described below:

Stormwater Detention

Stormwater detention utilizes a surface storage basin or facility to capture stormwater before it enters the combined sewer system. Typically, a flow restriction device is added to the catch basin to effectively block stormwater from entering the basin. The stormwater is then diverted along natural or man-made drainage routes to a surface storage basin or "pond-like" facility where evaporation and/or natural soil percolation eventually empties the basin. Such systems are applicable for smaller land areas, typically up to 75 acres, and are more suitable for non-urban areas. Such a system is not considered viable for a highly congested urban area such as New York City. Stormwater blocked from entering catch basins would be routed along streets to the detention pond which would be built in the urban environment. Extensive public education and testing is required to build support for this control and to address public concerns such as potential unsafe travel conditions, flood damage, damage to roadways.

Street Storage of Stormwater

Street storage of stormwater utilizes the City's streets to temporarily store stormwater on the road surface. Typically, the catch basin is modified to include a flow restriction device. This device limits the rate at which surface runoff enters the combined sewer system. The excess stormwater is retained on the roadway entering the catch basin at a controlled rate. Street storage can effectively reduce inflow during peak periods and can decrease CSO volume. It also can promote street flooding and must be carefully evaluated and planned to ensure that unsafe travel conditions and damage to roadways does not occur. For these reasons, street storage of stormwater is not considered a viable CSO control technology in New York City.

Water Conservation

Water conservation is geared toward reducing the dry weather flow in the combined sewer system, thereby increasing the system's ability to accommodate more stormwater and reduce CSO discharges. Water conservation includes measures such as installing low flow fixtures, public education to reduce wasted water, leak detection and correction, and other similar programs. The City of New York has an on-going water conservation and public education program. The DEP's ongoing efforts to save water that reduce inflows to the combined sewers include installing individual water meters on water service lines to encourage conservation and equipping fire hydrants with special locking devices. Water conservation programs have resulted in the reduction of water consumption Citywide by approximately 230 MGD over a 10-year period or a reduction of 43 gallons per person per day from 1996 to 2006 (DEP, 2007). This change equates to a 17.5 percent reduction in overall daily water consumption, even as the population increased by approximately nine percent. The water consumption on a daily per capita basis decreased by 24.5 percent. Water conservation, as a CSO control technology, is effectively implemented to a satisfactory level, and New York City has achieved significant reductions in wastewater flow through its existing water conservation program.

As described above, reduced flow strategies are expected to require little incremental expenditure as water consumption and wastewater flows have been on the decline in recent years. Furthermore, the combination of automated meter reading, the ability of customers to track water usage, and national water efficient fixture standards is expected to keep flows stable. Additional conservation measures, such as toilet and other fixture rebate programs, are expected to have only nominal costs associated with them, and would be necessary only if the declining trend reverses.

Infiltration/Inflow (I/I) Reduction

Infiltration and inflow is ground water and other undesired water that enters the collection system through leaking pipe joints, cracked pipes, and manholes. Excessive amounts of infiltration and inflow take up the hydraulic capacity of the collection system. In contrast, the inflow of surface drainage is intended to enter the CSS the combined sewer system. Sources of inflow that might be controlled include leaking or missing tide gates and inflow in the separate sanitary system located upstream of the combined sewer system.

DEP conducted an Infiltration/Inflow (I/I) analyses City-wide during the late 1980s and early 1990s, and follow-up Sewer System Evaluation Surveys (SSES) where indicated. These investigations identified areas of excessive I/I by comparing measured nighttime flow rates to estimates of water usage developed from a derived per capita water usage rate and data from available records. The Bowery Bay SSES identified an average of 40.2 MGD of infiltration, but despite a comprehensive track down program, the sources of less than 4 percent of the I/I anticipated were positively identified in the field. The sewer system was generally found to be in adequate condition, and diver inspections did not locate any obvious sources of infiltration. Because of the lack of success in locating sources during TV programs in other DEP sewer studies, only 15,000 feet of sewers were recommended for inspection, and as a result, only 2.5 percent of the expected infiltration was identified. The SSES determined that it would be more cost-effective to simply transport and treat the excess I/I flow rather than attempting to reduce it, and therefore recommended no further rehabilitation in the Bowery Bay collection system.

7.2.3 Green Infrastructure

See Sections 5.8 and 8.8.

7.2.4 DEP Sewer System Optimization

This CSO control technology involves making the best use of existing facilities to limit overflows. The techniques are described below:

Optimize Existing System

This approach involves evaluating the current standard operating procedures for facilities such as pump stations, control gates, inflatable dams, weir modifications, and treatment facilities to determine if improved operating procedures can be developed to provide benefit in terms of CSO control.

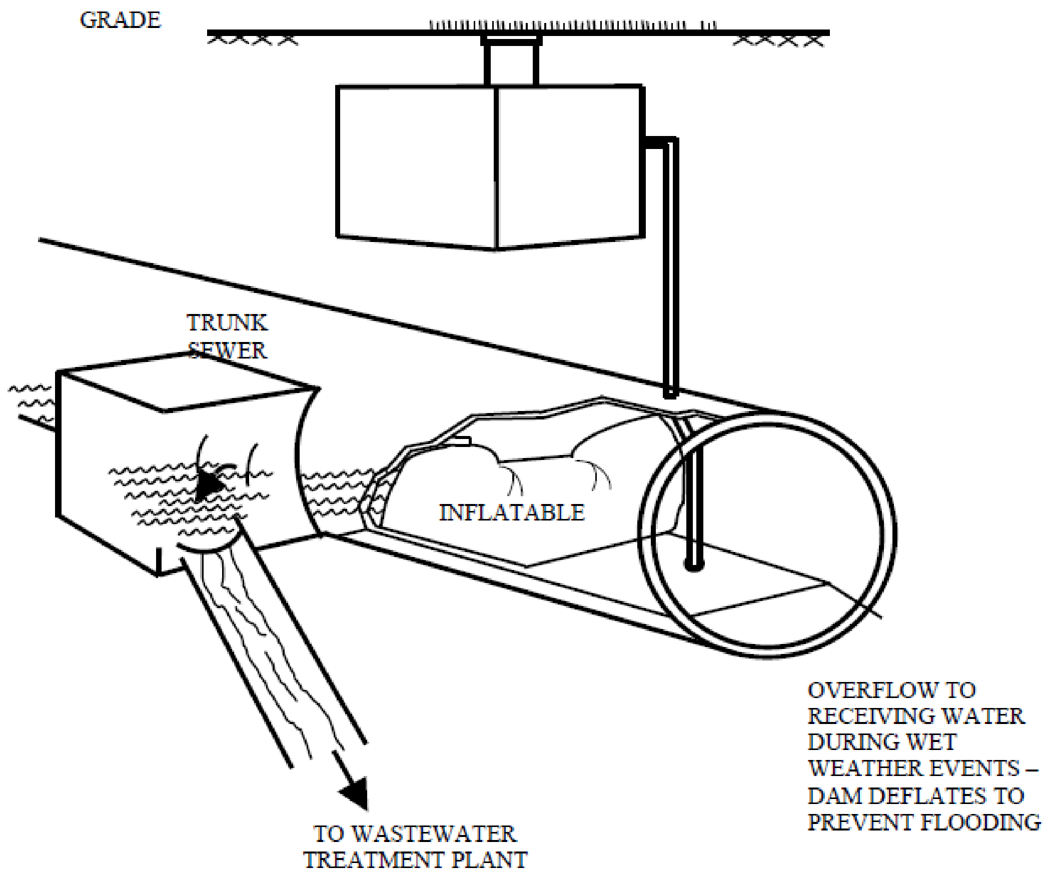
Real Time Control (RTC)

RTC is any response – manual or automatic – made in response to changes in the sewer system condition. For example, the depth of flow of sewage within the sewer system and flow data can be monitored in “real time” at key points in the sewer system and transferred to a control device such as a central computer where decisions can be made to operate control components (such as gates, pump stations or inflatable dams) to maximize use of the existing sewer system and to limit overflows. Data monitoring need not be centralized; local dynamic controls can be used to control regulators to prevent localized flooding. However, system wide dynamic controls are typically used to implement control objectives such as maximizing flow to the WWTP or transferring flows from one portion of the CSS to another to fully utilize the system. Predictive control, which incorporates use of weather forecast data, is also possible, but is complex and requires sophisticated operational capabilities. RTC can reduce CSO volumes when in-system storage capacity is available. In-system storage is a method of using excess sewer capacity by containing combined sewage within a sewer and releasing it to the WWTP after the storm event when capacity for treatment becomes available. Technologies available for equipping sewers for in-system storage include inflatable dams, mechanical gates and increased overflow weir elevations. RTC has been used in other cities such as Louisville, Kentucky; Cleveland, Ohio; and Quebec, Canada. Refer to Figure 7-1 for a diagram of an example inflatable dam system.

New York City has conducted an extensive pilot study of the use of inflatable dams (O'Brien & Gere, 2004) within the City's combined sewers. This pilot study involved the use of inflatable dams and RTC at two locations (Metcalf Avenue and Lafayette Avenue) in the Bronx. Testing was completed in early 2007 and the equipment remained idle until August 2009, when decommissioning was completed. From this study, the City found that the technology was feasible for further consideration, and constructed two permanent facilities that were completed in August 2010. However, widespread application of inflatable dams and RTC is limited in NYC as it does not provide for storage of large enough volumes of combined sewage to adequately improve water quality, especially in areas where tributary water quality is degraded.

Based on the experience gained from both the pilot and permanent installations, DEP has identified significant issues related to the viability of inflatable dams. Acquiring bidders was difficult because there has been only two manufacturers of inflatable dam systems historically: one no longer manufactures the dams and the other has curtailed service in the United States market. Aside from competitive bidding requirements, the limited market results in questionable reliability in the supply of replacement parts. While these challenges may be manageable for a limited number of facilities, wide spread application of dams may lead to ineffective operation, creating considerable operation and maintenance issues, and could lead to flood-inducing malfunctions.

Both optimization of the existing system and real time control will be retained for further consideration when evaluating potential alternatives for CSO control in Flushing Bay.



Environmental Protection

Inflatable Dam System

FIGURE 7-1

7.2.5 Sewer Separation

Sewer separation is the conversion of a combined sewer system into a system of separate sanitary and storm sewers. This alternative prevents sanitary wastewater from being discharged to receiving waters. However, when combined sewers are separated, storm sewer discharges to the receiving waters will increase since stormwater will no longer be captured and treated at the downstream WWTP. In addition, this alternative involves substantial excavation that could exacerbate traffic problems within the City.

Varying degrees of sewer separation could be achieved as described below and illustrated in Figure 7-2:

Rain Leader (Gutters and Downspouts) Disconnection

Rain leaders are disconnected from the combined sewer system with storm runoff diverted elsewhere. Depending on the location, leaders may be run to a dry well, vegetation bed, a lawn, a storm sewer or the street. Unfortunately, this scheme is inconsistent with existing city codes and regulations but these regulations may be modified in the future to support future green initiatives. Rain leader disconnection could contribute to nuisance street flooding and may only briefly delay the water from entering the combined sewer system through catch basins. For this reason, rain leader disconnection will be eliminated from further consideration.

Partial Separation

Combined sewers are separated in the streets only, or other public rights-of way. This is accomplished by constructing either a new sanitary wastewater system or a new stormwater system. Partial separation through construction of high level storm sewers (HLSS) is a potentially feasible alternative that is featured in the New York City Mayor's "PlaNYC 2030" initiative. Therefore, the DEP will continue to promote and support opportunities for local partial separation in select locations throughout the City. This technology is retained for further consideration on a site specific basis and is believed to be most cost-effective in areas near the shorelines where there is no need to build large diameter and long storm sewers to convey the separated stormwater to the receiving waterbody.

Complete Separation

In addition to separation of sewers in the streets, stormwater runoff from private residences or buildings (i.e. rooftops and parking lots) is also separated. Complete separation is almost impossible to attain in New York City since it requires re-plumbing of apartment, office and commercial buildings where roof drains are interconnected to the sanitary plumbing inside the building. In urban areas there is a lack of pervious surface areas to disperse the storm runoff into the ground, which could lead to nuisance flooding, and wet foundations and basements. These risks have led to the prohibition of stormwater disconnections from the combined sewers in the City Building Code. In addition, the widespread excavation and lengthy timeframes required to broadly implement separation would lead to unacceptable street disruptions and may not be feasible in areas with dense buried infrastructure.

7.2.6 Storage and Conveyance

The objective of retention basins (also referred to as off-line storage) is to reduce overflows by capturing combined sewage in excess of WWTP capacity during wet weather for controlled release into the WWTP after the storm event. Retention basins can provide a relatively constant flow into the treatment plant thereby reducing the hydraulic impact on downstream WWTPs. Retention basins have had considerable use and are well documented. Retention facilities may be located at overflow points or near dry weather or wet weather treatment facilities. A major factor determining the feasibility of using retention basins is land availability. Operation and maintenance costs are generally small, typically requiring only collection and disposal cost for residual sludge solids, unless inlet or outlet pumping is required. Many demonstration projects have included storage of peak stormwater flows, including those in Richmond, Virginia; Chippewa Falls, Wisconsin; Boston, Massachusetts; Milwaukee, Wisconsin; and Columbus, Ohio.

The following subsections describe types of CSO retention facilities:

Closed Concrete Tanks

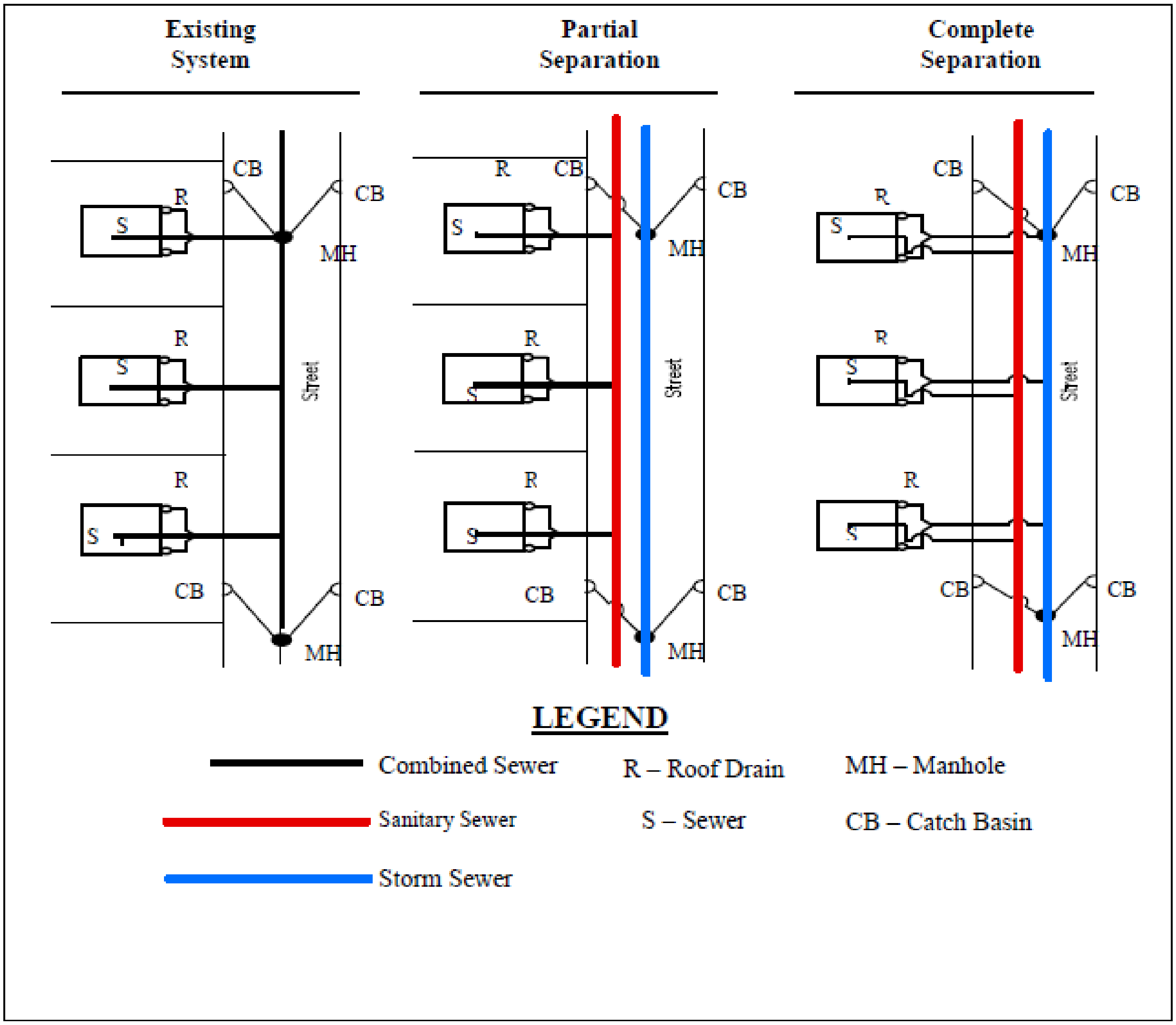
Closed concrete tanks are similar to open tanks except that the tanks are covered and include many mechanical facilities to minimize their aesthetic and environmental impact. Closed concrete tanks typically include odor control systems, washdown/solids removal systems, and access for cleaning and maintenance of the tank. Closed concrete tanks have been constructed below grade such that the overlying surface can be used for parks, playgrounds, parking or other light public uses.

Storage Pipelines/Conduits

Large diameter pipelines or conduits can provide significant storage in addition to the ability to convey flow. The pipelines are fitted with some type of discharge control to allow flow to be stored within the pipeline during wet weather. After the rain event, the contents of the pipeline are allowed to flow by gravity to downstream WWTPs for ultimate treatment. A pipeline has the advantage of requiring a relatively small right-of-way for construction. The primary disadvantage is that it takes a relatively large diameter pipeline or cast-in-place conduit to provide the volume required to accommodate large periodic CSO flows requiring a greater construction effort than a pipeline used only for conveyance. For large CSO areas, pipeline size requirements may be so large that construction of a tunnel is more feasible.

Tunnels

Tunnels are similar to storage pipelines in that they can provide both significant storage volume and conveyance capacity. Tunnels have the advantage of causing minimal surface disruption and of requiring little right-of-way for construction. Excavation to construct the tunnel is carried out deep beneath the city and therefore would not impact traffic. The ability to construct tunnels at a reasonable cost depends on the geology. Tunnels have been used in many CSO control plans including Chicago, Illinois; Rochester, New York; Cleveland, Ohio; Richmond, Virginia; and Toronto, Canada, among others. A schematic diagram of a typical storage tunnel system is shown in Figure 7-3. The storage tunnel stores flow and then conveys it



Existing System
Partial Separation
Complete Separation
CB
R
S
MH
Street
LEGEND
Combined Sewer
Sanitary Sewer
Storm Sewer
R – Roof Drain
S – Sewer
MH – Manhole
CB – Catch Basin

to a dewatering station where floatables are removed at a screening house and then flows are lifted for conveyance to the WWTP.

The three storage alternatives discussed above – closed concrete tanks, storage pipelines / conduits, and tunnels – will be retained for further consideration.

7.2.7 Treatment

Treatment alternatives include technologies intended to separate solids and/or floatables from the combined sewer flow, disinfect for pathogen treatment or provide secondary treatment for some portion of the combined flow. The following are types of treatment technologies:

Screening

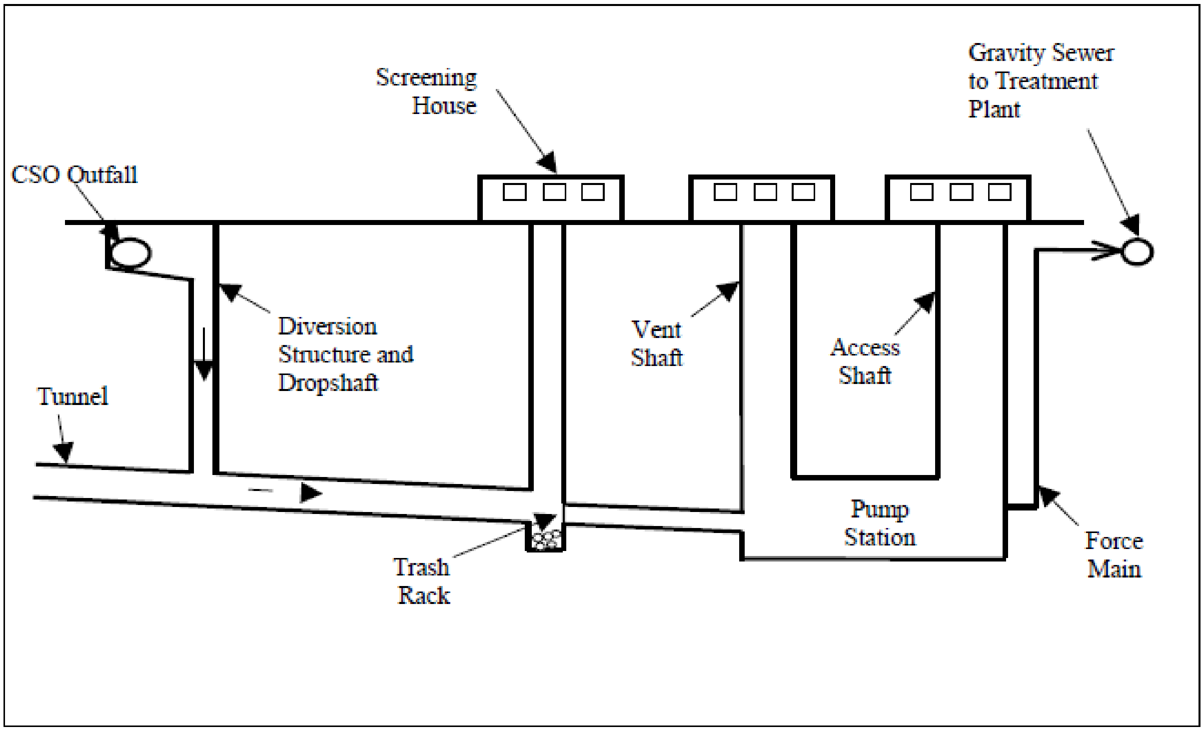
The major objective of screening is to provide high rate solids/liquid separation for combined sewer floatables and debris thereby preventing floatables from entering receiving waters. The following categories of screens are applicable to CSO outfall applications:

- Trash Racks and Manually Cleaned Bar Racks – Trash racks are intended to remove large objects from overflow and have a clear spacing of between 1.5 to 3.0 inches. Manually cleaned bar racks are similar to trash racks and have clear spacings of between 1.0 to 2.0 inches. Both screens must be manually raked and the screenings must be allowed to drain before disposal.

- Netting Systems – Netting systems are intended to remove floatables and debris at CSO outfalls. A system of disposable mesh bags is installed in either a floating structure at the end of the outfall or in an underground chamber on the land side of the outfall. Nets and captured debris must be periodically removed using a boom truck and disposed of in a landfill.

- Mechanically Cleaned Bar Screens – Mechanically cleaned bar screens typically have clear spacing between 0.25 and 1.0 inches. Bars are mounted 0 to 39 degrees from the vertical and rake mechanisms periodically remove material trapped on the bar screen. Facilities are typically located in a building to house collected screenings that must be collected after a CSO event and then transported to a landfill.

- Fine Screens – Fine screens in CSO facilities typically follow bar screens and have openings between 0.010 and 0.5 inches. Flow is passed through the openings and solids are retained on the surface. Screens can be in the shape of a rotary drum or linear horizontal or vertical screens. Proprietary screens such as ROMAG have been specifically designed for wet weather applications. These screens retain solids on the dry weather side of the overflow diversion structure so they can be conveyed to the wastewater treatment plant with the sanitary wastewater thereby minimizing the need for on-site collection of screenings for truck transport.



Environmental Protection

Storage Tunnel Schematic

Manually cleaned screens for CSO control at remote locations have not been widely applied due to the need to clean screens and the potential to cause flooding if screens blind. Mechanically cleaned screens have had much greater application at CSO facilities. Due to the widely varying nature of CSO flow rates, even mechanically cleaned screens are subject to blinding under certain conditions. In addition, the screening must be housed in a building to address aesthetic concerns and odor facilities may be required as well. Fine screens have had more limited application for CSOs in the United States. ROMAG reports that over 250 fine screens have been installed in Europe and several screens have been installed in the United States (EPA, 1999a).

While screening provides an aesthetic benefit to the waterbody, it would not provide any improvement to the measured water quality parameters, such as DO, total coliform and fecal coliform. Also, screening the combined sewer flow does not involve the capture of storm sewer floatables that would discharge into Flushing Bay. Screening technologies are generally considered to have significant operational and maintenance requirements.

Primary Sedimentation

The objective of sedimentation is to produce a clarified effluent by gravitational settling of the suspended particles that are heavier than water. It is one of the most common and well-established unit operations for wastewater treatment. Sedimentation tanks also provide storage capacity, and disinfection can occur concurrently in the same tank. It is also very adaptable to chemical additives, such as lime, alum, ferric chloride, and polymers, which provide higher suspended solids and BOD removal. Many CSO control demonstration projects have included sedimentation. These include Dallas, Texas; Saginaw, Michigan; and Mt. Clements, Michigan (EPA, 1978). Studies on existing stormwater basins indicate suspended solids removals of 15 to 89 percent; BOD_5 removals of 10 to 52 percent (EPA, 1978, Fair and Geyer, 1965, Ferrara and Witkowski, 1983, Oliver and Gigoropolulos, 1981).

The DEP's WWTPs are designed to accept their respective 2×DDWF for primary treatment during wet weather events. As such, NYC already controls a significant portion of combined sewage through the use of this technology.

Because new primary sedimentation facilities would occupy a significant amount of land, siting these facilities would be infeasible. Both the Bowery Bay and Tallman Island WWTPs are already densely developed and cannot accommodate new primary tanks. In the Flushing Bay community, land areas near significant outfalls are also insufficient to site primary sedimentation facilities. Given the land constraints, primary sedimentation will not be further considered.

Vortex Separation

Vortex separation technologies currently marketed include: USEPA Swirl Concentrator, Storm King Hydrodynamic Separator (of British design), and the FluidSep vortex separator (of German design). Although each of the three is configured somewhat differently, the operation of each unit and the mechanisms for solids separation are similar. Flow enters the unit tangentially and is directed around the perimeter of a cylinder, creating a swirling, vortex pattern. The swirling action causes solids to move to the outside wall and fall toward the bottom, where the solids concentrated flow is conveyed through a sewer line to the WWTP. The overflow is discharged over a weir at the top of the unit. Various baffle arrangements capture floatables that are subsequently carried out in the underflow. Principal attributes of the vortex separator are the ability to treat high flows in a very small footprint, and a lack of mechanical components and moving parts, thereby reducing operation and maintenance.

Vortex separators have been operated in Decatur Illinois; Columbus, Georgia; Syracuse, New York; West Roxbury, Massachusetts; Rochester, New York; Lancaster, Pennsylvania; Toronto, Ontario, Canada. Vortex separator prototypes have achieved suspended solids removals of 12 to 86 percent in Lancaster, Pennsylvania; 18 to 55 percent in Syracuse, New York; and 6 to 36 percent in West Roxbury, Massachusetts. BOD_5 removals from 29 to 79 percent have been achieved with the swirl concentrator prototype in Syracuse New York. (Alquier, 1982).

New York City constructed the Corona Avenue Vortex Facility (CAVF) in the late 1990's to evaluate the performance of three swirl/vortex technologies at a full-scale test facility (133 MGD each). The purpose of the test was to demonstrate the effectiveness of the vortex technology for control of CSO pollutants, primarily floatables, oil and grease, settleable solids and total suspended solids. The two-year testing program, completed in late 1999, evaluated the floatables-removal performance of the facility for a total of 22 wet weather events. Overall, the results indicated that the vortex units provided virtually no reductions in total suspended solids and an average floatables removal of approximately 60 percent during the tested events. Based on the results of the testing, DEP concluded that widespread application of the vortex technology is not effective for control of CSOs and was not a cost effective way to control floatables. As such, the application of this technology will be limited and other methods to control floatable discharges into receiving waters will need to be assessed. DEP is planning to decommission this facility in accordance with all applicable laws and regulations.

Also, the performance of vortex separators has been found to be inconsistent in other demonstrations. A pilot study in Richmond, Virginia showed that the performance of two vortex separators was irregular and ranged from 0 percent to 26 percent with an average removal efficiency of about 6 percent (Greeley and Hansen, 1995). The performance of vortex separators is also a strong function of influent TSS concentrations. A high average influent TSS concentration will yield a higher percent removal. As a result, if influent CSO is very dilute with stormwater, the overall TSS removal will be low. Suspended solids removal in the beginning of a storm event may be better if there is a pronounced first flush period with high solids concentrations (City of Indianapolis, 1996). Removal effectiveness is also a function of the hydraulic loading rate with better performance observed at lower loading rates. Furthermore, one of the advantages of vortex separation – the lack of required moving parts – requires sufficient driving head.

Based on the poor results of the testing at the Corona Vortex Facility (Evaluation of Corona Avenue Vortex Facility, City of New York Department of Environmental Protection, September 29, 2003, 2-volumes; Corona Avenue Vortex Facility Underflow Evaluation, City of New York, Department of Environmental Protection, October 2005), and the general lack of available head, vortex separators have been removed from further consideration in New York City in general and from consideration within the Flushing Bay watershed.

Further, as the CAVF pilot project has been completed and it has been found to have a limited value with respect to removal of CSO floatables and solids, the CAVF will not be considered as part of the Long Term CSO Control Plan for Flushing Bay. As such, CAVF could be decommissioned when other CSO controls are constructed for Flushing Bay CSOs.

High Rate Physical Chemical Treatment (HRPCT)

High rate physical/chemical treatment is a traditional gravity settling process enhanced with flocculation and settling aids to increase loading rates and improve performance. The pretreatment requirements for high rate treatment are screening and degritting, identical to that required prior to primary sedimentation. The first stage of HRPCT is coagulant addition, where ferric chloride, alum or a similar coagulant is added and rapidly mixed into solution. Degritting may be incorporated into the coagulation stage with a larger tank designed for gravity settling of grit material. The coagulation stage is followed by a flocculation stage where polymer is added and mixed to form floc particles that will settle in the following stage. Also in this stage recycled sludge or micro sand from the settling stage is added back in to improve the flocculation process. Finally, the wastewater enters the gravity settling stage that is enhanced by lamella tubes or plates. Disinfection, which is not part of the HRPCT process, typically is completed after treatment to the HRPCT effluent. Sludge is collected at the bottom of the clarifier and either pumped back to the flocculation stage or wasted periodically when sludge blanket depths become too high. The two principal manufacturers of HRPCT processes are Infilco Degremont Incorporated (IDI), which manufacturers the DensaDeg process, and US Filter, which manufactures the Actiflo process.

IDI offers the DensaDeg 2D and 4D processes, both of which require screening upstream. The 2D process requires upstream grit removal as well, but the 4D process integrates grit removal into the coagulation stage. Otherwise the 2D and 4D processes are identical. DensaDeg performance varies with surface overflow rate and chemical dosages, but in general removal rates of 80 to 95 percent for TSS and 30 to 60 percent for BOD can be expected. Phosphorous and nitrogen can also be removed with this process, although the removal efficiencies are dependent on the solubility of these compounds present in the wastewater. Removal efficiencies are also dependent on start-up time. Typically the DensaDeg process requires approximately 30 minutes before optimum removal rates are achieved to allow for the build-up of sludge solids.

The US Filter Actiflo process is different from the DensaDeg process in that fine sand is used to ballast the sludge solids. As a result, the solids settle faster, but specialized equipment must be incorporated in the system to accommodate the handling of sand throughout the system. Figure 7-4 shows the components of a typical US Filter Actiflo system. The process does require screening upstream. Grit removal is recommended, but since the system uses microsand as ballast in the process, the presence of grit is tolerable in the system. If grit removal does not precede the process, the tanks must be flushed of accumulated grit every few months to a year, depending on the accumulation of grit and system run times.

Actiflo performance varies with surface overflow rate and chemical dosages, but in general removal rates of 80 to 95 percent for TSS and 30 to 60 percent for BOD are typical. Phosphorous and nitrogen are also removable with this process, although the removal efficiencies are dependent on the solubility of these compounds present in the wastewater. Phosphorous removal is typically between 60 and 90 percent, and nitrogen removal is typically between 15 and 35 percent. Removal efficiencies are also dependent on start-up time. Typically the Actiflo process takes about 15 minutes before optimum removal rates are achieved.

Pilot testing of HRPCT was performed at the 26th Ward WWTP in Brooklyn, and consisted of evaluating equipment from three leading HRPCT manufacturers from May through August 1999. The three leading processes tested during the pilot test were the Ballasted Floc Reactor™ from Microsep/US Filter, the Actiflo™ from Kruger, and the Densadeg 4D™ from Infilco Degremont. Pilot testing suggested good to excellent performance on all units, often in excess of 80 percent for TSS and 50 percent for BOD_5. However, operational challenges suggested the need for further testing, which was to be performed in a demonstration-scale facility. Facility planning at that time did not reveal any opportunities to apply HRPCT for CSO abatement in New York City, so the demonstration project was indefinitely postponed. For the purposes of this technology evaluation, it is presumed that the operational challenges would be overcome once testing was re-initiated and, therefore, HRPCT will be retained for further consideration.

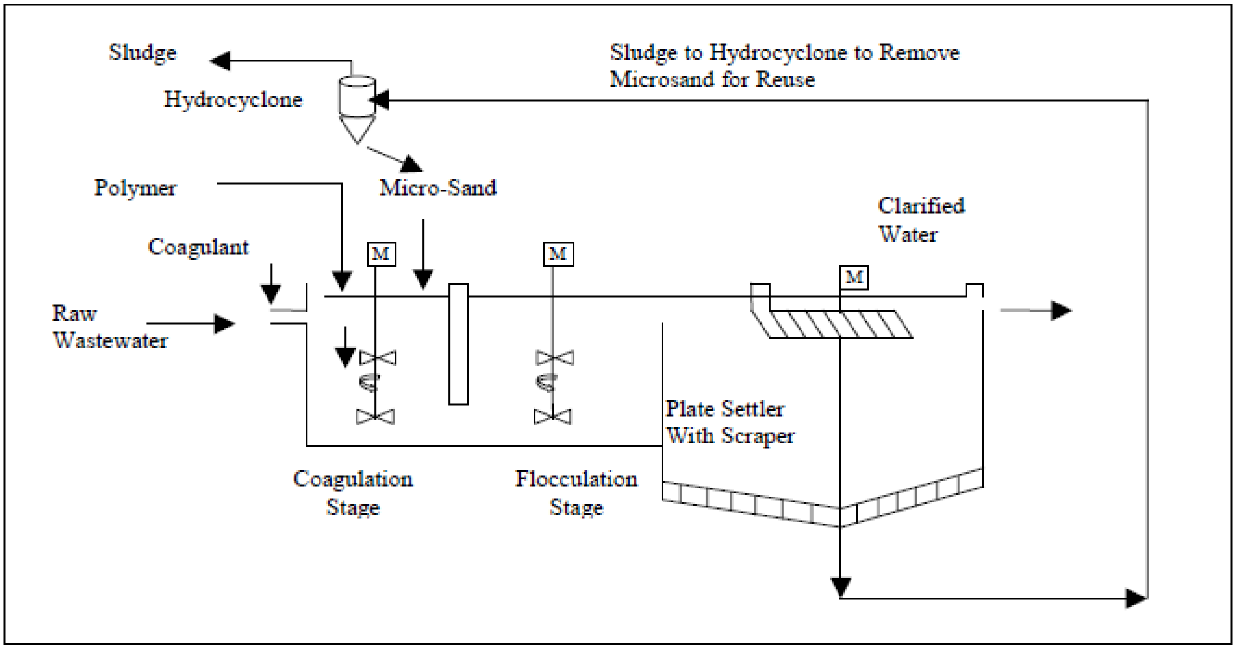
Disinfection

The major objective of disinfection is to control the discharge of pathogenic microorganisms in receiving waters. Disinfection of combined sewer overflow is included as part of many CSO treatment facilities, including those in Washington, D.C.; Boston, Massachusetts; Rochester, New York; and Syracuse, New York. The disinfection methods considered for use in combined sewer overflow treatment are chlorine gas, calcium or sodium hypochlorite, chlorine dioxide, peracetic acid, ozone, ultraviolet radiation, and electron beam irradiation. The chemicals are all oxidizing agents that are corrosive to equipment and in concentrated forms are highly toxic to both microorganisms and people. Each is described below.

- Chlorine gas – Chlorine gas is extremely effective and relatively inexpensive. However, it is extremely toxic and its use and transportation must be monitored or controlled to protect the public. Chlorine gas is a respiratory irritant and in high concentrations can be deadly. Therefore, it is not well suited to populous or potentially non-secure areas.

- Calcium or Sodium Hypochlorite – Hypochlorite systems are common in wastewater treatment installations. For years, large, densely populated metropolitan areas have employed hypochlorite systems in lieu of chlorine gas for safety reasons. The hypochlorite system uses sodium hypochlorite in a liquid form much like household bleach and is similarly effective as chlorine gas although more expensive. It can be delivered in tank trucks and stored in aboveground tanks. The storage life of the solution is 60 to 90 days.

- Chlorine Dioxide – Chlorine dioxide is an extremely unstable and explosive gas and any means of transport is potentially very hazardous. Therefore, it must be generated on site. The overall system is relatively complex to operate and maintain compared to more conventional chlorination.



US Filter Actiflo HRPCT

- Ozone – Ozone is a strong oxidizer and must be applied to CSO as a gas. Due to the instability of ozone, it must be generated on site. The principle advantage of ozone is that there is no trace residual chlorine remaining in the treated effluent. Disadvantages associated with ozone use as a disinfectant is that it is relatively expensive, with the cost of the ozone generation equipment being the primary capital cost item. Operating costs can be very high depending on power costs, since ozonation is a power intensive system. Ozonation is also relatively complex to operate and maintain compared to chlorination. Ozone is not considered practical for CSO applications because it must be generated on site in an intermittent fashion in response to variable and fluctuating CSO flow rates.

- UV Disinfection – UV disinfection uses light with wavelengths between 40 and 400 nanometers for disinfection. Light of the correct wavelength can penetrate cells of pathogenic organisms, structurally altering DNA and preventing cell function. As with ozone, the principle advantage of UV disinfection is that no trace chlorine residual remains in the treated effluent. However, because UV light must penetrate the water to be effective, the TSS level of CSOs can affect the disinfection ability. As such, to be effective UV must be preceded by thorough separation of solids from the combined sewage. Pretreatment by sedimentation, high-rate sedimentation, and/or filtration maybe required to reduce suspended solids concentrations to less than 20 to 40 mg/L or so depending on the water quality goals.

Disinfection reduces potential public health impacts from CSOs but needs to be used in conjunction with other technologies, as it cannot reduce CSO volume, settleable solids, or floatables.

In order to protect aquatic life in the receiving waters, dechlorination facilities would need to be installed whenever chlorination is used as a disinfectant. Dechlorination would be accomplished by injection of sodium bisulfite in the flow stream before discharge of treated CSO flow to waterways. Dechlorination with sodium bisulfite is rapid; hence no contact chamber is required. However, even with the addition of dechlorination, DEP believes that there could be a residual of as much as 1mg/L from a CSO disinfection facility and there is still a potential to form other harmful disinfection bi-products.

Disinfection would not reduce the CSO discharge volume and as such would not be considered as a stand-alone alternative. However, opportunities to use disinfection in combination with other technologies would be considered. Disinfection would be considered as a means of reducing pathogen concentrations.

Expansion of WWTP Treatment

The DEP developed WWOPs for the Tallman Island and Bowery Bay WWTPs (see Appendices A and B) per DEC requirement. These WWOPs provided recommendations for maximizing treatment of flow during wet weather events. The reports outlined three primary objectives in maximizing treatment for wet weather flows: (1) consistently achieve primary treatment and disinfection for wet weather flows up to 2xDDWF; (2) consistently provide secondary treatment for wet weather flows up to 1.5xDDWF before bypassing the secondary treatment system; and, (3) do not appreciably diminish the effluent quality or destabilize treatment upon return to dry weather operations.

7.2.8 Receiving Water Improvement

Receiving waters can also be treated directly with various technologies that improve water quality. Below are described the different treatment options that could aid in improving water quality in conjunction with CSO control measures:

Outfall Relocation

Outfall relocation involves moving the combined sewer outfall to another location. For example, an outfall may be relocated away from a sensitive area to prevent negative impacts to that area. In general, outfall relocation is not considered a feasible alternative in New York City, due in part to extensive construction, disruption to City streets and high construction costs.

However, it may be feasible for a collection system to be modified such that CSO is shifted to a different existing outfall that may have better mixing characteristics or the capability to better handle a CSO discharge. For example, moving a CSO discharge from poorly mixed or narrow channel/tributary to a well-mixed/open waters area would improve water quality in a particular waterbody.

Outfall relocation would improve Flushing Bay by sending the CSO discharge to another waterbody. Candidate outfalls can be divided into two groups based on WWTP service area: Bowery Bay (BB-006, BB-007 and BB-008) and Tallman Island (TI-014 through TI-018). CSO from the Tallman Island outfalls is being addressed by the partial sewer separation program described in Section 5, and, therefore, these outfalls were not considered for relocation. Reasons for relocating the Bowery Bay outfalls would be either to protect a sensitive area, or to diminish the CSO loading into Flushing Bay. There are no sensitive areas in Flushing Bay, so relocation would not be a benefit for this criterion. Relocation of the CSO load would require finding a suitable waterbody capable of assimilating the additional CSO load. The East River is the only nearby waterbody that might be suitable. However, given the distance from the existing Bowery Bay outfalls to the East River, and given that this technology would not result in any overall reduction in CSO, the cost of constructing a new pipeline to the East River would not be a judicious use of funds. Therefore, this technology was eliminated.

In-Stream Aeration

In-stream aeration would improve the DO content of the Bay by adding air directly to the water column via diffusers placed within the waterbody. Air could be added in large enough volumes to bring any waterbody into compliance with the ambient water quality standards. However, depending on the amount of air that would be required to be transferred into the water column, the facilities necessary and the delivery systems required could be extensive and impractical. An alternative would be to deliver a lower volume of air and control short term anoxic conditions that may result from intermittent wet weather overflows. DEP continues to investigate in-stream aeration as a method of meeting DO standards at the recently constructed English Kills in-stream aeration facility. The first of three years of testing was completed in the summer of 2009 and preliminary data analysis was completed in February 2010.

Environmental Dredging

The maintenance dredging technology is essentially the dredging of settled CSO solids from the bottom of waterbodies periodically. The settled solids would be dredged from the receiving waterbody as needed to prevent use impairments such as access by recreational boaters, as well as abate nuisance conditions such as odors. The concept would be to conduct dredging periodically or routinely to prevent the use impairment/nuisance conditions from occurring. Dredging would be conducted as an alternative to structural CSO controls such as storage. Bottom water quality between dredging operations would likely not improve and bottom habitat would degrade following each dredging.

This technology allows CSO settleable solids to continue to exit the sewer system and settle in the waterbody generally immediately downstream of the outfall, and without regular or periodic dredging the solids usually accumulate with leaves and other detritus into a “CSO mound". This CSO mound would then be dredged and removed from the water environment. The assumption is that dredging would occur prior to the CSO mound creating an impairment or nuisance condition. Generally, it is envisioned that maintenance dredging would be performed prior to a CSO mound building to an elevation that it becomes exposed at low tide or mean lower low tide. The extent and depth of dredging would depend on the rate of accretion, or build-up of settleable solids, and preferred years between dredging.

Dredging can be accomplished by a number of acceptable methods. Methods of dredging generally fall into either floating mechanical or hydraulic techniques, with a variety of variants for both techniques. The actual method of dredging selected would depend on the physical characteristics (grain size, viscosity, etc.) of the sediments that require removal, the extent of entrained pollutants (metals, etc), and the local water currents, the depth and width of the waterbody and other conditions such as bridges that could interfere with dredge/barge access. It is likely that CSO sediments would require removal with a closed bucket mechanical dredge or an auger/suction-head hydraulic dredge. Removal techniques, however, would be site specific.

After removal of CSO sediments, the material would likely be placed onto a barge for transport away from the site. On-site dewatering may be considered as well. Sediments would then be off-loaded from the barge and shipped by land methods to a landfill that accepts New York Harbor sediments. Recently, harbor sediments have been shipped to a facility licensed to accept such sediments.

All of the aforementioned receiving water improvement technologies are applicable to Flushing Bay, and are therefore retained for further consideration.

7.2.9 Solids and Floatables Control

Technologies that provide solids and floatables control do not reduce the frequency or magnitude of CSO overflows, but can reduce the presence of aesthetically objectionable items such as plastic, paper, polystyrene and sanitary “toilet litter” matter, etc. These technologies include both end-of-pipe technologies such as netting and screens, as well as BMPs such as catch basin modifications and street cleaning which could be implemented upstream of outfalls in the drainage area. Each of these technologies is summarized below:

Netting Devices

Netting devices can be used to separate floatables from CSOs by passing the flow through a set of netted bags. Floatables are retained in the bags, and the bags are periodically removed for disposal. Netting systems can be located in-water at the end of the pipe, or can be placed in-line to remove the floatables before discharge to the receiving waters. Netting alone will not reduce CSO discharges and, therefore, will only be considered as a supplemental treatment.

Containment Booms

Containment booms are specially fabricated floatation structures with suspended curtains designed to capture buoyant materials. They are typically anchored to a shoreline structure and to the bottom of the receiving water. After a rain event, collected materials can be removed using either a skimmer vessel or a land-based vacuum truck. A 2-year pilot study of containment booms was conducted by New York City in Jamaica Bay. An assessment of the effectiveness indicated that the containment booms provided a retention efficiency of approximately 75 percent. An illustration of a containment boom is shown in Figure 7-5.

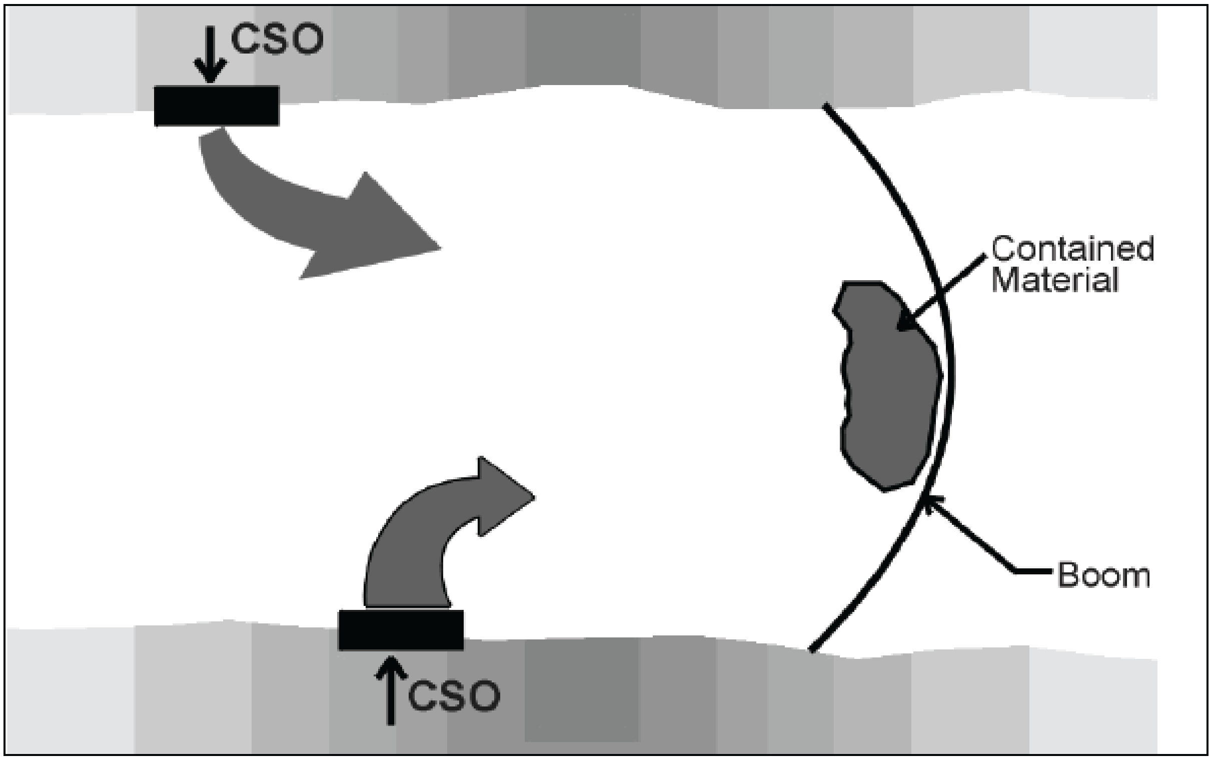
The use of booms may be necessary as an interim control until more permanent technologies are constructed. Booms are most useful at larger outfalls where the discharge of floatables is greatest. Within Flushing Bay, BB-006 and BB-008 are by far the largest dischargers. Booms are already in place at these locations and can be expected to remain in place while any recommended facilities are built. Because these booms are already in place, no new costs will be factored into the recommended plan.

Skimmer Vessels

Skimmer vessels remove materials floating within a few inches of the water surface and are being used in various cities, including New York City. The vessels range in size from less than 30 feet to more than 100 feet long. They can be equipped with moving screens on a conveyor belt system to separate floatables from the water or with nets that can be lowered into the water to collect the materials. Skimmer vessels are typically effective in areas where currents are relatively slow-moving and can also be employed in open-water areas where slicks from floatables form due to tidal and meteorological conditions. New York City currently operates skimmer vessels to service containment boom sites.

Bar Screens (Manually Cleaned)

Manually cleaned bar screens can be located within in-line CSO chambers or at the point of outfall to capture floatables. The configuration of the screen would be similar to that found in the influent channels of small wastewater pumping stations or treatment facilities. Retained materials must be manually raked and removed from the sites after every storm. For multiple CSOs, this would result in very high maintenance requirements. Previous experience with manually cleaned screens in CSO applications has shown these units to have a propensity for clogging. In Louisville, KY, screens installed in CSO locations became almost completely clogged with leaves from fall runoff. Because of the high frequency of cleaning required, it was



Containment Boom

FIGURE 7-5

decided to remove the screens. Thus, manually cleaned bar screens will be eliminated from further consideration.

Weir-Mounted Screens (Mechanically Cleaned)

Horizontal mechanical screens are weir-mounted mechanically cleaned screens driven by electric motors or hydraulic power packs. The rake mechanism is triggered by a float switch in the influent channel and returns the screened materials to the interceptor sewer. Various screen configurations and bar openings are available depending on the manufacturer. Horizontal screens can be installed in new overflow weir chambers or retrofitted into existing structures if adequate space is available. Electric power service must be brought to each site.

Although widely used in Europe, weir-mounted screens are relatively new devices in the United States. As with any type of screening device, they are used for removing floatables and other visible solids. Any removal of suspended solids would be incidental. As such, where water quality evaluations indicate that suspended solids or oxygen demanding materials need to be removed, weir-mounted screens are not effective. Since water quality evaluations for Flushing Bay indicate removal of these materials, other control or treatment processes downstream would be more effective.

Baffles Mounted in Regulator

- Fixed Underflow Baffles - Underflow baffles consist of a transverse baffle mounted in front of and typically perpendicular to the overflow pipe. During a storm event, the baffle prevents the discharge of floatables by blocking their path to the overflow pipe. As the storm subsides, the floatables are conveyed to downstream facilities by the dry weather flow in the interceptor sewer. The applicability and effectiveness of the baffle depends on the configuration and hydraulic conditions at the regulator structure. Baffles are being used in CSO applications in several locations including Boston, Massachusetts and Louisville, Kentucky. However, the typical regulator structures in New York City are not amenable to fixed baffle retrofits. Therefore, fixed underflow baffles will be eliminated from further consideration.

- Floating Underflow Baffles - A variation on the fixed underflow baffle is the floating underflow baffle developed in Germany and marketed under the name HydroSwitch by Grande, Novac & Associates. The floating baffle is mounted within a regulator chamber sized to provide floatables storage during wet weather events. All floatables trapped behind the floating baffle are directed to the WWTP through the dry weather flow pipe. By allowing the baffle to float, a greater range of hydraulic conditions can be accommodated. Although this technology has not yet been demonstrated in the United States, there are operating units in Germany.

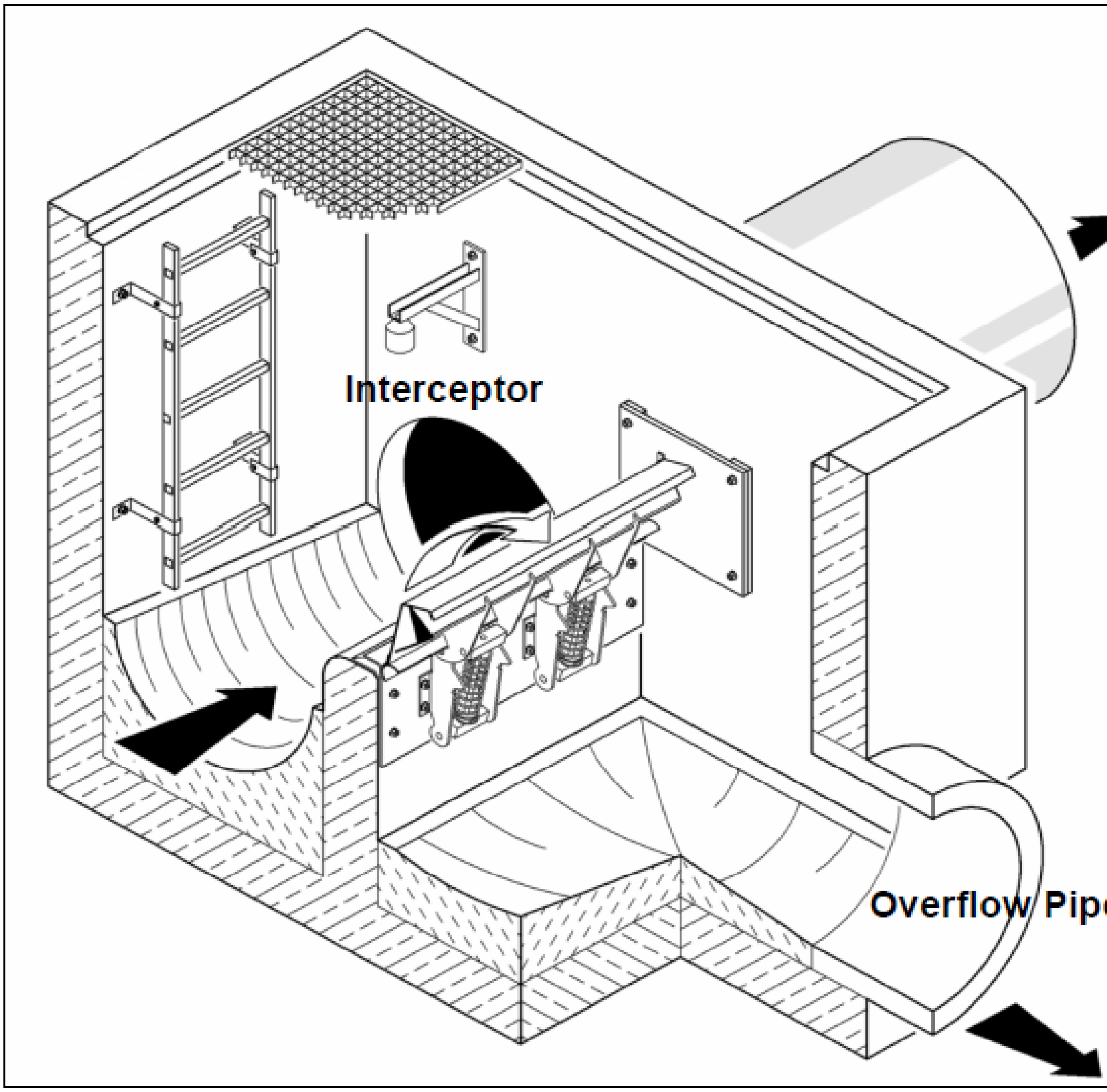
- Hinged Baffle – The hinged baffle system incorporates two technologies, the hinged baffle and the bending weir. The system design is intended to retain floatables in regulators during storm events. During a storm event, the hinged baffle provides floatables retention while the bending weir increases flow to the plant. After a storm event, retained floatables drop into the regulator channel and then into the sewer interceptor to be removed at the treatment plant. During large storm events that exceed the capacity of the regulator, more flow backs up behind the baffle. To prevent flooding, the hinged baffle opens to allow more flow to pass through the regulator. The bending weir provides additional storage of stormwater and floatables within the regulator during storm events by raising the overflow weir elevation. Similar to the hinged baffle, the bending weir also helps to prevent flooding during large storm events by opening and allowing additional combined sewage to overflow the weir. The bending weir allows an increasing volume of combined sewage to overflow the weir as the water level inside the regulators rise. The major benefit of the system is that it includes a built-in mechanical emergency release mechanism. This feature eliminates the need for the construction of an emergency bypass that many other in-line CSO control technologies require. In addition, the system has no utility requirements and therefore has low operation and maintenance costs of a scale similar to tide gates. For the reasons stated above, a bending weir is the preferred technology over a hinged baffle. A three dimensional view of a bending weir installation is shown in Figure 7-6 (from John Meunier, Inc).

Catch Basin Modifications

Catch basin modifications consist of various devices to prevent floatables from entering the CSS. Inlet grates and closed curb pieces reduce the amount of street litter and debris that enters the catch basin. Catch basin modifications such as hoods, submerged outlets, and vortex valves, alter the outlet pipe conditions and keep floatables from entering the CSS. Catch basin hoods are similar to the underflow baffle concept described previously for installation in regulator chambers. These devices also provide a water seal for containing sewer gas. The success of a catch basin modification program is dependent on having catch basins with sumps deep enough to accommodate hood-type devices. A potential disadvantage of catch basin outlet modifications and other insert-type devices is the fact that retained materials could clog the outlet if cleaning is not performed frequently enough. This could result in backup of storm flows and increased street flooding. New York City has moved forward with a program to hood all of its catch basins.

Floatables Control Best Management Practices (BMPs)

BMPs such as street cleaning and public education have the potential to reduce solids and floatables in CSO. These are described in the beginning of this section.



Environmental Protection

Bending Weir Diagram

Table 7-3 provides a comparison of the floatables control technologies discussed above in terms of the effort to implement the technology, its required maintenance, effectiveness and relative cost. For implementation effort and required maintenance, technologies that require little to low effort are preferable to those requiring moderate or high effort. When considering effectiveness, a technology is preferable if the rating is high.

Table 7-3. Comparison of Solids and Floatable Control Technologies

Technology	Implementation Effort	Required Maintenance	Effectiveness	Relative Capital Cost
Public Education	Moderate	High	Variable	Moderate
Street Cleaning	Low	High	Moderate	Moderate
Catch Basin Modifications	Low	Moderate	Moderate	Low
Weir-Mounted Screens	Low	Moderate	High	Moderate
Screen with Backwash	High	Low	High	High
Fixed Baffles	Low	Low	Moderate	Low
Floating Baffles	High	Low	Moderate	Moderate
Bar Screens – Manual	Low	High	Moderate	Low
In-Line Netting	High	Moderate	High	High
End-of-Pipe Netting	Moderate	Moderate	High	Moderate
Containment Booms	Moderate	Moderate	Moderate	Moderate

7.2.10 CSO Control Technology Evaluation Summary

Table 7-4 presents a tabular summary of the results of the preliminary technology screening discussed in this section. Technologies that will advance to the alternatives development screening phase are noted under the column entitled “Retain for Consideration”. These technologies have proven successful and have the potential for producing some measurable level of CSO control for Flushing Bay. Other technologies were considered as having a positive effect on CSOs but either could only be implemented to a certain degree or could only provide a specific benefit level and, thusly, would have a variable effect on CSO overflow. For instance, DEP has implemented a water conservation program which, to date, has been largely effective. This program, which will be maintained in the future, directly affects dry weather flow since it pertains to water usage patterns. As such, technologies included in this category provide some level of CSO control but in-and-of-themselves do not provide the level of control sought by this program.

Technologies included under the heading “Consider Combining with Other Control Technologies” are those that would be more effective if combined with another control or would provide an added benefit if coupled with another control technology.

The last classification is for those technologies which did not advance through the preliminary screening process.

Table 7-4. Screening of CSO Control Technologies

CSO Control Technology	Retain for Consideration	Implemented to Satisfactory Level	Consider Combining with Other Control Technologies	Eliminate from Further Consideration
Source Control				
Public Education		X		
Street Sweeping		X		
Construction Site Erosion Control		X		
Catch Basin Cleaning		X		
Industrial Pretreatment		X		
Inflow Control				
Storm Water Detention				X
Street Storage of Storm Water				X
Water Conservation		X		
Infiltration/Inflow Reduction	X		X	
Green Infrastructure (see Sections 5.8 and 8.8)				
Sewer System Optimization				
Optimize Existing System	X			
Real Time Control	X			
Sewer Separation				
Complete Separation				X
Partial Separation	X		X	
Rain Leader Disconnection				X
Storage				
Closed Concrete Tanks	X			
Storage Pipelines/Conduits	X			
Tunnels	X			
Treatment				
Screening	X		X	
Primary Sedimentation		X		
Vortex Separator				X
High Rate Physical Chemical Treatment	X			
Disinfection			X	
Expansion/ Upgrade of WWTP	X		X	
Receiving Water Improvement				
Outfall Relocation				X
In-stream Aeration			X	
Maintenance Dredging	X			
Solids and Floatable Controls				
Netting Systems	X		X	
Containment Booms		X		
Manual Bar Screens				X
Weir Mounted Screens			X	
Fixed Baffles				X
Floating Baffles				X
Hinged Baffle (Bending Weir)	X		X	

Table 7-4. Screening of CSO Control Technologies

CSO Control Technology	Retain for Consideration	Implemented to Satisfactory Level	Consider Combining with Other Control Technologies	Eliminate from Further Consideration
Catch Basin Modifications		X		

7.3 ANALYSIS OF FEASIBLE ALTERNATIVES

The analysis of feasible alternatives will review the control technologies that were retained from Table 7-4 to "consider a reasonable range of alternatives" as expected by federal CSO policy. Full-year model simulations were performed for each engineering alternative selected, and each of these alternatives was then evaluated in terms of compliance with applicable water quality criteria, designated uses, and overall improvement from the established Baseline condition. Compliance with fish and aquatic-life uses was evaluated by comparing projected DO conditions to the applicable New York State numerical criterion. Compliance with recreational uses was evaluated by comparing projected indicator bacteria levels to New York State numerical criteria for secondary recreation. Aesthetics and riparian uses were evaluated by comparing projected levels of floatables, odors and other aesthetic conditions (based on CSO volume reduction) to narrative water quality standards.

The baseline sewer system characteristics, overflow volumes, interceptor conveyance capacity, and outfall and regulator configurations were thoroughly reviewed. From this evaluation it was determined that a number of conditions exist that could benefit from the application of CSO control technologies. Outfalls BB-006 and BB-008 combined account for most of the CSO discharge (almost 2 billion gallons of annual CSO volume), so technologies that can reduce the discharge at these outfalls would be particularly beneficial. As described below, the CSO technologies remaining after the initial screening (see Table 7-4) were further developed to determine the applicability of each to improve the conditions in the watershed.

The retained technologies, summarized below, are considered to be feasible insofar as there is no fatal flaw or obvious cost-benefit limitation, and implementation is expected to result in substantial improvements to water quality.

- *Baseline* (Section 7.3.1). The future "no build" case is not a retained technology as such because water quality goals are not currently attained. However, the Baseline serves as a metric for the other alternatives.
- *Treatment* (Sections 7.3.2, 7.3.4, 7.3.5, 7.3.9, and 7.3.10). Improvements to the Bowery Bay WWTP Headworks are ongoing to overcome limitations with treating 2XDDWF (Section 7.3.2). Additionally, HRPCT was determined to be a viable option and is explored in conjunction with other controls (Sections 7.3.4, 7.3.5, 7.3.9, and 7.3.10)
- *Sewer System Optimization* (Sections 7.3.2 through 7.3.14). During recent investigations it was discovered that planks were removed from Regulator BB-R02,

lowing the weir elevation. This weir will be restored to its original elevation and the low-lying sewers will be disconnected from the BB-HLI and diverted to the BB LLI, to maximize the wet weather capacity of the Bowery Bay WWTP (Sections 7.3.2 through 7.3.14). Additionally, a BB HLI relief sewer alternative was considered (Sections 7.3.3, 7.3.5, 7.3.8, 7.3.9 7.3.11, 7.3.12) to provide additional wet weather conveyance capacity between regulators BB-R06 and BB-R02 was evaluated. Another alternative was evaluated to divert flow from the BB HLI into the BB LLI and ultimately to the East River, which has a greater assimilative capacity than both Bowery Bay and Flushing Bay (Sections 7.3.4 and 7.3.5). Modifications to BB HLI regulators were also considered to maximize conveyance to the Bowery Bay WWTP (Sections 7.3.6 through 7.3.9 and 7.3.11 through 7.3.14).

- *Storage* (Sections 7.3.11 through 7.3.14). In-line storage and deep storage tunnel alternatives were retained to reduce discharges from BB-006 and BB-008. In-line storage within outfalls BB-006 and BB-008 (Sections 7.3.11 and 7.12) has potential based on review of the sewer system layout, as-builts, contract drawings, other documents, and drainage calculations. Deep storage tunnels were considered, as opposed to closed storage tanks, because they have an advantage where siting issues present a major challenge, such as in an urban environment. For very large volumes, they are often the only feasible approach, and were therefore used to develop alternatives to provide various level of CSO reduction in Flushing Bay. These alternatives are discussed in Sections 7.3.13 and 7.3.14.
- *Solids and Floatables Controls* (Sections 7.3.11 through 7.3.14). Screening technologies were evaluated as part of the dewatering system for the various storage alternatives considered.
- *Sewer Separation* (Section 7.3.7). High Level Sewer Separation (HLSS) is an ongoing program in DEP and was evaluated specifically for BB HLI drainage area.
- *Receiving Water Improvements (Sections 7.3.2 through 7.3.14).* Dredging was considered in the areas identified in Section 4 as having mud flats exposed at low tide.

This list of feasible alternatives retained from the preliminary screening represents a toolbox from which a suitable technology may be applied to a particular level of CSO abatement. As suggested in USEPA guidance for long-term CSO control plans, water quality modeling was performed for a “reasonable range” of CSO volume reductions, from no reduction up to 100 percent CSO abatement. The technology employed at each level of this range was selected based on engineering judgment and established principles. For example, any of the storage technologies may be employed to achieve a certain reduction in CSO discharged, but the water quality response would be the same, so the manner of achieving that level of control is a matter of balancing cost-effectiveness and feasibility. In that sense the alternatives discussed below each represents an estimate of the optimal manner of achieving that particular level of control. All elements of Alternative 1, described below, are included in each subsequent alternative. All costs presented in this section are in August 2011 dollars.

7.3.1 Baseline Conditions

The baseline conditions establish a "no build" alternative that can be used to judge the effectiveness of any proposed alternative. Baseline conditions for the Bowery Bay High Level Interceptor system were described previously in Section 3.5, and are summarized below.

1. Dry-weather sanitary sewage flow rates reflective of year 2045 population projections (89.0 MGD for BB-HLI and 37.7 MGD for BB-LLI for a total of 126.7 MGD);

2. Wet-weather treatment capacity based on hydrographs from the top ten storms as reported in the 2003 BMP report (236 MGD total flow at Bowery Bay WWTP, split as 127 MGD for the Bowery Bay High Level wet well and 109 MGD for the Low Level wet well to approximate observed flow balances).

3. Documented sediments in sewers.

Table 7-5 presents an overview of the CSO discharge volume associated with the various outfalls as well as the number of annual CSO events.

Table 7-5. Bowery Bay Discharge Summary for Baseline Conditions (1,2,3)

Combined Sewer Outfall	Water Body	Discharge Volume (MG)	Number of Annual CSO Events
BB-006	Flushing Bay	1,539	60
BB-008	Flushing Bay	559	56
BB-007	Flushing Bay	179	18
Total		**2,277**	**134**

(1) Baseline condition reflects design precipitation record (JFK, 1988), treatment plant capacity reaching 2003 sustained wet weather flow and projected sanitary flows for year 2045.
(2) Totals may not sum exactly due to rounding.
(3) Bowery Bay High Level Interceptor – Operating Capacity 127 MGD (54% of 236 MGD).

Baseline conditions for the Tallman Island sewer system were described previously in Section 3.5, and are repeated below in Table 7-6.

1. Dry-weather sanitary sewage flow rates reflect year 2045 population projections (estimated at 60 MGD);

2. Wet-weather treatment capacity of 122 MGD at the Tallman Island WWTP based on hydrographs from the top ten storms in 2003, as reported in the 2003 BMP report provided to DEC; and

3. Documented sediments in sewers.

Table 7-6. Tallman Island Discharge Summary for Baseline Conditions (1,2,3,4)

Combined Sewer Outfall	Water Body	Discharge Volume (MG)	Number of Annual CSO Events
TI-012	Flushing Bay	6	See Note 5.
TI-013	Flushing Bay	12	See Note 5.
TI-014	Flushing Bay	2	32
TI-015	Flushing Bay	1	29
TI-016	Flushing Bay	28	45
TI-017	Flushing Bay	0*	10
TI-018	Flushing Bay	2	34
Total CSO		51	NA

(1) Baseline condition reflects design precipitation record (JFK, 1988), treatment plant capacity reaching 2003 sustained wet weather flow and projected sanitary flows for year 2045.
(2) Totals may not sum exactly due to rounding.
(3) Tallman Island Operating Capacity 122 MGD.
(4) Outfalls discharging to Flushing Creek are not included; see the Flushing Creek WB/WS Facility.
(5) These discharges were all stormwater, thus the number of CSO events was zero.
* The model predicted only trace discharges, 0.4 MG, from TI-017

7.3.2 Alternative 1: Bowery Bay Upgrades, Regulator BB-R02 Modifications, Divert Low-Lying Sewers, Dredging

All of the following Flushing Bay alternatives excluding the Baseline include the elements of Alternative 1 described below.

Ongoing WWTP stabilization construction to the Bowery Bay WWTP headworks (pumps, screens, etc.) will provide for treatment of flows up to 300 MGD on a sustained basis. The cost for improving the pumping capacity is estimated to be $20 million. This upgrade is included in all of the following alternatives as the work is in progress. However, costs for this upgrade are not included in this WB/WS Facility Plan as they will be accounted for in the East River and Open Waters WB/WS Facility Plan.

Additionally, the current literature (Hazen and Sawyer 1985) shows that the weir elevation at Regulator BB-R02 located at the end of the high level interceptor has historically been at +2.50 Queens Sewer Datum (QSD). However, it has been observed during recent field inspections that stop planks have been removed, lowering the weir elevation to -1.75 and effectively reducing the amount of flow that is conveyed to Bowery Bay WWTP. Upon examination of the sewer maps, it was found that there are a few sewer segments in low-lying areas along 19th Ave and Berrian Blvd, in the vicinity of the Bowery Bay WWTP, that would be susceptible to flooding if the BB-R02 weir were raised to +2.50. After disconnecting these low-lying sewers from the BB HLI and diverting them to the BB LLI, it is recommended that this weir elevation be restored to elevation +2.50, to allow more flow to enter Bowery Bay WWTP. This modification will help to maximize the wet weather capacity of the Bowery Bay WWTP and is included in all Flushing Bay alternatives. The estimated Probable Total Project Cost

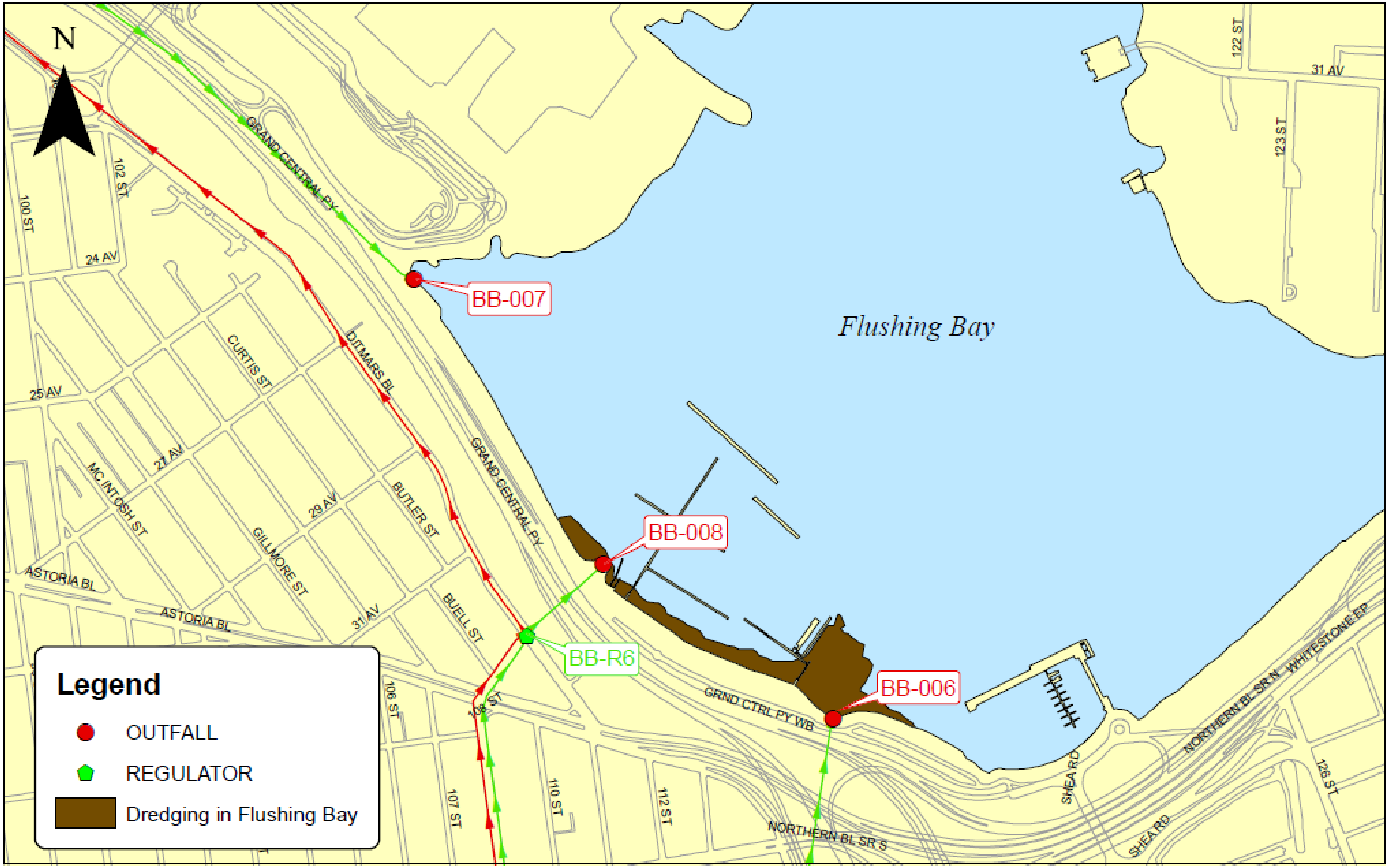
(PTPC) for raising the weir elevation at Regulator BB-R02 to +2.50 (QSD) and diverting low-lying sewers is $6.5 million.

Dredging portions of Flushing Bay has the potential to reduce hydrogen sulfide (H_2S) flux from CSO sediments in Flushing Bay, and consequently, reduce odors associated with the flux. The area of Flushing Bay to be dredged is shown in Figure 7-7, as this is the area that had previously been identified in Section 4 as having mud flats exposed at low tide. Dredging this area to 5 feet below mean lower low water (MLLW) will require the removal of 84,000 cubic yards of sediment. It is anticipated that sediments exposed after dredging will be capped to cover any exposed sediments that might be classified as Class C, per New York State DEC guidance, although the final plans will be developed during the design and permitting of such dredging options. The estimated PTPC of the dredging and capping is $48.7 million. These quantities were calculated based on Flushing Bay bathymetry that was measured in an April 2005 survey.

A summary of the cost for each component of Alternative 1, each of which is included in all subsequent alternatives, is provided in Table 7-7. The estimated Probable Total Project Cost (PTCP) for Alternative 1 is $55.4 million. No reduction in CSO is expected in Flushing Bay as a result of this alternative.

Table 7-7. Summary of Alternative 1

Component	**PTPC ($ Million)**
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
Total	**$55.4**



Environmental Protection

Flushing Bay Waterbody/Watershed Facility Plan

Dredging in Flushing Bay

FIGURE 7-7

7.3.3 Alternative 2: 8-foot Diameter Relief Pipe for BB HLI

According to initial hydraulic analyses, a section of the BB HLI downstream of regulator BB-R05 has limited capacity due to its mild slope. This causes the hydraulic grade line to back up considerably during wet weather events, thereby limiting the amount of wet weather flow that can be conveyed to the Bowery Bay WWTP for primary treatment. Increasing the capacity of the BB HLI would increase the flow to the Bowery Bay WWTP, and possibly decrease the overflow volumes at the Flushing Bay CSO outfalls.

In order to improve the high level interceptor conveyance downstream of regulator BB-R05, an 8-foot diameter relief pipe (approximately 17,000 linear feet) to provide additional wet weather conveyance capacity between regulators BB-R06 and BB-R02 was evaluated. A plan view of the portion of the BB HLI requiring the proposed 8-foot diameter relief pipe is shown in Figure 7-8. This section of interceptor is capable of conveying 143 MGD to the WWTP. The probable total project cost of this 8-foot diameter relief pipe is $367.6 million. This additional section of piping would increase the ability of the BB HLI to deliver flow to the WWTP, thereby reducing CSO to Flushing Bay. Including the PTPC of Alternative 1, which includes raising the weir at BB-R02, diverting the low lying sewers ($6.7 million), and dredging ($48.7 million), the estimated PTPC of this alternative is $423.0 million. The estimated reduction in CSO is 16 percent. A summary of the cost for each component of Alternative 2 is provided in Table 7-8.

Table 7-8. Summary of Alternative 2

Component	**PTPC ($ Million)**
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
8-foot Diameter Relief Pipe	$367.6
Total	**$423.0**

7.3.4 Alternative 3: Divert Flow from HLI to LLI, HRPCT for LLI

The CSO regulators on the BB LLI discharge to the East River, while the CSO regulators on the BB HLI discharge to Bowery Bay and Flushing Bay. Optimization of the existing system and addition of a new conveyance pipe could be utilized to connect the high level collection system to the low level collection system near the Bowery Bay WWTP. This would permit flow to be diverted from the BB HLI into the BB LLI and ultimately to the East River which has a greater assimilative capacity for CSO discharges than both Bowery Bay and Flushing Bay.

This alternative evaluated the effects of diverting flow from the BB HLI into the BB LLI via a diversion sewer between the two interceptor systems. One scheme examined was to install a throttling gate on BB LLI and close it during wet weather to preferentially accept additional wet weather flow from the BB HLI through a diversion sewer. This throttling gate would limit flow in the BB LLI to 50 MGD, down from a normal wet weather maximum of 138 MGD (46 percent of 300 MGD). However, analyses indicated that such a throttling gate would cause 46 percent and 16 percent increases in the annual CSO overflow volumes to Newtown Creek and Dutch Kills, respectively. Considering that Newtown Creek and Dutch Kills are already impacted by CSOs, an increase in untreated CSO to these water bodies was considered unacceptable and this scheme was rejected.

A second scheme was developed wherein excess flow from BB LLI is diverted to an HRPCT process rather than to Newtown Creek and Dutch Kills. The following configuration was used to prevent increases in CSOs from BB LLI due to the restriction at the throttling gate:

- Build a diversion structure and a 6-foot diameter, 300-foot long sewer on the BB HLI to divert flows in excess of 163 MGD to the BB LLI. This diversion structure would tie into a junction chamber and energy dissipating structure on the BB LLI (probable total project cost for sewer and diversion structure of $17.6 million).

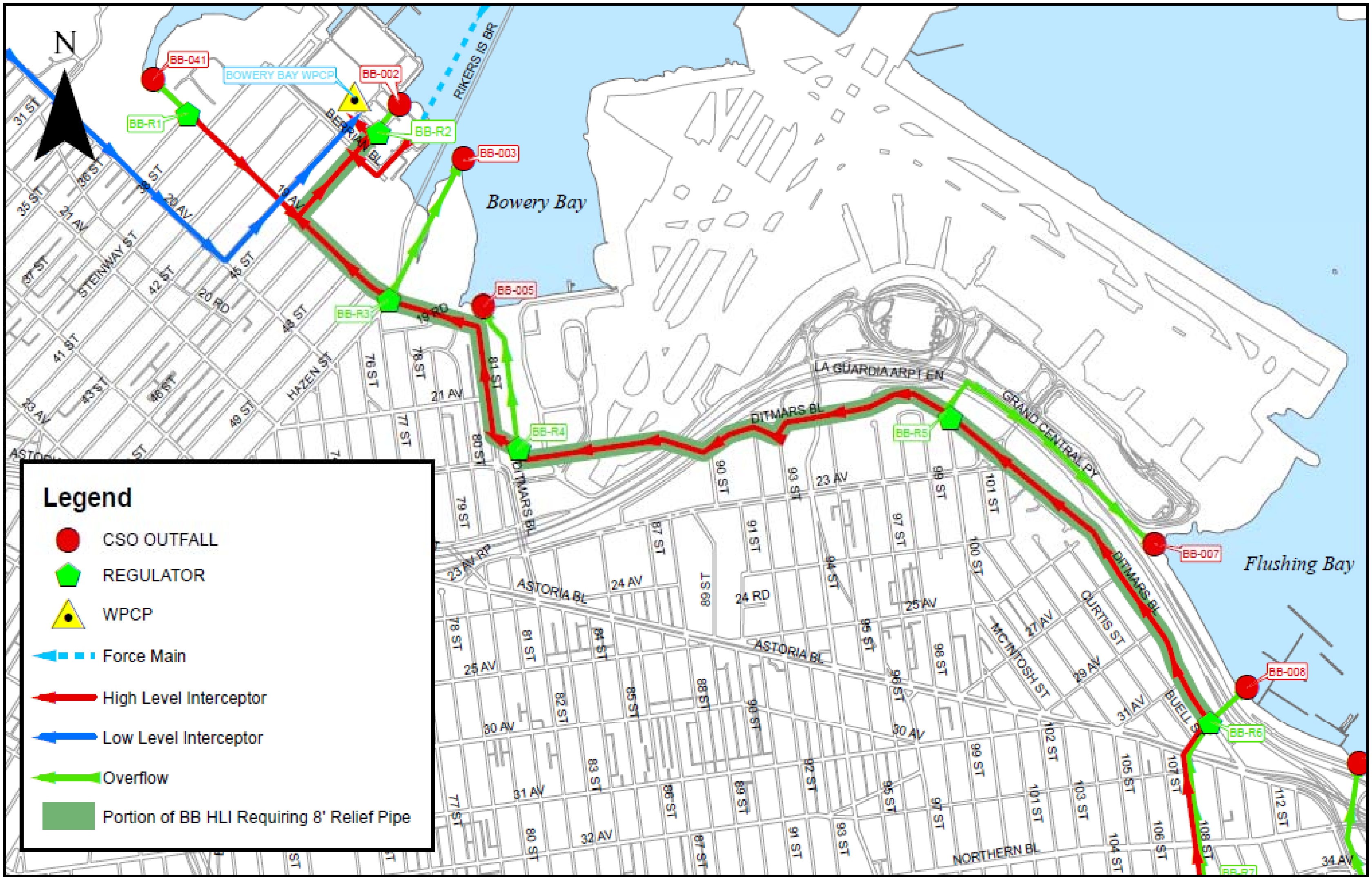
- Build a throttling gate on the BB LLI and on the BB HLI (PTPC $20.8 million).

- Build a diversion structure and a 10.5-foot diameter, 100-foot long sewer (PTPC $10.6 million) on the BB LLI near 23rd St and 20th Ave to divert BB LLI flows in excess of 50 MGD to an HRPCT system on the existing industrial site presently occupied by the Astoria Generating facility. Include a weir to limit the flow entering the Low Level wet well to 50 MGD.

The hydraulic analyses indicated that the diversion structure and the HRPCT system should be sized to handle 161 MGD. A plan view of this proposed configuration is shown in Figure 7-9. It was estimated that a 162 MGD HRPCT (based on the Actiflo system) and a 162 MGD pumping station for the HRPCT would cost $1,582.4 million. Including the cost of Alternative 1, the estimated PTPC of this alternative is $1,686.8 million. A summary of the cost for each component of Alternative 3 is provided in Table 7-9. No reduction in CSO is expected in Flushing Bay as a result of this alternative.

Table 7-9. Summary of Alternative 3

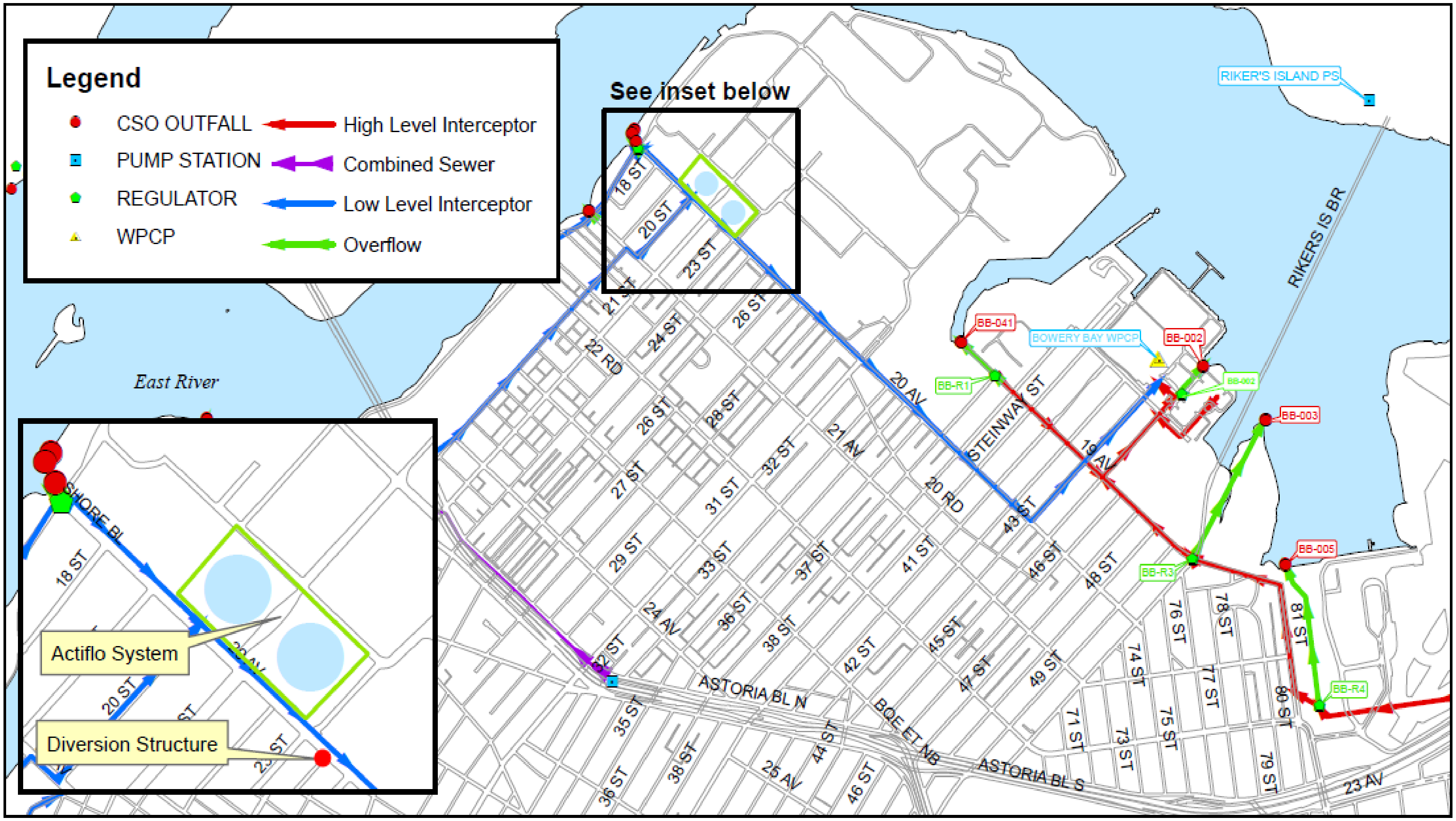
Component	**PTPC ($ Million)**
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
6-foot Diameter Diversion Sewer and Related Structures	$17.6
Throttling gates at BB LLI and BB HHI	$20.8
10.5-foot Diameter Diversion Sewer	$10.6
162 MGD HRPCT and Pumping Station	$1,582.4
Total	**$1,686.8**



Environmental Protection

Relief Sewer Between Regulators BB-R06 and BB-R02

FIGURE 7-8



NYC Environmental Protection

Diversion Structiure on LLI For Actiflo System

7.3.5 Alternative 4: 8-foot Diameter Relief Pipe, Divert Flow from HLI, HRPCT for LLI and HLI

This alternative includes the elements of Alternatives 2 and 3, and also includes the diversion of overflow from the 8-foot diameter Relief Pipe on the High Level Interceptor system, to an HRPCT system. According to hydraulic analyses, this alternative requires the additional diversion of up to 50 MGD of flow from the High Level Interceptor system, thus requiring a total HRPCT system capacity of 211 MGD. The Alternative 3 diversion structure connecting the High Level Interceptor to the Low Level Interceptor would be modified to also divert flow into a new 60-inch diameter, 6,500-foot long diversion sewer that would convey flow to the HRPCT. The cost of this 60-inch diversion sewer and the associated diversion structure is $87.6 million. The probable total project cost of a 211 MGD HRPCT system (based on the Actiflo system) and 211 MGD pumping station is $1,824.9 million. Including the cost of the other elements from Alternatives 2 and 3 (shown in the table below), the estimated PTPC of this alternative is $2.356 billion. The estimated reduction in CSO is 16 percent. A summary of the cost for each component of Alternative 4 is provided in Table 7-10.

Table 7-10. Summary of Alternative 4

Component	PTCP ($ Million)
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
6-foot Diameter Diversion Sewer and Related Structures	$17.6
8-foot Diameter Relief Pipe	$338.9
60-inch Diameter Sewer and Diversion Structure	$87.6
10.5 ft Dia Diversion Sewer	$10.6
Throttling gates at BB LLI and BB HHI	$20.8
211 MGD HRPCT and Pumping Station	$1,824.9
Total	**$2,355.8**

7.3.6 Alternative 5: Regulator Modifications

Several regulators within the Bowery Bay sewer system have side overflow weirs to relieve wet weather flow when the water surface exceeds the elevation of these weirs. These regulators could be reconstructed to accommodate modifications that would maintain more flow in the BB HLI to be conveyed to the Bowery Bay WWTP. Modification of these weirs could be accomplished in a number of ways, including:

- Raising the fixed weir crest elevation and lengthening proportionally to maintain capacity;

- Installing either flexible plate or rigid plate bending weirs in the Bowery Bay system to achieve in-line storage during storm events and to divert combined sewage from smaller rainfall events to the Bowery Bay WWTP for treatment. These weirs have the effect of raising the weir height during smaller storms while they “bend” out of the way to pass larger overflows. The bending weir devices are available from a number of manufacturers, each with a somewhat different configuration and operating principle.

A detailed analysis completed in May 2011 evaluated optimizing regulator improvements within the Bowery Bay HLI by identifying critical regulators and refining the scope of work to be performed at each selected location. A critical requirement of each evaluated alternative was the avoidance of elevating the hydraulic grade line (HGL) in the sewers under the 5-year storm condition specified by the DEP "drainage plan" criteria. Based on the analysis of a number of different improvement scenarios, it was determined that the most cost-effective solution included the installation of bending weirs at six key Bowery Bay HLI regulators, The locations of the key regulators that would be modified are shown in Figures 7-10 and 7-11. Table 7-11 lists the regulators and describes the improvements proposed at each regulator.

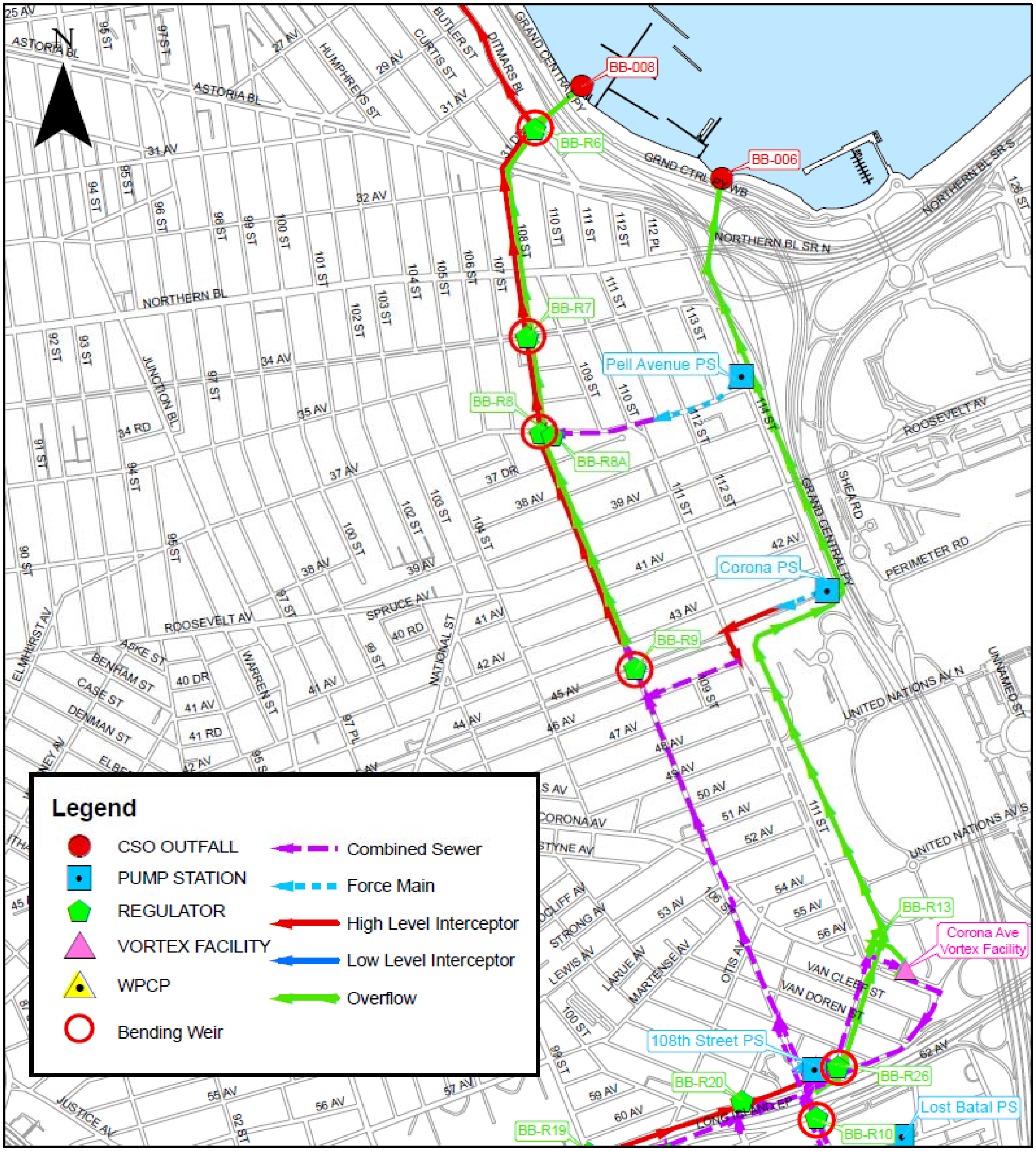
Table 7-11. Proposed Bowery Bay HLI Regulator Modifications

Regulator	Improvement Description
BB-4	Installation of a rigid bending weir on top of a new 10" vertical extension (wood planks removed)
BB-5	Installation of a flexible bending weir on top of a lowered weir crest and downstream step
BB-6	Installation of a flexible bending weir on top of a lowered weir crest and downstream step with reduced width
BB-9	Customized installation of a flexible bending weir in conjunction with the expansion of the regulator and modifications to the east-west weir
BB-10	Installation of a rigid bending weir on top of the existing fixed weir crest
24th Ave Weir	Customized installation of a flexible bending weir on a support cantilevered from the existing fixed weir of the DWF diversion channel

The total PTCP for the regulator modifications is $17.1 million. Including the costs of the elements of Alternative 1, the estimated PTPC of this alternative is $72.5 million. The estimated reduction in CSO is 19 percent. A summary of the cost for each component of Alternative 5 is provided in Table 7-12.

Table 7-12. Summary of Alternative 5

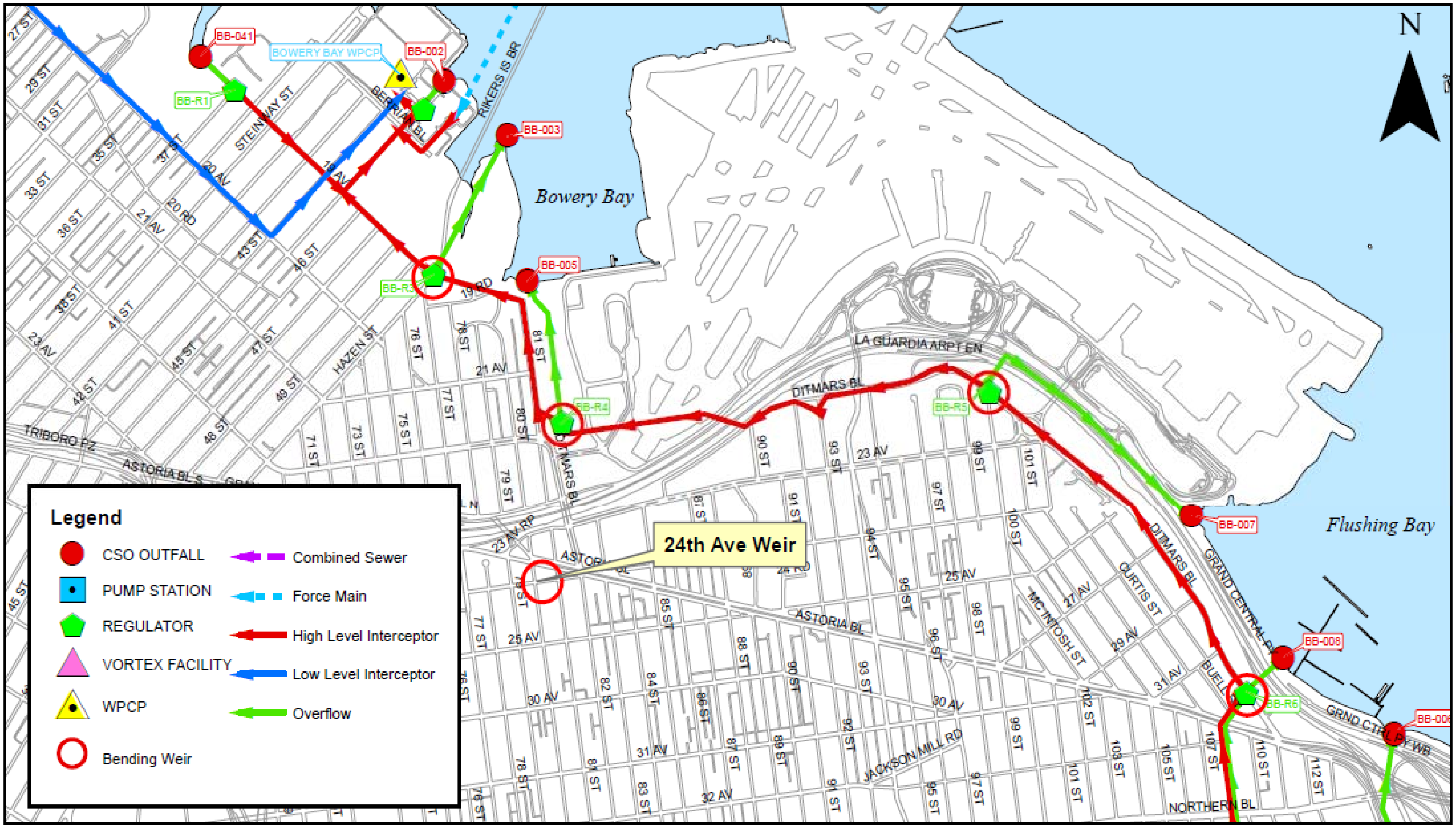
Component	**PTPC ($ Million)**
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
Weir Modifications	$17.1
Total	**$72.5**



1 inch = 1, 250 feet

Environmental Protection

Bowery Bay Regulator Bending Weir Installations (Sheet 1 of 2)



Bowery Bay Regulator Bending Weir Installations (Sheet 1 of 2)

7.3.7 Alternative 6: Alternative 5 and High Level Sewer Separation

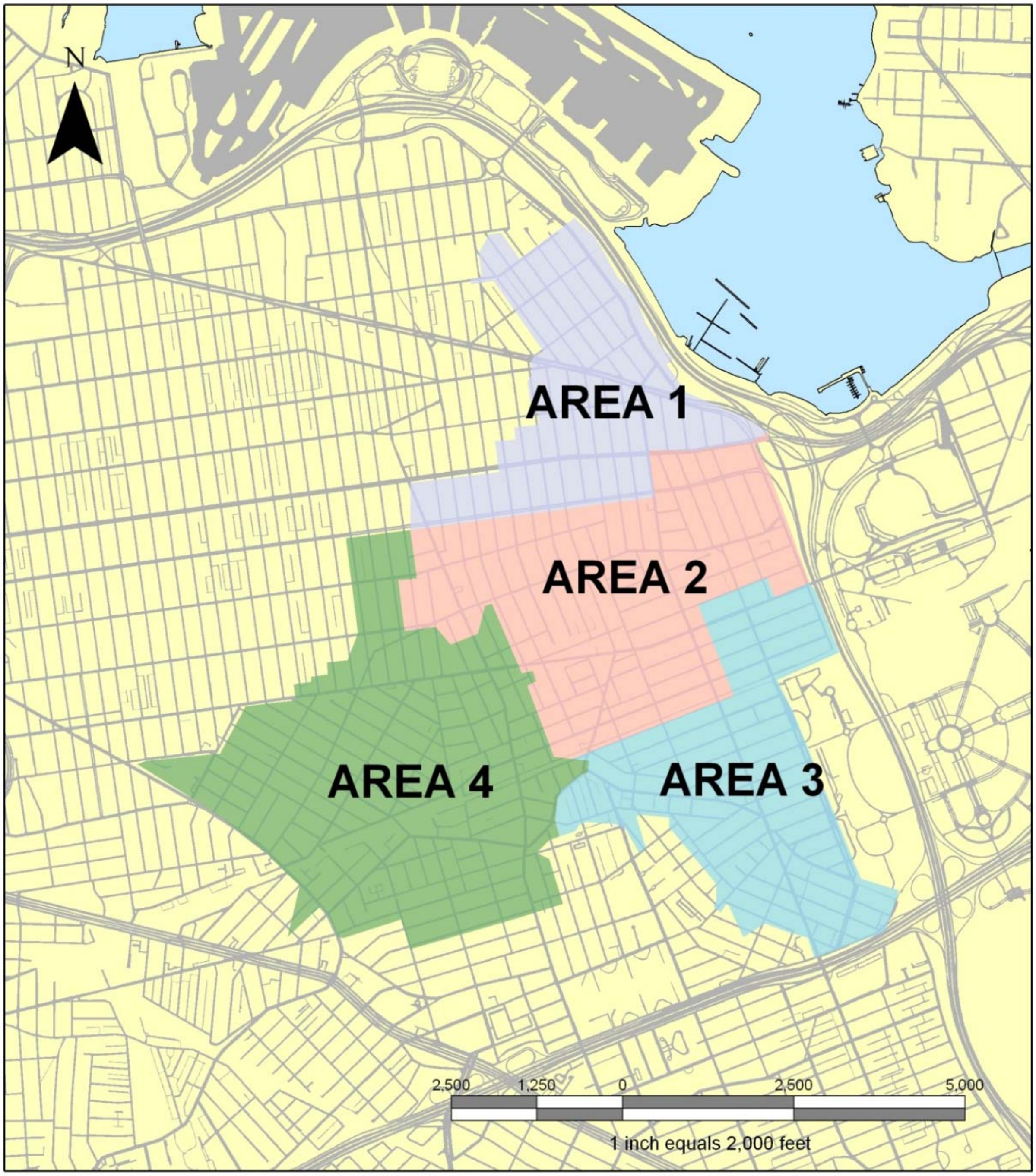
The City of New York is expecting to continue its program of high level sewer separation to improve the overall level-of-service. Both PlaNYC and the Green Infrastructure Plan submitted by the City consider HLSS as an integral component to cost-effective water quality improvements, and HLSS is therefore retained for further consideration.

To simulate HLSS in detail, GIS data was used to determine the area within each model subcatchment that is composed of property lots as defined by the Department of City Planning, then assuming that the "non-lot areas" would constitute the streets and sidewalks that would no longer contribute runoff to the combined sewers. Both the total subcatchment area and the percent impervious were recomputed and the model was rerun with the adjusted runoff properties.

The areas targeted are shown in Figure 7-12. The area immediately adjacent to Flushing Bay and extending southward into Queens was targeted first, with each successive alternative having area further from Flushing Bay added, similar to how HLSS would be built out in reality. CSO reductions are shown in Table 7-13.

Table 7-13. Estimated CSO Reduction from Detailed HLSS Alternatives (MG/yr)

Alternative	Sewer Separation	Area (acres)	Cost ($M)	CSO Reduction BB-wide	CSO Reduction Flushing Bay	Estimated Construction Timeframes
6A	**Area 1**	222	$61.2	93	40	Drainage Plan: 1 yr Design: 1 yr Construction: 5 yrs
6B	**Areas 1&2**	563	$154.9	177	121	Drainage Plan: yrs Design: 2 yrs Construction: 10.5 yrs
6C	**Areas 1 to 3**	834	$229.5	274	197	Drainage Plan: 2 yr Design: 3 yr Construction: 15 yr
6D	**All 4 Areas**	1,278	$351.4	405	311	Drainage Plan: 2 yr Design: 4 yr Construction: 20 yr



Environmental Protection

Flushing HLSS Area Delination

Each of the separation areas listed above were evaluated in combination with the elements of Alternative 5. Table 7-14 provides a summary of the estimated PTPCs for Alternatives 6A-6D and the associated CSO reduction for each.

Table 7-14. Summary of Alternatives 6A-6D

Parameter	Alternative 6A: Alternative 5 & HLSS in Area 1	Alternative 6B: Alternative 5 & HLSS in Areas 1 & 2	Alternative 6C: Alternative 5 & HLSS in Areas 1, 2, & 3	Alternative 6D: Alternative 5 & HLSS in All 4 Areas
% CSO Reduction in Flushing Bay	21%	25%	28%	33%
Dredging PTPC ($ Million)	$48.7	$48.7	$48.7	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers ($ Million)	$6.7	$6.7	$6.7	$6.7
Regulator Modifications ($ Million)	$17.1	$17.1	$17.1	$17.1
HLSS	$61.2	$154.9	$229.5	$351.4
Total PTPC ($ Million)	**$102.8**	**$196.5**	**$271.1**	**$393.0**

The anticipated schedule requirements for the Flushing Bay WB/WS Facility Plan do not allow adequate time to fully build out HLSS in the local area. Therefore, HLSS will be deferred to the LTCP phase for this waterbody.

7.3.8 Alternative 7: 8-foot Diameter Relief Pipe and Regulator Modifications

This alternative evaluates the effects of combining the elements of Alternatives 2 and 5 to further increase capacity of the BB HLI. Combined with the cost of Alternative 1, the estimated PTPC of this alternative is $505.8million. The estimated reduction in CSO is 33 percent. Table 7-15 provides a summary of the PTPC for Alternative 7.

Table 7-15. Summary of Alternative 7

Component	PTPC ($ Million)
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
8-foot Diameter Relief Pipe	$360.8
Regulator Modifications	$17.1
Total	**$505.8**

7.3.9 Alternative 8: Alternative 7 and Divert Flow from HLI to LLI, HRPCT for LLI

This alternative combines elements of Alternative 7 (the 8-foot diameter relief pipe and regulator modifications) with the elements of Alternative 3 (diverting flow from HLI to LLI and the addition of the Actiflo system for BB LLI). Combined with the cost of Alternative 1, the estimated PTPC of this alternative is $2,064.7 billion. The estimated reduction in CSO is 33 percent. Table 7-16 provides a summary of the estimated PTPC for Alternative 8.

Table 7-16. Summary of Alternative 8

Component	PTPC ($ Million)
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
6-foot Diameter Diversion Sewer	$17.6
Throttling gates at BB LLI and BB HHI	$20.8
10.5-foot Diameter Diversion Sewer	$10.6
162 MGD HRPCT and Pumping Station	$1,582.4
8-foot Diameter Relief Pipe	$360.8
Regulator Modifications	$17.1
Total	$2,064.7

7.3.10 Alternative 9: Convey BB-006 and BB-008 to HRPCT System

As outfalls BB-006 and BB-008 account for 98 percent of the overflow volume directly entering Flushing Bay, this alternative considered conveying these CSOs via a 22,000-foot long, 10-foot diameter tunnel to an HRPCT system that would be sited at the existing industrial site presently occupied by the Astoria Generating facility. According to initial hydraulic modeling results, the peak flow rates at BB-006 and BB-008 are approximately 1,100 and 450 MGD, respectively. These high peak flow rates make HRPCT a viable alternative. The estimated PTPC of the tunnel, pumping station, 345 MGD HRPCT system, and Alternative 1 elements is $3.752 billion. The estimated reduction in CSO is 90 percent. Table 7-17 provides a summary of the estimated PTPC for Alternative 9.

Table 7-17. Summary of Alternative 9

Component	PTPC ($ Million)
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
Tunnel, 345 MGD HRPCT, 345 MGD pumping station – combined	$3,716.0
Total	$3,771.4

7.3.11 Alternative 10: Alternative 7 and Outfall Storage at BB-006 and BB-008

The large cross sectional area and significant length of the outfall sewers for BB-006 and BB-008 provide an excellent opportunity for storage within the outfall barrels. This would be achieved by placing inflatable dams, discussed under real time control in Subsection 7.2.4., at the downstream end of the barrels and using small pump stations constructed adjacent to the inflatable dams for dewatering at the end of each rainfall event. This alternative included inflatable dams in the following locations:

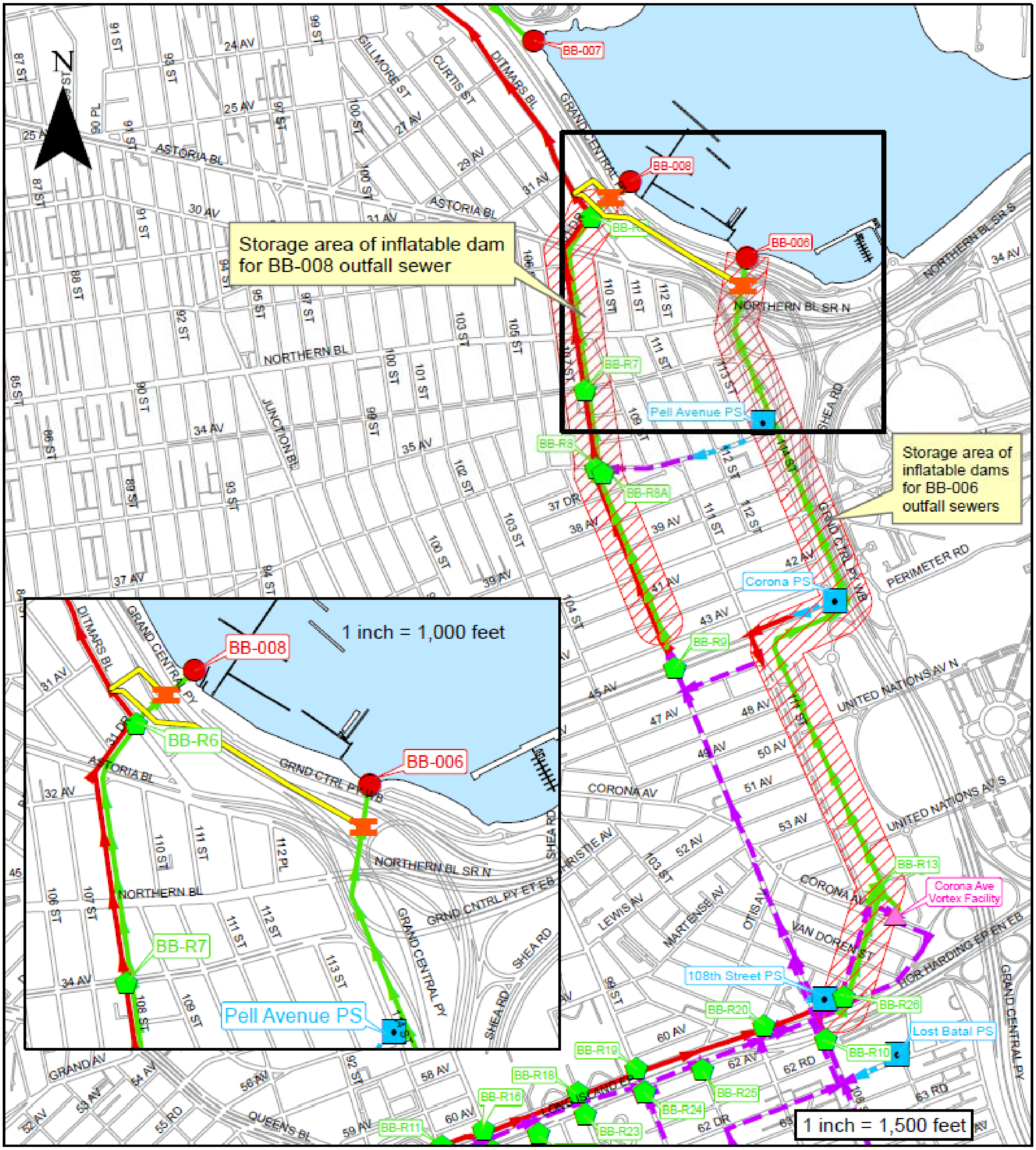
- The 7,000-foot long, 22-foot x 8.5-foot lower level of the outfall sewer for BB-006, provides 6.5 MG of conduit storage between the overflow point at the bay and the CAVF. The use of this outfall for CSO storage would interfere with the operation of the CAVF, thus the CAVF would have to be taken out of service before the inflatable dams could be installed. Further, with the removal of the CAVF some additional sewer system improvements (weirs, sewers) will be required to convey sanitary flow to the 108 Street Pump Stations.

- The 8,400-foot long, 22-foot x 10-foot barrel of the upper level of the outfall sewer for BB-006, provides 7.8 MG of conduit storage up to regulator BB-R10. This alternative includes construction of a second outfall barrel to provide for additional 7.8 MG of conduit storage of combined sewage.

- The 5,400-foot long, 12.5-foot outfall sewer for BB-008, to provide 2 MG of conduit storage up to regulator BB-R09.

The stored volume (a maximum of 24.1 MG) behind the inflatable dams would be pumped into the Bowery Bay High Level Interceptor after the storm event. Small dewatering and screening facilities would need to be installed adjacent to the inflatable dams to dewater the outfall barrels and remove retained floatables. The inflatable dam locations are shown in Figure 7-13. A typical profile view of one of the three installations (for BB-006 lower level) is shown in Figure 7-14. In addition, the installations would require floatables control facilities to remove floatables that would otherwise be discharged to the receiving water when the inflatable dams deflate. These floatables control facilities would replace the existing floating booms because (1) the booms are located with the waterbodies near the marinas whereas the netting structures would be built into the outfall structures, thereby less of a visual impairment (2) the floatables control facilities would be more effective at floatables retention (95% vs. 75%), and (3) the booms were installed as interim facilities until more substantial facilities could be constructed. A diagram of a typical screening facility and a typical end-of-pipe floatables control facilities is shown in Figure 7-15.

The estimated costs of the inflatable dams, pumps, screening facilities, and end-of-pipe floatables control facilities are $215.7 million and $73.8 million for BB-006 and BB-008, respectively. The estimated cost of access and maintenance shafts required for the cleaning of accumulated debris in the outfall sewers is $37.7 million. In addition, the estimated cost of the new 22-foot x 10-foot barrel for BB-006 is $478.0 million. Including the cost of the 8-foot diameter relief pipe, the regulator modifications, the decommissioning of the CAVF, the construction of a new diversion sewer and structure from the CAVF to the 108th St Pumping Station, and Alternative 1 the estimated PTPC of this alternative is $1.245 billion. The estimated reduction in CSO is 60 percent. Table 7-18 provides a summary of Alternative 10.

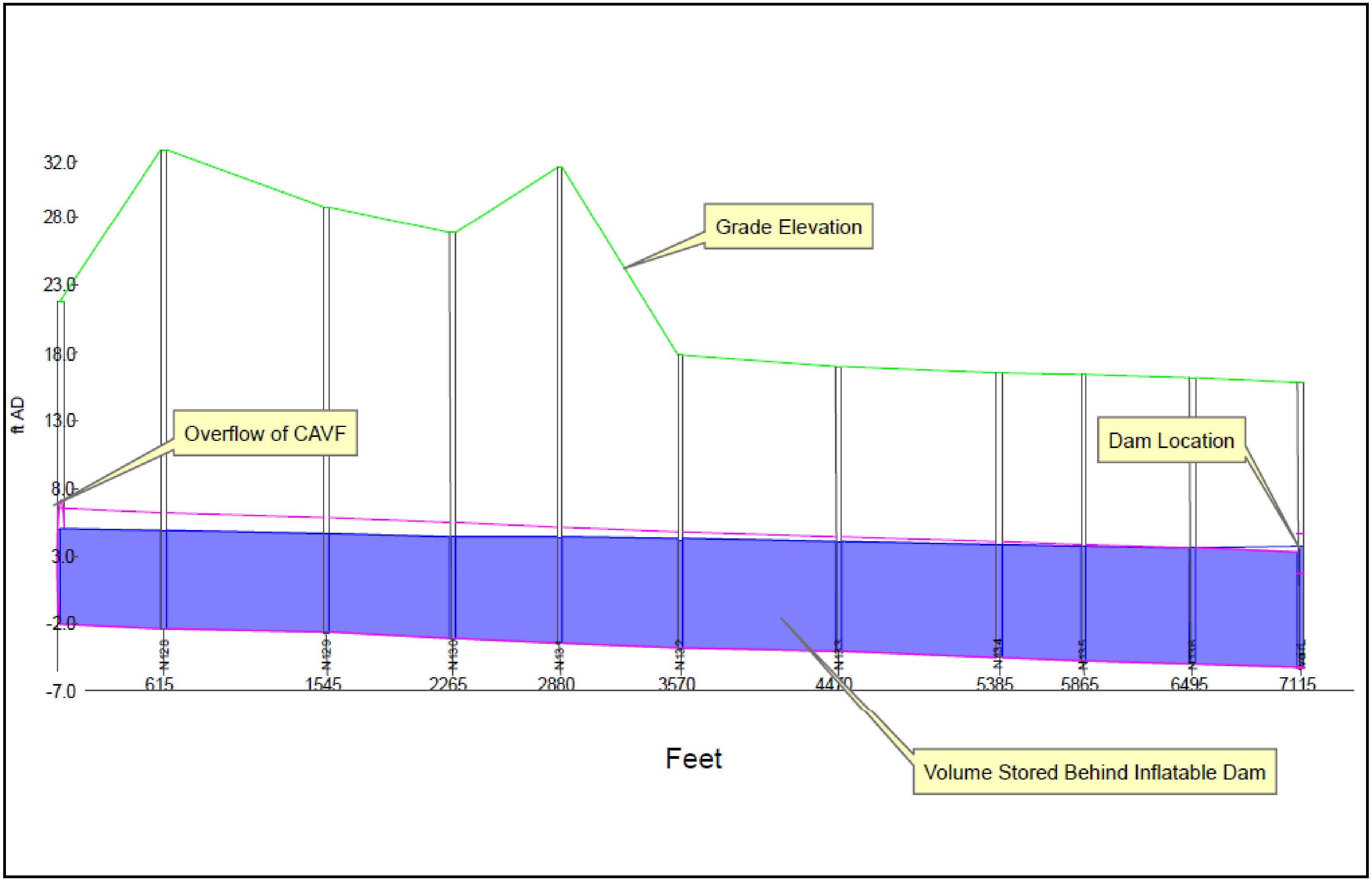


Legend

- Dams
- Dam Dewatering
- Inflatable Dam Storage
- Outfall
- Pump Station
- Vortex Facility
- Regulator
- Combined Sewer
- Force Main
- High Level Interceptor
- Low Level Interceptor
- Overflow

Environmental Protection

Bowery Bay
Inflatable Dam Installations

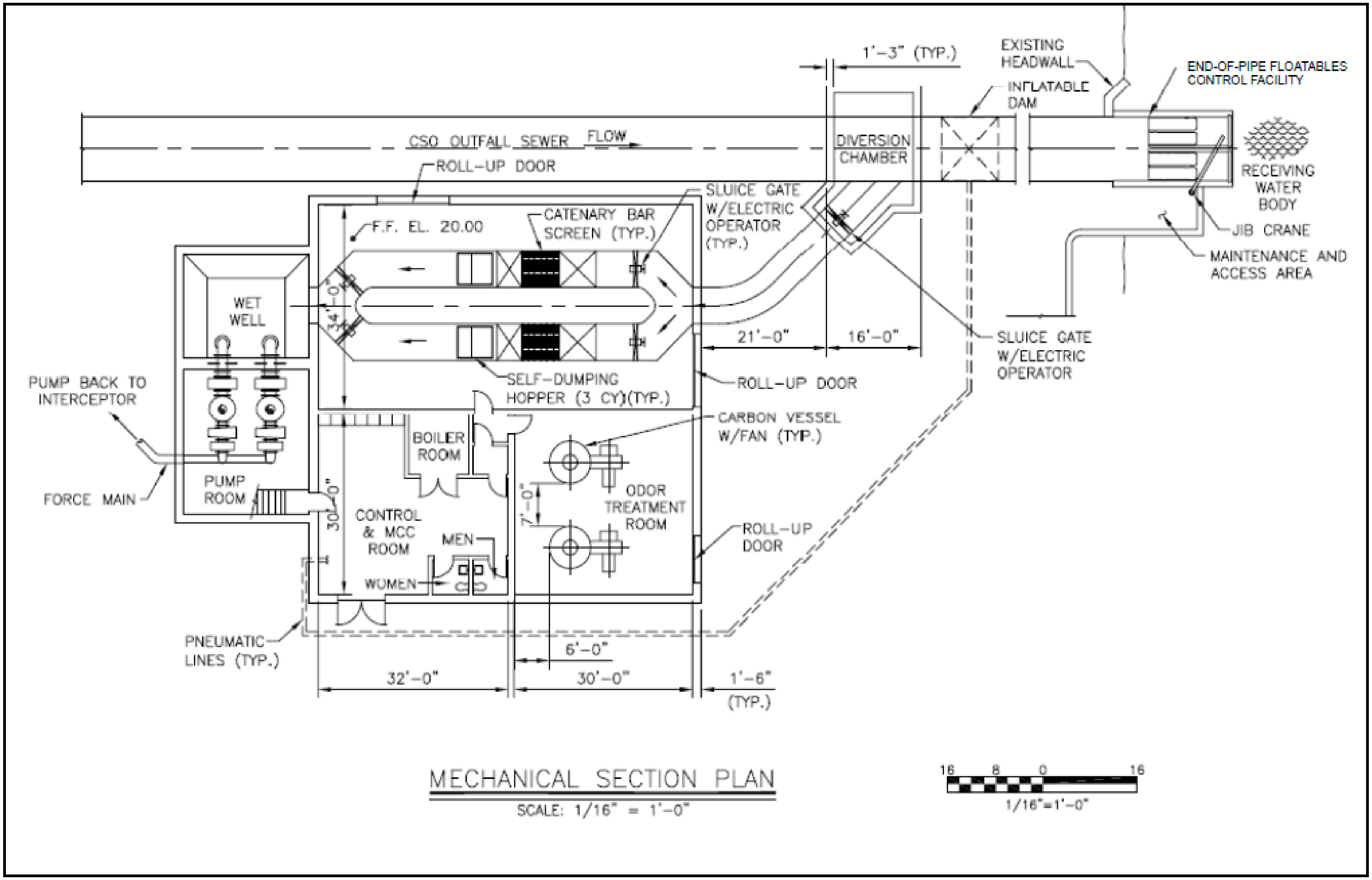


Environmental Protection

Profile for Inflatable Dam For BB-006 Lower Level

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE 7-14



Environmental Protection

Screening Facilities for Inflatable Dams

Table 7-18. Summary of Alternative 10

Component	PTPC ($ Million)
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
8-foot Diameter Relief Pipe	$360.8
Regulator Modifications	$17.1
Decommission CAVF	$6.2
Inflatable Dam, Pumps, Screening and Floatables Control Facilities at BB-006	$215.7
Inflatable Dam, Pumps, Screening and Floatables Control Facilities at BB-008	$73.8
Access and Maintenance Shafts, BB-006 and BB-008	$37.7
22-ft x 10-ft Barrel at BB-006	$478.0
Total	$1,244.7

7.3.12 Alternative 11: Alternative 10 Without Additional Storage

This alternative is identical to Alternative 10, but excludes the construction of a new 22' x 10' barrel for outfall BB-006. As the cost of constructing this new barrel comprised almost half the cost of Alternative 10, it was decided to evaluate the marginal benefit of including this new barrel. For this alternative, the cost of the inflatable dams, pumps, screening facilities, and end-of-pipe floatables control facilities systems for BB-006 is $183.2 million, as excluding the new barrel will require a smaller pumping station, force main, and screening facility. This alternative also includes the cost of access and maintenance shafts for the outfall sewers ($37.7 million). The estimated PTPC of this alternative is $734.2 million. Table 7-19 provides a summary of the PTPC for Alternative 11. The expected reduction in CSO is 53 percent.

Table 7-19. Summary of Alternative 11

Component	PTPC ($ Million)
Dredging	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers	$6.7
8-foot Diameter Relief Pipe	$360.8
Regulator Modifications	$17.1
Decommission CAVF	$6.2
Inflatable Dam, Pumps, Screening and Floatables Control Facilities at BB-006	$183.2
Inflatable Dam, Pumps, Screening and Floatables Control Facilities at BB-008	$73.8
Access and Maintenance Shafts, BB-006 and BB-008	$37.7
Total	$734.2

Variations of this alternative, with 10' and 12' relief sewers instead of an 8-foot diameter relief sewer, were evaluated. However, the incremental CSO reduction achieved was minimal, as the Bowery Bay WWTP would not have the capacity to treat the additional flow. Therefore, the use of these larger relief sewers was ruled out.

7.3.13 Alternatives 12-14: Loop Storage Tunnels for BB-006 and BB-008

Outfalls BB-006 and BB-008 combined account for over 2 billion gallons of annual CSO volume to Flushing Bay making storage a worthwhile consideration. Large reductions in CSO overflows to the Bay could be obtained through either offline storage in a CSO retention facility similar to that being constructed for outfall TI-010 or through the use of a storage tunnel. After an extensive review of the properties surrounding Flushing Bay and close to the outfalls (BB-006 and BB-008) that would be the primary focus of the alternative plans, the use of an offline retention facility was eliminated because there are no large parcels of land that would be suitable for such a facility. Consequently, tanks similar to the recently completed Flushing Creek Retention Facility would be difficult to site and, therefore, infeasible. Storage in tunnels is a viable option, however, because tunnels could be located hundreds of feet below ground. A number of storage tunnel alternative plans were devised and evaluated for Flushing Bay.

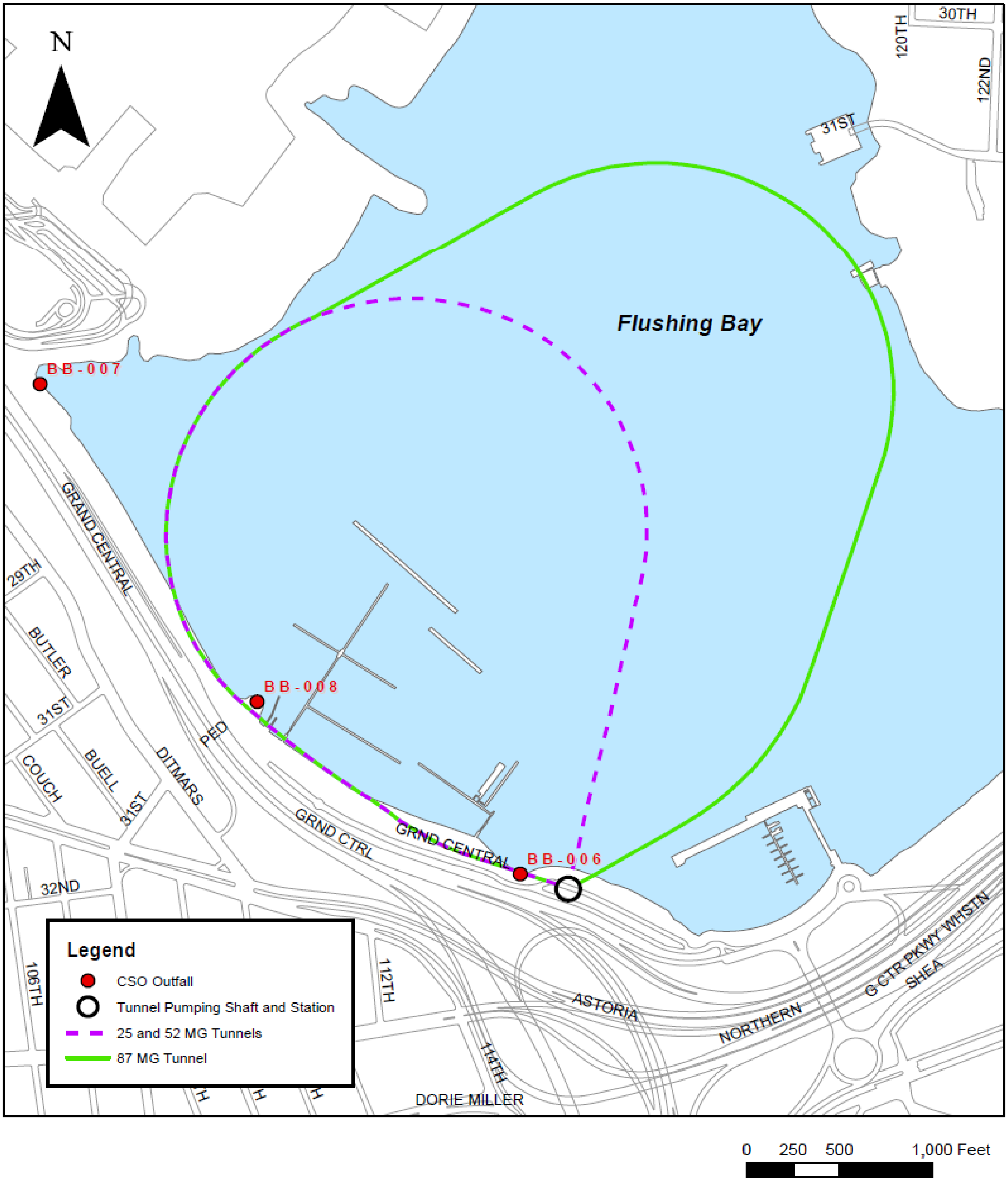
Tunnels to remove 50, 70, and 85 percent of the annual CSO volume from outfalls BB-006 and BB-008 were evaluated. The proposed alignments of these tunnels are shown in Figure 7-16. The pumping station, shaft, and process equipment building would be sited at the location shown in the figure. The pumping station would be sized to dewater the entire tunnel to the BB HLI, via a force main, within 24 hours. Dewatering rates for the tunnel were limited by assuming the WWTP could accept no more than 1.5 times DDWF. The simulated pumping rate was constrained to account for dry weather flows during the dewatering period. In addition, a lag period was included between the end of the storm event and the start of dewatering in order to allow the WWTP to recover from the storm event. The 24 hour dewatering period does not start until after this lag period.[1]

These alternatives also included the regulator modifications as described in Alternative 7, as they can maintain more flow in the interceptor. Also included are the end-of-pipe floatables control facilities for BB-006 and BB-008, and Alternative 1 elements.

The tunnel for Alternative 12 is designed to capture approximately 50 percent of the CSO from BB-006 and BB-008. Based on the hydraulic analysis, the required tunnel volume would be approximately 25 million gallons. The combined PTPC for this alternative is $1,008.4 million as shown in Table 7-21. The final analysis indicates an estimated 52 percent reduction in CSO.

Alternative 13 would require approximately 52 million gallons of storage to produce a 70 percent reduction in CSO. The proposed alignment is similar to Alternative 12 but would extend further into the Bay and would require a larger diameter tunnel. The pumping station, shaft, and process equipment building would be sited at the same locations shown in Figure 7-16. The combined PTPC for this alternative is $1,276.8 million as shown in Table 7-21.

[1] The WB/WS Facility Plan provides a roadmap for the development of the facilities. However, actual operating pumping rates may differ from the assumed values. The maximum flow to the WPCP is a wet weather operating plan (WWOP) issue. The final tunnel dewatering rates would be determined as any new facilities are factored into the Wet Weather Operating Plan.



Environmental Protection

Conceptual Level Flushing Bay Tunnel Alignment

The tunnel for Alternative 14 was designed to capture approximately 80 percent of the total CSO discharged into Flushing Bay. The tunnel volume would increase to 87 MG. alignment of this tunnel is identical to Alternative 10 but requires a larger diameter to obtain the desired percent capture. Locations of the tunnel pumping station, shaft, and process equipment building would be sited at the same locations shown in Figure 7-16. The combined estimated PTPC for this alternative is $1,546.1 million as summarized in the Table 7-20. The final analysis indicates an estimated reduction in CSO is 83 percent.

Table 7-20. Summary of Alternatives 12 - 14

Component			
	Alt. 12	**Alt. 13**	**Alt. 14**
Number of Events per Year from BB-006 and -008	19	13	7
% CSO Reduction in Flushing Bay	52%	70%	83%
Tunnel Volume (MG)	25	52	87
Dredging (PTPC $ Million)	$48.7	$48.7	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers (PTPC $ Million)	$6.7	$6.7	$6.7
Regulator Modifications (PTPC $ Million)	$17.1	$17.1	$17.1
Tunnel and Dewatering Facility (PTPC $ Million)	$872.3	$1,140.7	$1,410.0
Floatables Control Facilities (PTPC $ Million)	$63.6	$63.6	$63.6
Total (PTPC $ Million)	**$1,008.4**	**$1,276.8**	**$1,546.1**

7.3.14 Alternatives 15-18: Tunnels for BB-006 and BB-008 with Potential Expansion to Flushing Creek

A series of tunnels was also designed to limit the number of CSO events from BB-006 and BB-008 to eleven, seven, three and zero events per year. The primary purpose of this alternative is to reduce overflows to the Inner Flushing Bay to the maximum extent possible by routing them to a new storage tunnel. These tunnels and dewatering arrangement would also be suitable for a secondary purpose, namely extension to Flushing Creek in order to capture overflows from that watershed. Consequently, the tunnels were designed to correspond to the preferred tunnel configuration from the Flushing Creek WB/WS Facility Plan (i.e., Flushing Creek Tunnel B, which captures overflows from Tallman Island outfalls TI-010, TI-011 and TI-022). Tunnels were sized to accommodate the needs of a combined Bay/Creek tunnel. Conceptually, the tunnel would be built in two phases, with Phase I handling Flushing Bay outfalls and Phase II extending to Flushing Creek outfalls. Behavior of the tunnel was modeled to include the influence of the Flushing Creek outfalls. However, for the purpose of the Flushing Bay WB/WS Facility Plan, cost evaluations will be limited to the Phase I portion of the tunnel serving Flushing Bay only. Similarly, water quality analyses will be limited to the impact resulting from the CSO capture from the Flushing Bay outfalls only. Extension to Flushing Creek is discussed in the Flushing Creek WB/WS Facility Plan.

A tunnel alignment was developed that would take the captured CSO and convey it closer to the Bowery Bay WWTP. A tunnel dewatering pumping station and shaft were assumed to be sited at an industrial area to the west of the Bowery Bay WWTP, as shown in the aerial photograph in Figure 7-17. The plans assumed that the tunnel would be dewatered to the Bowery Bay WWTP via a new force main constructed as part of the proposed alternative plan. The proposed tunnel alignment is shown in Figure 7-18. Note that it was uneconomical to build tunnel drop shafts and laterals to capture the relatively small CSO discharge from BB-007, so the alignment does not extend to this outfall.

The largest practical tunnel diameter was limited to no more than 40 feet. As in Alternative 9, the pumping station would be sized to dewater the entire tunnel within 24 hours. Dewatering rates for the tunnel were limited by assuming the WWTP could accept no more than 1.5 times DDWF. The simulated pumping rate was constrained to account for dry weather flows during the dewatering period. In addition, a lag period was included between the end of the storm event and the start of dewatering in order to allow the WWTP to recover from the storm event. The 24 hour dewatering period does not start until after this lag period.

Alternatives 15-18 also include the regulator modifications described in Alternative 4, the end-of-pipe floatables control facilities for BB-006 and BB-008, raising the weir at BB-R02 and diverting low-lying sewers and dredging.

Alternative 15 was designed to limit the overflow events to eleven per year from BB-006 and BB-008. The estimated combined PTPC for Alternative 15 is $2.199 billion as summarized in Table 7-22. The estimated reduction in CSO is 55 percent.

Alternative 16 follows the same assumptions as Alternative 15, but the tunnel is larger in order to limit the number of overflow events to seven per year from BB-006 and BB-008. The estimated combined PTPC for this alternative is $2.546 billion as summarized in Table 7-22. The estimated reduction in CSO is 70 percent.

Alternative 17 was designed to limit the number of CSO events to three per year from BB-006 and BB-008. The estimated combined PTPC for this alternative is $3.418 billion as shown in Table 7-22. The estimated reduction in CSO is 90 percent.

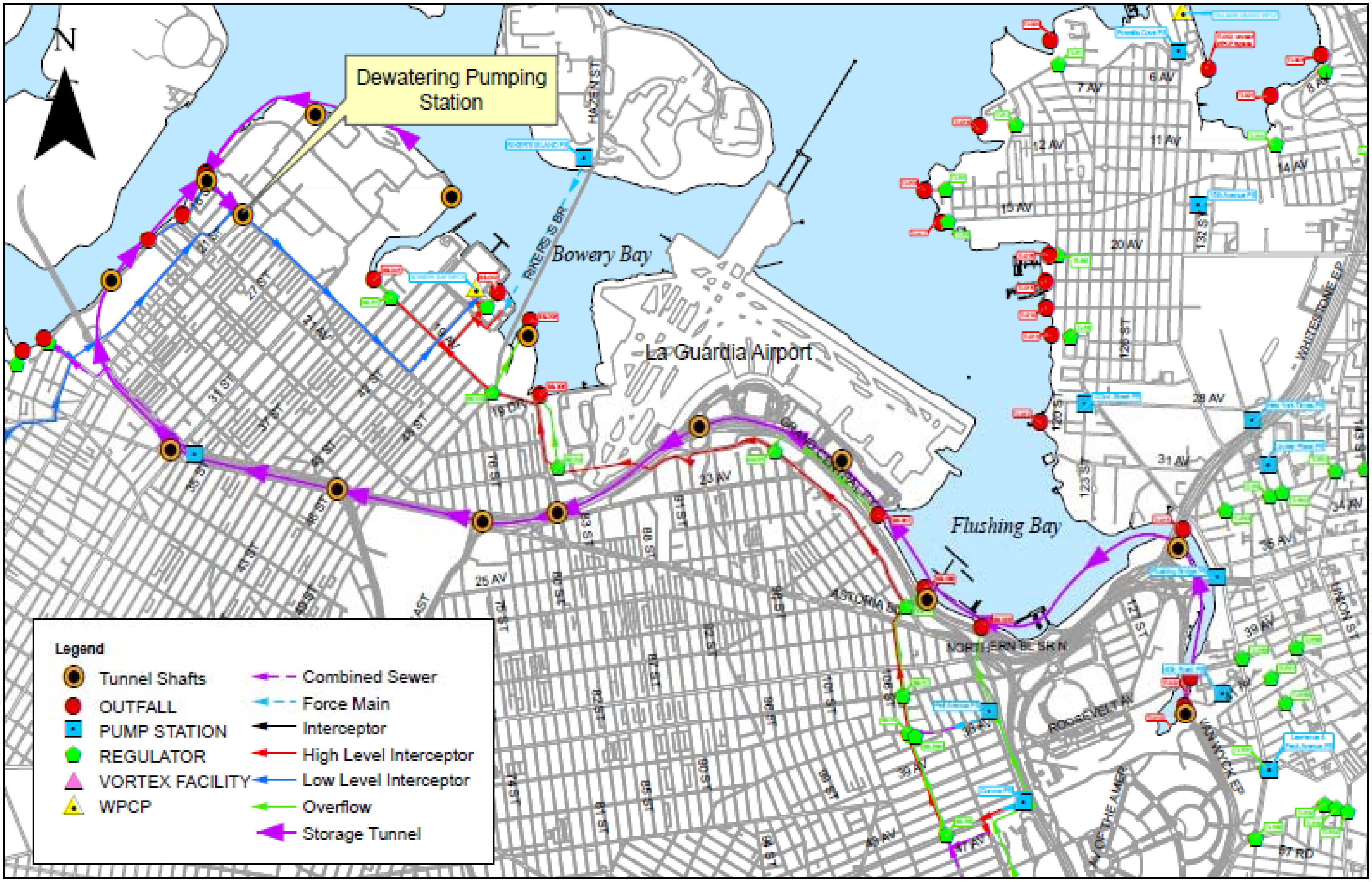
Alternative 18 is a tunnel designed to limit the number of CSO events to zero per year from BB-006 and BB-008. Alternative 18 follows the same assumptions as Alternative 12, but the tunnel is larger in order to capture more CSO events. The estimated combined PTPC for this alternative is $4.081 billion. Note that because it was uneconomical to build a tunnel system that would include capture of CSO from outfall BB-007, there is still a residual annual CSO discharge of 1.1 MG/yr. The estimated CSO reduction is approximately 98 percent.

Estimated costs and CSO reductions for Alternatives 15 through 18 are summarized in Table 7-21.

Industrial Area West of Bowery Bay WPCP

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE 7-17



Environmental Protection

Deep Tunnel Alignment

Table 7-21. Summary of Alternatives 15-18

Parameter	Alternative 15	Alternative 16	Alternative 17	Alternative 18
Number of Events per Year from BB-006 and -008	11	7	3	0
Number of Events per Year for all Flushing Bay Outfalls	45*	45*	45*	45*
% CSO Reduction in Flushing Bay	55%	70%	90%	98%
Tunnel Volume (MG)	88	136	258	340
Dredging PTPC ($ Million)	$48.7	$48.7	$48.7	$48.7
Raise BB-R02 Weir and Divert Low-Lying Sewers ($ Million)	$6.7	$6.7	$6.7	$6.7
Regulator Modifications ($ Million)	$17.1	$17.1	$17.1	$17.1
Tunnel and Dewatering Facility ($ Million)	$2,159.0	$2,516.4	$3,413.9	$4,096.7
Floatables Control Facilities ($ Million)	$63.6	$63.6	$63.6	$63.6
Total PTPC ($ Million)	$2,295.1	$2,652.5	$3,550.0	$4,232.8
* Number of events listed occur at outfall TI-016 in outer Flushing Bay which contributes minimal CSO discharge compared to BB-006 and BB-008.				

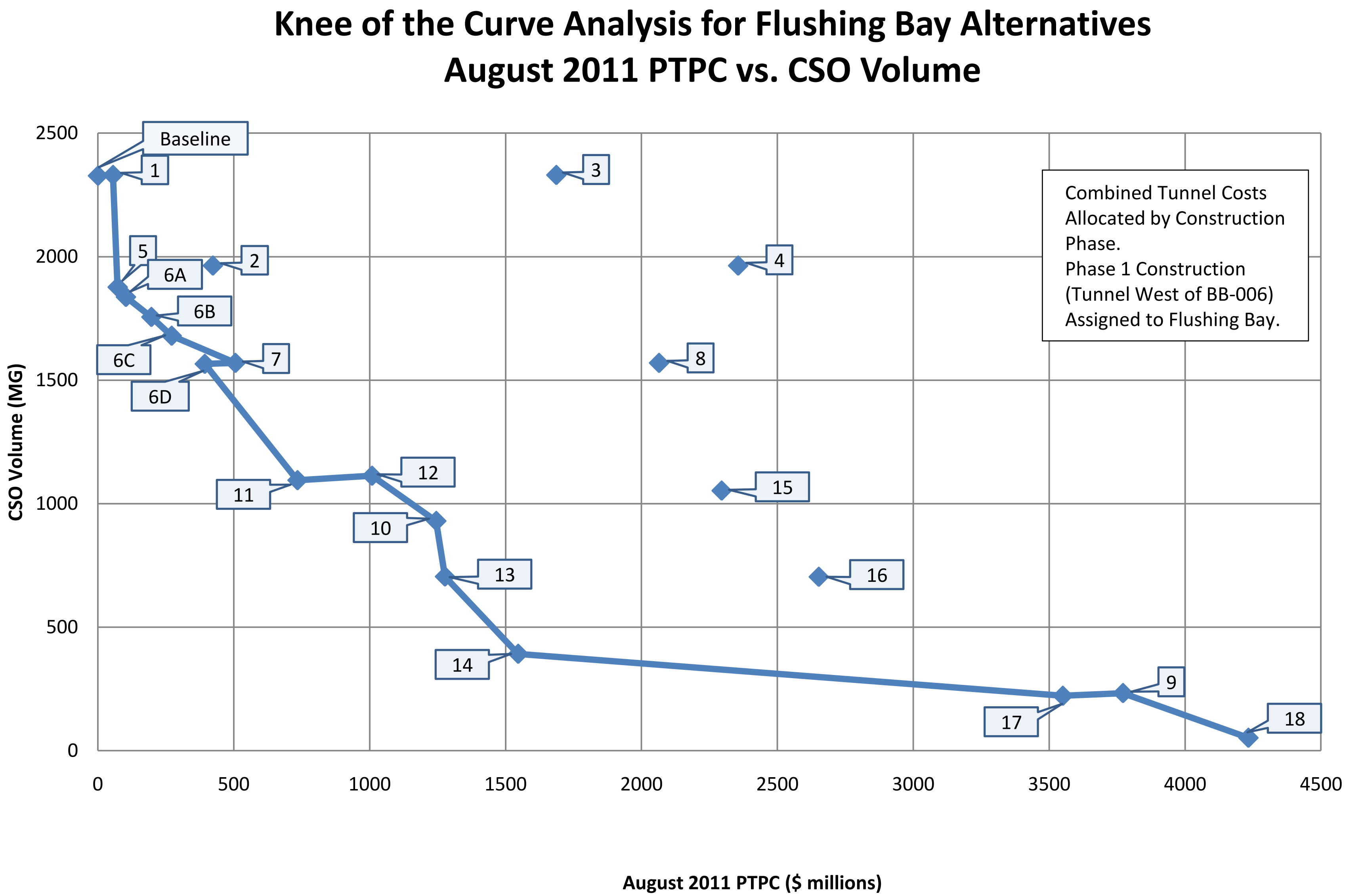
7.4 EVALUATION OF ALTERNATIVE PLANS

7.4.1 CSO Reduction

The computerized landside hydraulic models were used to assess the ability of each of these alternatives to reduce overflows to Flushing Bay. The Baseline annual untreated overflow volume was calculated by adding the overflow volumes for BB-006, 007, 008 (shown in Table 7-5), and those for TI-012, 013, 014, 015, 016, 017, and 018 (shown in Table 7-6). The outfalls with the “BB” prefix discharge to inner Flushing Bay, while those with the “TI” prefix discharge to Outer Flushing Bay.

The alternatives span a wide range of CSO reduction. Hydraulic model results are summarized in Table 7-22 along with each alternative’s cost. The annual CSO volume, number of CSO events, and percent CSO reduction for the alternatives were plotted against probable total project cost in Figures 7-19, 7-20, and 7-21, respectively. Some alternatives have cost-performance values that significantly depart from the general trends in Figures 7-19 through 7-21. In these cases, the data are plotted as outlying points with no trend line passing through them. Key observations are as follows:

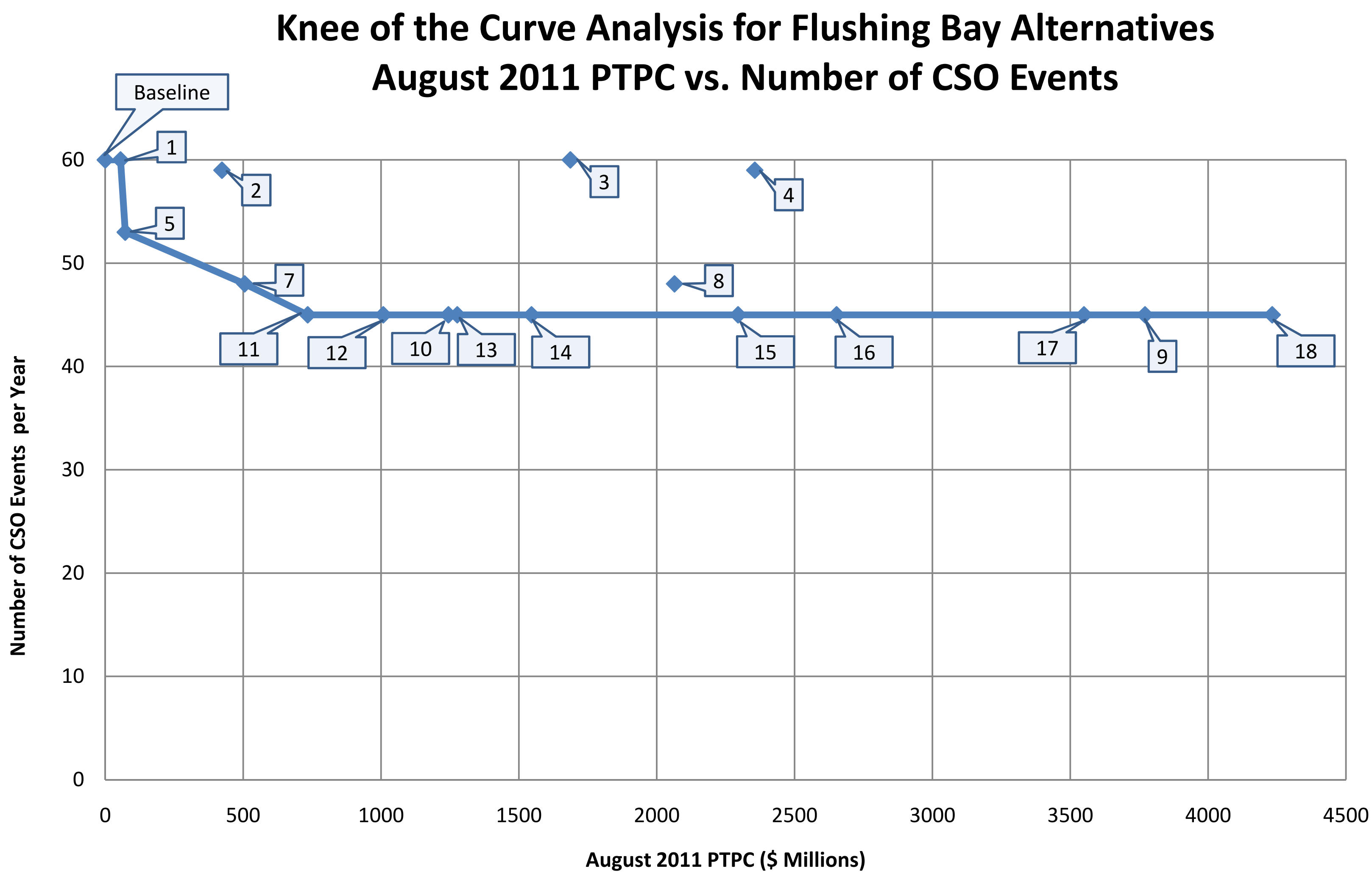
- Alternative 2 does not provide sufficient CSO volume reduction for the probable total project cost as compared to the other alternatives, as seen in Figure 7-19. Therefore, Alternative 2 was eliminated from further consideration as well.
- Increasing the amount of wet weather flow treated by diverting flow from the HLI to the LLI as proposed in Alternative 3 had no effect on the overflow volume to Flushing Bay. Therefore, this alternative was not considered further.



Environmental Protection

Flushing Bay Alternatives
Annual CSO Volume vs. Cost

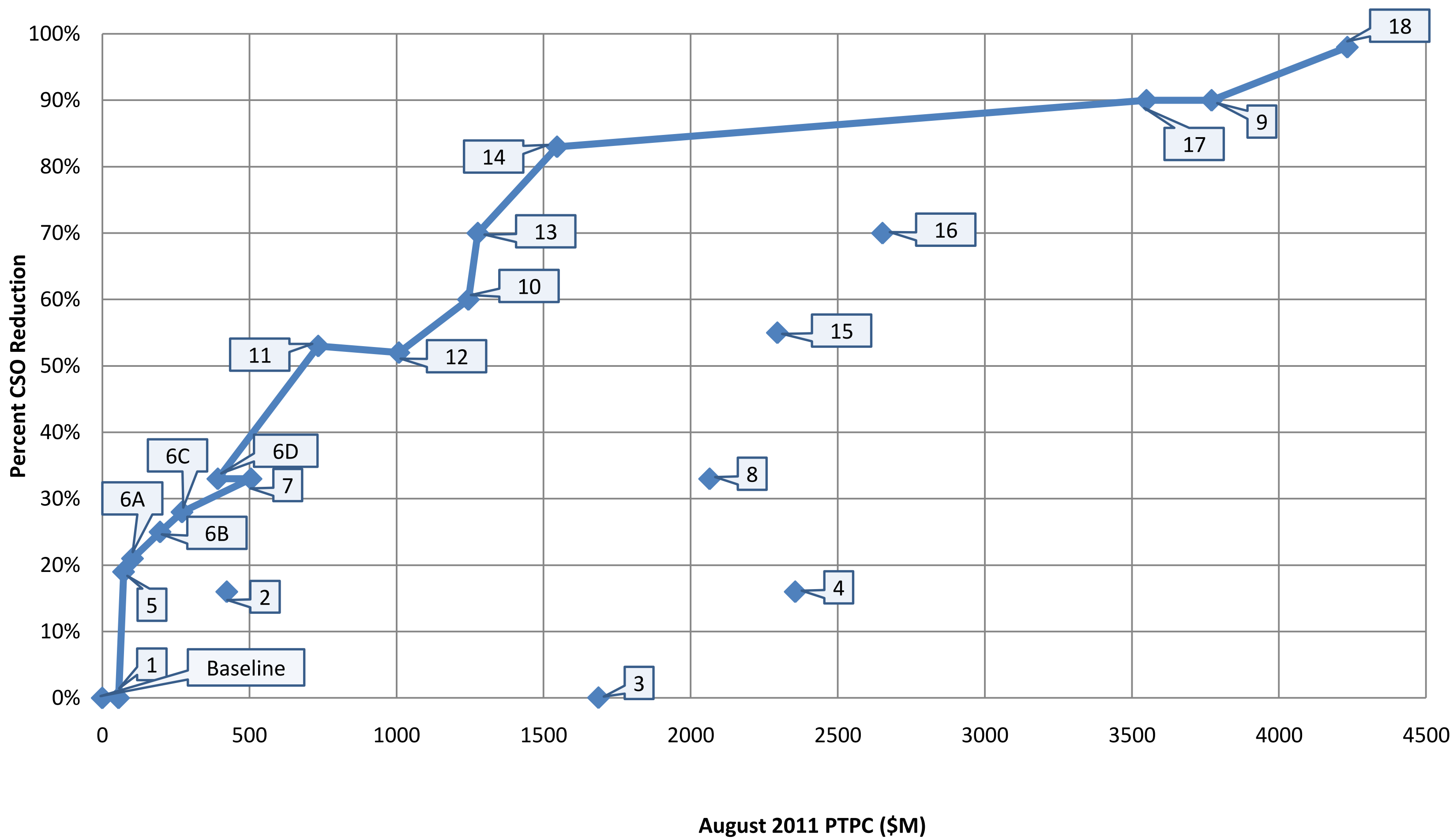
FIGURE 7-19



Environmental Protection

Flushing Bay Alternatives
CSO Events vs. Cost

Knee of the Curve Analysis for Flushing Bay Alternatives
August 2011 PTPC vs. Percent CSO Volume Reduction



Flushing Bay Alternatives
% CSO Volume Reduction vs. Cost

- Alternative 4 builds on Alternative 3's eight-foot diameter relief pipe by also diverting flow from the HLI to the LLI as well as diverting flow from the HLI to an HRPCT system. However, these additional elements did not decrease the Flushing Bay overflow volumes from Alternative 2 to 4. As such, Alternative 4 was eliminated from further consideration.

- Alternative 5 consists of modifications to key HLI regulators and increased annual CSO reduction for Flushing Bay by 19 percent between Alternatives 1 and 5. This is a substantial incremental benefit in annual overflow volume, provided by a low-cost, highly implementable alternative. Therefore, Alternative 5 was retained for further consideration.

- Alternative 6A through 6D will be deferred to the LTCP phase for this waterbody, since the anticipated schedule requirements for the Flushing Creek WB/WS Facility Plan do not allow adequate time to fully build out HLSS in the local area.

- As shown in Alternative 7, the modifications to key HLI regulators in association with the 8-foot diameter relief interceptor pipe increased the annual CSO reduction for Flushing Bay from 19 percent to 33 percent between Alternatives 5 and 7. This is a substantial incremental benefit in annual overflow volume. Therefore, Alternative 7 was retained for further consideration.

- Alternative 8 was developed by expanding Alternative 7 to also include the diversion of flow from the HLI to the LLI and to an HRPCT system. Compared to Alternative 7, Alternative 8 did not result in less overflow volume to Flushing Bay. As such, this alternative was not retained for further evaluation.

- Alternative 9 offers a 92 percent reduction in the Flushing Bay CSO over the Baseline Alternative. It also reduces the number of overflow events to 18. However, compared to tunnel alternatives, Alternative 9 offers only a slight improvement in the reduction of CSO volume and events at a substantial increase in cost over the loop storage tunnel alternatives (Alternative 12-14) and at a lesser increase in cost over Alternative 17. Therefore, Alternative 9 was eliminated from further consideration.

- Alternatives 10 and 11 are similar except that Alternative 11 does not include the additional 22-foot x 10-foot barrel to store CSO from BB-006. Alternative 10 provides a significant degree of CSO reduction (60 percent) while Alternative 11 achieves nearly as much CSO reduction (53 percent) at a significantly lower cost (only 58 percent of the cost for Alternative 10). As such, Alternative 11 was retained for further consideration and Alternative 10 was eliminated.

- The loop storage tunnels in Alternatives 12 through 14 can achieve a significant degree of CSO reduction, with the largest tunnel reducing the number of overflow events to seven per year. Therefore, these tunnels were retained for further consideration.

- Alternative 14 (87 MG loop tunnel) outperforms the 11-event (Alternative 15) and 7-event (Alternative 16) linear tunnels and does so at a lower cost. Therefore, these two linear tunnels were eliminated.

- The linear storage tunnels in Alternative 17 and 18 also achieve significant degrees of CSO reduction with even fewer events per year than the loop tunnels. However, they are well beyond the knee-of-curve and would not be cost effective solutions. Therefore, these two linear tunnels were eliminated too.

- Compared to the other alternatives, Alternatives 3, 4, 8, 15 and 16 are especially not cost-effective. They fall so far off the overall knee-of-curve plot that they are shown only as outlying data points and not as part of the cost-performance trend plot.

- Based on knee-of-curve analyses, Alternatives 5, 7, and 11 – 14 are the most promising.

Table 7-22. Summary of Flushing Bay Alternative Plans

Alternative	Description	PTPC ($ million)	Events per year	Annual Untreated Overflow Volume (MG/year)	% Flushing Bay CSO Reduction from Baseline
Baseline		$0	60	2,328	-
1	Bowery Bay Upgrades, Regulator BB-R02 Modifications, Divert Low-Lying Sewers, Dredging	$55.4	60	2,331	0
2	8-foot Relief Pipe for BB HLI	$ 423.0	59	1,964	16
3	Divert Flow from HLI to LLI, HRPCT for LLI	$ 1,686.8	60	2,331	0
4	8-foot Relief Pipe, Divert Flow from HLI to LLI, HRPCT for LLI and HLI	$ 2,355.8	59	1,964	16
5	Regulator Modifications	$72.5	53	1,877	19
6A	Alternative 5 and HLSS in Area 1	$ 102.8	-	1,837	21
6B	Alternative 5 and HLSS in Areas 1 & 2	$ 196.5	-	1,756	25
6C	Alternative 5 and HLSS in Areas 1, 2, & 3	$ 271.1	-	1,680	28
6D	Alternative 5 and HLSS in Areas 1, 2, 3, & 4	$ 393.0	-	1,566	33
7	8-foot Relief Pipe and Regulator Modification	$ 505.8	48	1,570	33
8	Alternative 7 and Divert Flow from HLI to LLI, HRPCT for LLI	$ 2,064.7	48	1,570	33
9	Convey BB-006 and BB-008 to HRPCT System	$ 3,771.4	45*	233	90
10	Alternative 7 and Outfall Storage at BB-006 and BB-008	$ 1,244.7	45*	930	60
11	Alternative 10 Without Additional Storage	$ 734.2	45*	1,095	53
12	25 MG Storage Tunnel	$ 1,008.4	45*	1,113	52
13	52 MG Storage Tunnel	$ 1,276.8	45*	705	70
14	87 MG Storage Tunnel	$1,546.1	45*	392	83
15	Linear Tunnel - 11 Events per Year	$ 2,295.1	45*	1,053	55
16	Linear Tunnel - 7 Events per Year	$ 2,652.5	45*	704	70
17	Linear Tunnel - 3 Events per Year	$ 3,550.0	45*	222	90
18	Linear Tunnel - 0 Events per Year	$ 4,232.8	45*	52	98

Table 7-22. Summary of Flushing Bay Alternative Plans

Alternative	Description	PTPC ($ million)	Events per year	Annual Untreated Overflow Volume (MG/year)	% Flushing Bay CSO Reduction from Baseline
* Number of events listed occur at outfall TI-016 in outer Flushing Bay which contributes minimal CSO discharge compared to BB-006 and BB-008.					

Alternative plans 5, 7, 11, 12, 13, and 14 were retained for further evaluation using the water quality model. Storage tunnel systems designed to allow expansion to Flushing Creek (Alternatives 15-18) were not cost-effective for Flushing Bay given that similar CSO reductions could be achieved in the Bay using other, less costly alternatives. However, tunnel Alternative 18 was also evaluated using the water quality model in order to establish the limit of water quality benefit that could be realized by CSO elimination.

7.4.2 Water Quality Benefits of Alternative Plans

To evaluate their impacts to water quality in Flushing Bay, the retained alternative plans were analyzed using the receiving water quality model. These analyses focused on the improvements in pathogen (coliform) levels and DO concentration resulting from the various alternatives. Under baseline conditions, the water quality of Flushing Bay is affected by the CSO discharges into Flushing Creek. Even if no Flushing Bay alternatives were to be implemented (i.e., the Flushing Bay baseline condition does not change), there would be improvements in the bay's water quality due to the CSO reductions expected from the Flushing Bay CSO Retention Facility placed into service in 2009. Because it is not possible to evaluate the impacts of the Flushing Bay alternatives in isolation from the effects of actions taken in Flushing Creek, it was assumed that the Flushing Creek WB/WS Facility Plan (March 2009) recommendations would be implemented when modeling the Flushing Bay alternatives. Consequently, a small portion of the water quality improvements shown in the following figures and tables is due to improvements made in Flushing Creek. To be as conservative as possible, both the sewer system and water quality models treated overflows from the Flushing Creek CSO retention facility as CSO discharges. In addition to the water quality modeling, the alternatives were evaluated for non-numerical water quality benefits including odor and floatables.

<u>Coliform Improvements</u>

Model runs to quantify pathogen concentrations for each month of the year were conducted for the retained alternatives. Model results are presented by water quality monitoring locations within Flushing Bay (See Section 4). Station S06 is shown in Figures 4-1 and LMS station 2 is shown in Figure 4-9. Table 7-23 summarizes by water quality sampling location where the model predicts monthly geometric means of total fecal coliforms in excess of 10,000 per 100 mL and 2,000 per 100 mL, respectively, the DEC Class I criteria for fecal and total coliforms. A dashed line indicates that the geometric mean calculated from the model results is less than the numeric criteria and therefore in attainment.

The water quality modeling shows that for the baseline conditions, the numerical coliform bacteria criteria are only exceeded during non-recreation periods (January, February, and November). No exceedances of the numerical criteria were predicted for any of the alternatives listed in Table 7-23. Therefore, exceedance of fecal and total coliform numerical criteria will not be a significant factor in selecting the alternatives for CSO control. Also, in light of the predicted coliform concentrations, disinfection as a supplemental treatment technology will not be considered.

Table 7-23. Monitoring Locations Predicted to Exceed Class I Fecal and Total Coliform Counts

	Flushing Bay Alternative Plan No.							
Month	**Baseline**	**5[(2)]**	**7[(2)]**	**11[(2)]**	**12 [(2)]**	**13[(2)]**	**14 [(2)]**	**18[(2)]**
Jan	2[(1,3)], S06	-	-	-	-	-	-	-
Feb	S06	-	-	-	-	-	-	-
Mar	-	-	-	-	-	-	-	-
Apr	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-
Jun	-	-	-	-	-	-	-	-
Jul	-	-	-	-	-	-	-	-
Aug	-	-	-	-	-	-	-	-
Sep	-	-	-	-	-	-	-	-
Oct	-	-	-	-	-	-	-	-
Nov	2[(1)], S06	-	-	-	-	-	-	-
Dec	-	-	-	-	-	-	-	

(1) LMS Station
(2) Water Quality results assume the Facility Plan and conveyance enhancements will be implemented in Flushing Creek.
(3) Only total coliform geometric mean GM was greater than Class I numeric criteria (10,000 MPN/100 mL). Fecal coliform geometric mean (GM) was less than 2,000 MPN/100 mL.

DO Improvements

The water quality model was used to predict the percent of time the DO concentration would be in compliance with Class I DO criteria (a minimum concentration of 4.0 mg/L).

Under baseline conditions, May through September is the only time of the year when DO concentrations are computed to be less than the numerical criteria of 4.0 mg/L for significant periods of time, with July being the most impaired month. All other times of the year, DO is greater than 4.0 mg/L between 98 and 100 percent of the time. The computed percentage of time that DO drops below 4.0 mg/L on an annual basis and for the month of July are plotted against the estimated probable total project cost in Figure 7-22. Under Baseline conditions, the percentage of time that DO concentrations were predicted to be greater than 4.0 mg/L was 56 percent in July and ranged from 64 percent to 79 percent for the alternatives shown in Figure 7-22. For illustrative purposes, the complete transect plots for the month of July for several alternatives are shown in Figure 7-23, which shows that the percent time greater than 4.0 mg/L approaches 100 percent for most of the transect. The percent time greater than 4.0 mg/L falls below 90 percent only along limited portions of the Inner Flushing Bay transect with most of the Inner Bay transect being greater than 85 percent for all of the alternatives shown.

For months of the year other than July, as well as on an overall annual basis, there is only a marginal difference in DO quality between Alternatives 5, 7, 11 through 14, and 18 (see Figure 7-22) even though the incremental cost between these alternatives is approximately $4 billion.

Therefore, in terms of DO improvements, any of these alternatives could be a viable recommended plan for Flushing Bay. Based on these results, supplemental in-stream aeration is unnecessary and was therefore eliminated.

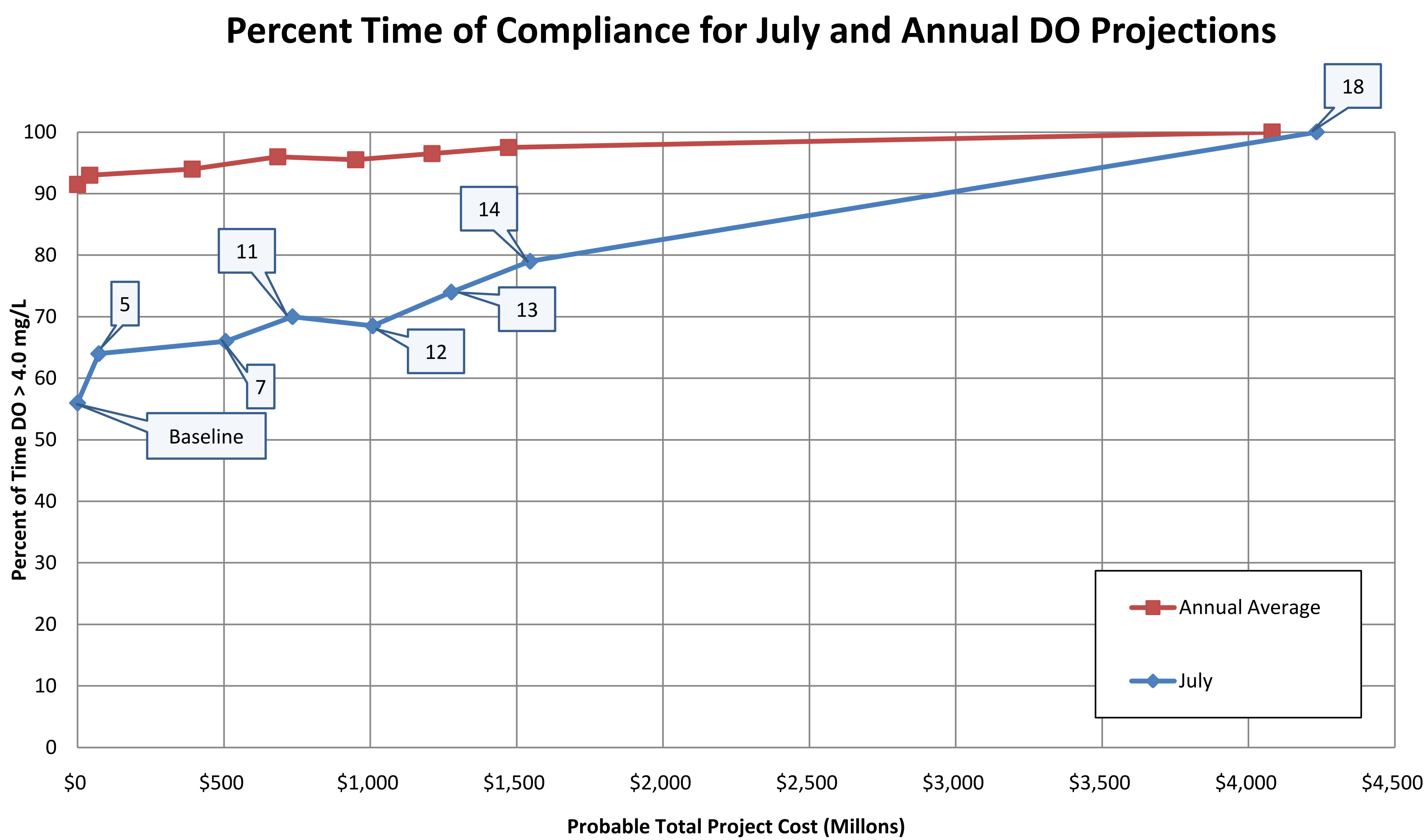
Odor Improvements

Odors emanating from Flushing Bay have been attributed at least in part to the presence of organic sediments from CSO discharges being exposed to the atmosphere intertidally. These highly reactive organic solids are oxidized rapidly, depleting oxygen in the sediments so that bacteria must rely on oxygen bound in sulfate to assimilate carbon, a reaction that ultimately releases H_2S gases into the atmosphere, creating a characteristic “rotten egg” odor.

Odor improvements for Flushing Bay will be achieved through a combination of two actions. First, Flushing Bay will be dredged to 5’ below MLLW to remove existing CSO sediments that cause the odors in the areas adjacent to the Bay. This will ensure that odor-producing mud flats will no longer be exposed at low tide. Second, the implemented alternative will reduce the amount of organic carbon discharging from CSOs that might settle in the Inner Bay to form odor producing mounds. Reductions in the annual amount of CSO discharging into the Bay will reduce the available carbon, thereby reducing the amount of odor produced through the anaerobic decay of this carbon source. These annual reductions are shown in Table 7-24 below.

Table 7-24. Summary of CSO Reductions

Alternative	Description	Reduction in CSO Volume to Flushing Bay (%)
Baseline	Baseline	0
5	Regulator Modifications	19
7	8- relief pipe, regulator modifications	33
11	8-foot relief pipe, regulator modifications, inflatable dams	53
12	25 MG Flushing Bay Tunnel	52
13	52 MG Flushing Bay Tunnel	70
14	87 MG Flushing Bay Tunnel	83
100% CSO reduction	-	98

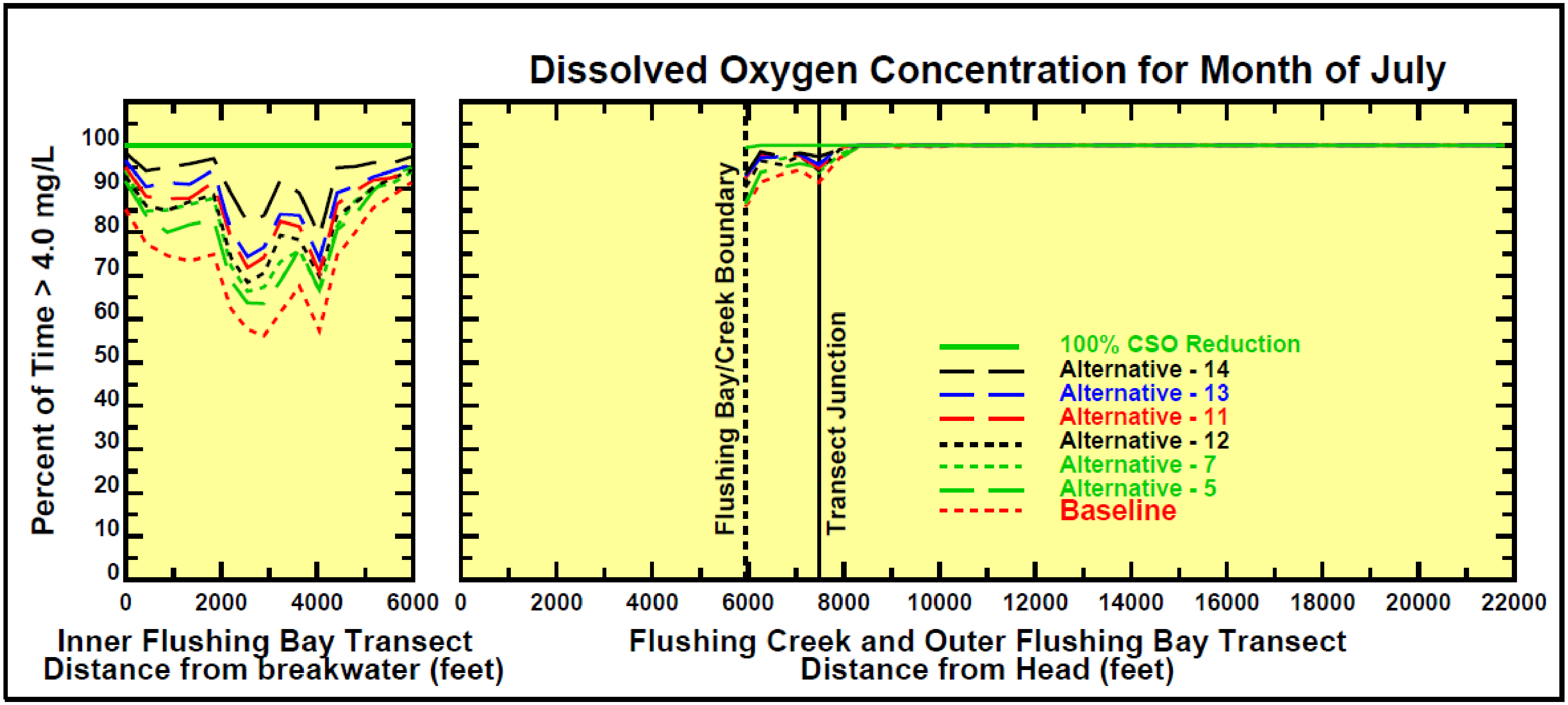


Flushing Bay Alternatives DO Benefit-Cost Analysis

Environmental Protection

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE 7-22



NYC Environmental Protection

Flushing Bay Alternatives DO Transect Plot for July

Floatables Improvements

The Worlds Fair's Marina would be impacted by the discharge of CSO floatables since it is located immediately adjacent to two of the largest CSO outfalls. As discussed in Section 5, DEP has taken a number of steps to reduce floatables entering Flushing Bay though the implementation of the 14 SPDES required BMPs. The major floatables reductions associated with these programs come through the diversion of additional wet weather flow to WWTPs for treatment, capture of floatables in catch basins with the installation of catch basin hoods, and the end-of-pipe collection of floatables in the Interim Floatables Containment Program (booms). However, some floatables are still discharged from CSOs and impact the uses of local waters.

Each of the alternatives noted above will result in substantial reductions in floatables entering the Bay. Because the plans convey additional flow to the WWTP for treatment, each is expected to reduce overflow floatables in proportion to the amount of increased conveyance to the WWTP. In addition, certain alternatives (i.e., Alternatives 11-14) include positive screening of floatables. Therefore, the flow discharging from the outfalls with these controls will have a substantial portion of the visible floatables removed before discharge.

Table 7-25 below summarizes the anticipated floatable reductions associated with each of the proposed alternatives. Any outfall with an inflatable dam was assumed to achieve 100 percent capture of floatables with the installation of end-of-pipe floatables control facilities at the outfall. With the exception of Alternative 5 and 7, all of the alternatives achieve significant floatables reductions with most alternatives near 100 percent reduction.

Table 7-25. Summary of Floatables Reductions

Alternative	Description	Reduction in CSO Floatables to Flushing Bay (%)
Baseline	Baseline	0
5	Regulator Modifications	19
7	8-foot relief pipe, regulator modifications	33
11	8-foot relief pipe, regulator modifications, inflatable dams	97
12	25 MG Flushing Bay Tunnel	99.9
13	52 MG Flushing Bay Tunnel	99.9
14	87 MG Flushing Bay Tunnel	99.9
100% CSO reduction	-	100

As presented in Section 5.3.7 and in Table 5-6, the volumes of collected floatables captured in the containment booms at BB-008 and BB-006 in 2009 were 10.3 cy and 6.5 cy, respectively. The challenges related to installing facilities along Flushing Bay are considerable. First, the land is owned by the Parks Department and an act of State Legislature may be necessary for parkland alienation. Second, two active marinas would be displaced during construction. Third, the shoreline is separated from the remainder of the service area by the Grand Central Parkway, further restricting the siting of a facility. Finally, floatables controls currently in place along Flushing Bay do not yield quantities of floatable debris large enough to justify the comparatively high capital and O&M expenditure required to construct dedicated facilities. As an alternative, opportunities for passive floatables control will be identified and evaluated during the design of the regulator modifications.

7.5 RECOMMENDED ALTERNATIVE

7.5.1 Basis for Recommendation

As outlined above a reasonable range of CSO reduction alternatives was evaluated for Flushing Bay. A number of the alternatives were potentially cost-effective. The recommended plan is formulated below, based on cost-effectiveness as well as other factor, such as constructability, operability, and reliability. Alternative 11 appears cost-effective; however, this alternative has several disadvantages. Certain purchase, installation, and operation and maintenance issues must be considered prior to selecting any plan that uses inflatable dams. At other locations in the City where inflatable dam systems were considered, acquiring a bidder was difficult. Competition in the market has diminished with one of the two manufacturers (Bridgestone)no longer producing the dam fabric, and the other (Sumitomo) curtailing direct service in the United States market. A third company, Dyrhoff, has purchased the rights to furnish Sumitomo dam systems in the United States, and has located a fabric supplier in China that can supply fabric similar to Bridgestone's, but they cannot use the Bridgestone clamping arrangement and there has not been a satisfactory demonstration of a hybrid system in New York City. There is thus only one potential distributor with one tested system, creating a problem purchasing the system and ensuring a reliable supply of replacement parts. Furthermore, inflatable dams would cause periodic stagnant water in the outfall sewers for BB-006 and BB-008 that would lead to sediment accumulation over time. Confined space entry with a front end loader would be required to remove this sediment.

The next closest alternative in terms of CSO reduction is Alternative 12 (25 MG tunnel) which achieves a CSO reduction similar to Alternative 11, albeit at a somewhat higher cost. Alternative 12 will reduce CSO overflow volumes to the Bay from 2,328 MG/yr to 1,113 MG/yr (a 52 percent reduction). A tunnel will be much easier to maintain than the inflatable dam system as it can be sufficiently sloped to allow any accumulated sediment to be scoured from the bottom during tunnel dewatering. However, any tunnel project would incur a high capital cost with a schedule that extends far into the future.

Water quality modeling of both pathogens and DO does not provide a clear preference among the alternatives. The knee-of-curve analysis for annual DO does not show a clear knee among Alternatives 5, 7, and 11 through 14. The difference in DO attainment between the least expensive alternative, Alternative 5, and the most expensive, Alternative 14, is only 15 percent in July and five percent averaged annually. The tunnel alternatives can achieve almost 100 percent reduction in floatables; however, these alternatives are expensive and have lengthy implementation schedules. Alternatives 5 and 7 do not perform as well as the other alternatives in terms of floatables reduction, but they are relatively low-cost system improvements that can be implemented quicker than the tunnels. With respect to odors, the expected improvement among the alternatives is directly related to their CSO reduction. Therefore, the selection based on odor would mirror that for CSO reduction.

7.5.2 Conclusions

Weighing cost-effectiveness, as well as water quality improvements and constructability issues, Alternative 5 is recommended as the most viable WB/WS Facility Plan. The major elements of the selected alternative are regulator modifications at regulators BB-04 through BB-06, BB-09 & BB-10, and the 24th Avenue Weir. Additionally the recommended plan includes raising the weir height at regulator BB-R02 from -1.75 to +2.5, the diversion of low-lying sewers, and dredging in Flushing Bay. Costs for the Bowery Bay headworks upgrade is not accounted for in this WB/WS Facility Plan as they will be included in the East River and Open Waters WB/WS Facility Plan.

For the purposes of alternative evaluations, bending weirs, which have the potential to reduce CSO at a moderate cost, were assumed to be the implemented regulator modification technology. However, implementation of bending weirs is contingent upon further hydraulic analysis and constructability evaluation. The potential for flooding related to bending weir installation must be evaluated and, assuming the hydraulics are feasible, the constructability of the weirs within the existing regulator structures would need to be evaluated as well. The implementation of bending weirs in key regulator will also be subject to a successful pilot test of bending weir technology. Therefore, final selection of the regulator modification technology will not be determined until completion of subsequent planning and preliminary design. During the evaluation and design of appropriate regulator modification technologies, upstream passive floatables capture will also be considered to address floatables at BB-06 and BB-08. This may be achieved through underflow baffles, static screening facilities, or some other floatables technology.

Alternative 5 is a cost-effective, highly-implementable CSO reduction plan for Flushing Bay that produces a 19 percent decrease in the annual CSO volumes discharged to the Bay. The regulator modifications will reduce the CSO floatables discharged to the Bay by 19 percent. Odors will be reduced as a result of dredging to remove exposed sediment mounds and due to the reduction CSO volume. The regulator modifications are projected to increase the attainment of Class I DO standard (4.0 mg/L minimum DO concentration) from 92 percent to 93 percent of the time annually. During the critical month of July, DO attainment will improve from 56 percent to 64 percent of the time. Also, fecal and total coliform concentrations are expected to achieve 90 percent or greater attainment with the numeric criteria during the entire year. Given the modeling results for both pathogens and DO, neither supplemental disinfection nor in-stream aeration are necessary. The specific elements of the recommended plan along with the PTPCs are summarized in Section 8. Although the regulator modifications achieve a lower level of CSO removal than many of the larger storage projects, the modifications are cost-effective, implementable, and achieve satisfactory water quality benefits without precluding the future construction of additional controls, and adaptive approach that will benefit the LTCP phase of facility planning in Flushing Bay.

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8.0 WATERBODY/ WATERSHED FACILITY PLAN

The WB/WS Facility Plan described in this section is the culmination of efforts by DEP to attain the existing water quality standards for Flushing Bay and recognizes that achieving water quality objectives may require more than the simple reduction in CSO discharges. The multi-faceted approach incorporates several cost-effective engineering solutions with demonstrable positive impacts on water quality, including increased DO concentrations, decreased coliform concentrations, and reductions in nuisance odors and floatables that are a consequence of CSO discharges. The recommended approach also maximizes utilization of the existing collection system infrastructure and treatment of combined sewage at the Bowery Bay and Tallman Island WWTPs.

The subsections that follow present the recommended CSO control components required to ensure the full implementation of the Flushing Bay WB/WS Facility Plan goals. Post-construction compliance monitoring (including modeling), discussed in detail in Section 8.3, is an integral part of the WB/WS Facility Plan, and provides the basis for adaptive management for Flushing Bay.

If post-construction monitoring indicates that additional controls are required, protocols established by DEP and the City of New York for capital expenditures require that certain evaluations are completed prior to the construction of the additional CSO controls. Depending on the technology implemented and on the engineer's cost estimate for the project, these evaluations may include pilot testing, detailed facility planning, preliminary design, and value engineering. Each of these steps provides additional opportunities for refinement and adaptation so that the fully implemented program achieves the goals of the original WB/WS Facility Plan.

8.1 PLAN OVERVIEW

The central element of the Flushing Bay WB/WS Facility Plan is the reduction in CSO to Flushing Bay by implementing regulator modifications at key locations throughout the Bowery Bay High Level sewershed. As discussed in Section 7.0, a variety of CSO control alternatives have been examined to reduce CSO pollution impacts to Flushing Bay, ranging from watershed management approaches to total CSO removal, and the regulator modifications necessary to achieve the additional capture yields the greatest improvement in water quality for the capital expenditure required, based on a knee-of-curve type analysis.

The recommended Flushing Bay Waterbody/Watershed Facility Plan consists of the following elements:

- Continued implementation of programmatic controls
- Raising of the regulator BB-R02 weir height from -1.75 to +2.5
- Diversion of low-lying sewers from BB HLI to BB LLI
- Regulator modifications at regulators BB-3 through BB-10, BB-26 and 24th Ave Weir.
- Incorporate passive floatables control as an element of the regulator modifications.
- Dredging of Flushing Bay to reduce the occurrences of odors

The WB/WS Facility Plan is predicted to achieve attainment of DO numerical criteria a minimum of 64 percent of the time during the critical month of July. Annually, the WB/WS Facility Plan is predicted to achieve a minimum 93 percent DO attainment. In the outer Bay, 100 percent compliance is achieved. Total and fecal coliform attains secondary contact numerical criteria on an annual basis in a typical precipitation year. The estimated PTPC of the Flushing Bay WB/WS Facility Plan is $72.5 million in August 2011 dollars.

Each component of the Plan is discussed in greater detail in the following sections.

8.2 WATERBODY/WATERSHED FACILITY PLAN COMPONENTS

8.2.1 Raising of Regulator BB-R02 Weir Height and Diversion of Low Lying Sewers

The weir height at Regulator BB-R02 will be raised from elevation -1.75 feet Queens Sewer Datum (Q.S.D.) to elevation +2.50 Q.S.D. This modification will help to maximize the wet weather capacity of the Bowery Bay WWTP. However, there are a few sewer segments in low-lying areas along 19th Ave and Berrian Blvd in the vicinity of the Bowery Bay WPCP that may be subject to flooding once the weir is raised. To avoid such flooding, these low-lying sewers will be disconnected from the BB HLI and diverted to the BB LLI. The probable total project cost of this weir adjustment and sewer disconnection and diversion is $6.7 million in August 2011 dollars.

8.2.2 Regulator Modifications

Key regulators located along the Bowery Bay High Level Interceptor will be modified to improve in-line storage during storm events and to divert combined sewage from smaller rainfall events to the Bowery Bay WWTP for treatment. These key regulators have been identified as regulators BB-04 through 06, BB-09 and 10 and the 24th Ave Weir. The locations of these regulators are shown in Figures 7-10 and 7-11. The PTPC of these regulator modifications as described in section 7.3.8 is $17.1 million in August 2011 dollars. The design phase of these regulator modifications will also evaluate means of incorporating floatables capture upstream of the outfalls via underflow baffles or some other type of static screening facilities.

8.2.3 Dredging of Flushing Bay

Portions of Flushing Bay will be dredged to five feet below mean lower low water (MLLW) to remove existing sediments that cause odors in the areas adjacent to the Bay. It is anticipated that the bottom 2 feet will then be capped to cover any exposed sediments that might be classified as Class C, per New York State DEC guidance, although the final details will be developed during the design and permitting of such dredging. The estimated probable total project cost of the dredging and capping is $48.7 million in August 2011 dollars. The area of Flushing Bay to be dredged is shown in Figure 7-7.

8.2.4 Continued Implementation of Programmatic Controls

As discussed in detail in Section 5.0, DEP currently operates several programs designed to reduce CSO to a minimum and provide treatment levels appropriate to protect waterbody uses. As the effects of the Waterbody/Watershed Facility Plan and subsequent LTCP become understood through long-term monitoring, ongoing programs will be routinely evaluated based on receiving water quality considerations. Floatables reduction plans, targeted sewer cleaning, real-time level monitoring, and other operations and maintenance controls and evaluations will continue, in addition to the following.

- The 14 BMPs for CSO control required under the City's 14 SPDES permits will continue. In general, the BMPs address operation and maintenance procedures, maximum use of existing systems and facilities, and related planning efforts to maximize capture of CSO and reduce contaminants in the combined sewer system, thereby reducing water quality impacts. A detailed discussion of the existing BMP program is included in Section 5.3.

- Maintaining the capability of the recently constructed headworks upgrade at the Bowery Bay WWTP to convey up to 300 MGD (2×DDWF) through preliminary treatment, primary clarification and chlorination along with a portion of the wet weather flow through secondary treatment is a key component of Flushing Bay WB/WS Facility Plan to capture CSO.

- The Citywide Comprehensive CSO Floatable Plan (HydroQual, 2005b and 2005c) provides substantial control of floatables discharges from CSOs throughout the City and provides for compliance with appropriate DEC and IEC requirements. The Floatables Plan is a living program that is expected to change over time based on continual assessment and changes in related programs.

8.2.5 Construction Costs

Costs for the recommended plan are summarized in Table 8-1. Costs are presented as estimated PTPCs adjusted to August 2011 dollars and do not account for escalation over the time period shown in the schedule.

Table 8-1. Recommended Plan PTPC

Elements of the Recommended Plan	PTPC [1] (Million)
Regulator Modifications	$17.1
Raise Weir at BB-R02 and associated diversion of low-lying sewers.	$6.7
Dredging of Flushing Bay	$48.7
Total	$72.5
(1) Probable Total Project Cost: Includes Hard and Soft Construction Costs - baselined to August 2011	

8.3 POST-CONSTRUCTION COMPLIANCE MONITORING

Post-construction compliance monitoring will commence just prior to implementation of CSO controls and will continue for several years in order to quantify the difference between the expected performance (as described in this report) and the actual performance once those controls are fully implemented. Any performance gap identified by the monitoring program can then be addressed through operations adjustments, retrofitting additional controls, or through the implementation of additional technically feasible and cost effective alternatives under the Long Term Control Plan. If it becomes clear that CSO control will not result in full attainment of applicable standards, DEP will pursue the necessary regulatory mechanism for a Variance and/or Water Quality Standards Revision. Due to the dynamic nature of water quality standards and approaches to non-compliance conditions, a period of ten years of operation will be necessary to generate the minimal amount of data necessary to perform meaningful statistical analyses for water quality standards review and revision as discussed in Section 9. The data collection monitoring will contain three basic components:

1. Monitoring and reporting requirements contained in the Bowery Bay WWTP and Tallman Island WWTP SPDES permits, as well as Flushing Bay CSO Tunnel Facility monitoring requirements.

2. DEP Harbor Survey program data collection in Flushing Creek and Flushing Bay; and

3. Modeling of the associated receiving waters to characterize water quality.

8.3.1 Receiving Water Monitoring

The New York City Harbor Survey primarily measures four parameters related to water quality: DO, fecal coliform, chlorophyll “a”, and secchi depth. These parameters have been used by the City to identify historical and spatial trends in water quality throughout New York Harbor. Secchi depth and chlorophyll “a” have been monitored since 1986; DO and fecal coliform have been monitored since before 1972. Recently, enterococci analysis has been added to the program. Except for secchi depth and vertical profiling of conductivity, temperature, and dissolved oxygen, parameters are analyzed from samples collected at a depth of three feet below the water surface to reduce influences external to the water column chemistry itself, such as wind and precipitation influences near the surface. DEP samples 33 open water stations routinely, which are supplemented each year with approximately 20 rotating tributary stations or periodic special stations sampled in coordination with capital projects, planning, changes in facility operation, or in response to regulatory changes.

The post-construction compliance monitoring program will continue along the protocols of the Harbor Survey initially, including laboratory protocols listed in Table 8-2. As shown on Figure 8-1, three stations in Flushing Bay will be monitored regularly. In addition, Flushing Creek contains two locations (mid-channel and mouth) that were added to the Harbor Survey program in the fall of 2006. All stations related to the Interim Flushing Bay/Creek Post-Construction Monitoring Program will be sampled a minimum of twice per month from May through September and a minimum of once per month during the remainder of the year.

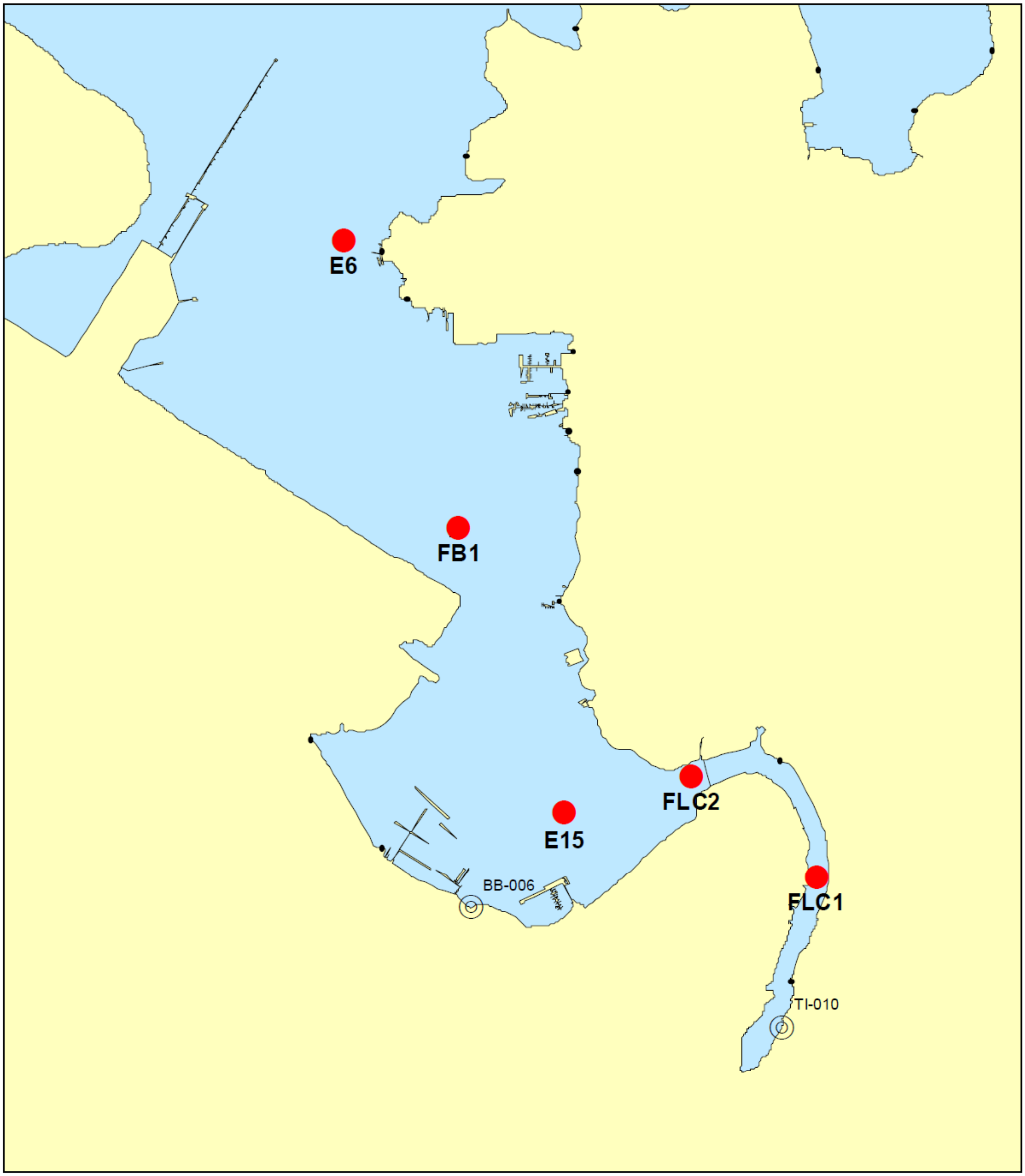
Monitoring in Flushing Bay and Creek commenced in May 2007 in response to the activation of the Flushing Creek CSO Retention Facility. Sampling stations FLC1, FLC2, and E15 may be covered with ice during cold weather. DEP personnel will not be engaging in sampling where access is restricted by ice conditions.

Table 8-2. Current Harbor Survey Laboratory Protocols

Parameter	**Method**
Ammonia (as N)	EPA 350.1
Chlorophyll 'a'	EPA 445.0, modified for the Welschmeyer Method
Dissolved Oxygen	SM 4500-O C, Azide Modification (Winkler Method)
Dissolved Silica	SM 18-19 4500-Si D or USGS I-2700-85
Enterococcus	EPA Method 1600, Membrane Filter
Fecal Coliform	SM 18-20 9222D, Membrane Filter
Nitrate (as N)	EPA 353.2 or SM 18-20 4500-NO3 F
Orthophosphate (as P)	EPA 365.1
pH	SM 4500-H B, Electrometric Method
Total Kjeldahl Nitrogen	EPA 351.2
Total Phosphorus	EPA 365.4
Total Suspended Solids	SM 18-20 2540D
Notes: SM – Standard Methods for the Examination of Water and Wastewater; EPA – EPA's Sampling and Analysis Methods. Field instrumentation also includes an SBE 911 Sealogger CTD which collects salinity, temperature, and conductivity, among other parameters.	

Data collected during this program will be used primarily to verify the East River Tributaries Model (ERTM) that will be used to demonstrate relative compliance levels in Flushing Bay. Therefore, during each annual cycle of compliance monitoring, the data collected will be evaluated for its utility in model verification, and stations may be added, eliminated, or relocated depending on this evaluation. Similarly, the parameters measured will be evaluated for their utility and appropriateness for verifying the receiving water model calibration. At a minimum, the program will collect those parameters with numeric WQS (i.e., DO, fecal coliform, and enterococci). In addition, moored instrumentation may be added or substituted at one or more of these locations if continuous monitoring is determined to be beneficial to model verification, or if logistical considerations preclude the routine operation of the program (navigational limits, laboratory issues, etc.).

Post-construction monitoring protocols, QA/QC, and other details are being fully developed under the Citywide LTCP to assure adequate spatial coverage and a technically sound sampling program. The monitoring within each waterbody under DEP's purview will commence no later than the activation of any constructed CSO abatement facility. In those waterbodies where constructed facilities are not proposed, sampling will commence no later than the summer following DEC approval of the WB/WS Facility Plan.



Environmental Protection

Flushing Bay and Creek
Post Construction Monitoring Locations

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE 8-1

8.3.2 Floatables Monitoring Program

The Flushing Bay Waterbody/Watershed Facility Plan incorporates by reference the *Citywide Comprehensive CSO Floatables Plan Modified Facility Planning Report* (DEP, 2005a) and *Addendum 1 – Pilot Floatables Monitoring Program* (December 2005) to the Floatables Plan. These documents contain a conceptual framework for the monitoring of floatables conditions in New York Harbor and a work plan for the ongoing pilot program to develop and test the monitoring methodology envisioned in the framework. The objectives set forth in the Floatables Plan provides a metric for LTCP performance, and floatables monitoring is conducted in conjunction with post-construction compliance monitoring with regard to staffing, timing, and location of monitoring sites. The program includes the collection of basic floatables presence / absence data from monitoring sites throughout the harbor that will be used to rate and track floatables conditions, correlate rating trends to floatables control programs where applicable, and trigger investigations into the possible causes of consistently poor ratings should they occur. Actions based on the floatables monitoring data and investigations could include short-term remediation in areas where monitored floatables conditions create acute human or navigation hazards and, as appropriate, longer-term remediation actions and modifications to the Flushing Bay WB/WS Facility Plan if monitored floatables trends indicate impairment of waters relative to their intended uses. Currently, the results of this ongoing monitoring program are reported in the annual BMP report.

8.3.3 Meteorological Conditions

The performance of any CSO control facility cannot be fully evaluated without a detailed analysis of precipitation, including the intensity, duration, total rainfall volume, and precipitation event distribution that led to an overflow or, conversely, the statistical bounds within which the facility may be expected to control CSO completely. DEP has established 1988 as representative of long-term average conditions and therefore uses it for analyzing facilities where "typical" conditions (rather than extreme conditions) serve as the basis for design. The comparison of rainfall records at JFK airport from 1988 to the long-term rainfall record is shown in Table 8-3, and includes the return period for 1988 conditions.

Table 8-3. Rainfall Statistics, JFK Airport, 1988 and Long-Term Average

Statistic	1970-2002 Median	1988	
		Value	Return Period (years)
Total Volume (inches)	39.4	40.7	2.6
Intensity, (in/hr)	0.057	0.068	11.3
Number of Storms	112	100	1.1
Storm Duration (hours)	6.08	6.12	2.1

In addition to its aggregate statistics indicating that 1988 was representative of overall long-term average conditions, 1988 also includes critical rainfall conditions during both beach season and shellfishing periods. Further, the average storm intensity for 1988 is greater than one standard deviation from the mean so that using 1988 as a design rainfall year would be conservative with regard to water quality impacts since CSOs and stormwater discharges are driven primarily by rainfall intensity. However, considering the complexity and stochastic nature of rainfall, selection of any year as "typical" is ultimately qualitative.

Given the uncertainty of the actual performance of the proposed upgrades and the response of Flushing Bay with respect to widely varying precipitation conditions, rainfall analysis is an essential component of the post-construction compliance monitoring. Multiple Sources of rainfall data will be compiled as part of the final City-Wide Post-Construction Monitoring Program. On an interim basis, however, the primary source of rainfall data will be from La Guardia Airport and from any DEP gauges that may be available. The use of NEXRAD cloud reflectivity data as proposed in the Waterbody/Watershed Facility Plan will be limited to testing implementation techniques until its utility is fully understood. Any data sets determined to be of limited value in the analysis of compliance may be discontinued.

8.3.4 Analyses

The performance of the Flushing Bay WB/WS Facility Plan will be evaluated on an annual basis using a landside mathematical computer model as approved by DEC. The collection system model that was used in the development of the present WB/WS Facility Plan is expected to serve as the basis for future model-related activities. In addition, DEP believes that the analysis of water quality compliance is best accomplished using computer modeling supported and verified with a water quality monitoring program. Modeling has several advantages over monitoring:

- Modeling provides a comprehensive vertical, spatial, and temporal coverage that cannot reasonably be equaled with a monitoring program;

- Modeling provides the data volume necessary to compute aggregate statistical compliance values, such as a geometric mean, an absolute limit (e.g., "never-less-than" or "not-to-exceed"), or a cumulative statistic;

- Discrete grab sampling for data collection is necessarily biased to locations and periods of logistical advantage, such as navigable waters, safe weather conditions, daylight hours, etc.; and

- Quantification of certain chemical parameters must be performed in a laboratory setting which either (a) complicates the use of a smaller sampling vessel that is necessary to access shallower waters not navigable by a vessel with on-board laboratory facilities or (b) limits the number sampling locations that can be accessed due to holding times and other laboratory quality assurance requirements if remote laboratory (non-vessel mounted) facilities are used.

The InfoWorks collection system model of the Bowery Bay and Tallman Island WWTP service area was developed under the LTCP project based in part on historical models used in facility planning. InfoWorks is a state-of-the-art modeling package that includes the ability to represent storage tunnel dynamics, hydraulic analyses and other sophisticated aspects of performance within the collection system. Overflow volumes will be quantitatively analyzed on a monthly basis to isolate any periods of performance issues and their impact on water quality. Water quality modeling re-assessment will be conducted every two years based on the previous two years water quality field data. Modeling conditions will be based on the hydrodynamic and meteorological conditions for the study year, documented operational issues that may have impacted the facility performance, and water quality boundary conditions based on the Harbor Survey data from outside Flushing Bay. Results will be compared to the Harbor Survey data collected within Flushing Bay to validate the water quality modeling system, and performance will be expressed in a quantitative attainment level for applicable numerical criteria based on the receiving water model. Should this analysis indicate that progress towards the desired results is not being made, the analysis will:

- Re-verify all model inputs, collected data and available QA/QC reports;
- Consult with operations personnel to ensure unusual operational problems (e.g., screening channel o/s, pump repair, etc.) were adequately documented;
- Evaluate specific periods of deviations from modeled performance.
- Confirm that all operational protocols were implemented, and that these protocols are sufficient to avoid operationally-induced underperformance;
- Re-evaluate protocols as higher frequency and routine problems reveal themselves; and finally
- Revise protocols as appropriate and conduct Use Attainability Analysis (UAA) and if necessary, revise WB/WS Facility Plan.

Following completion of the tenth annual report containing data during facility operation, a more detailed evaluation of the capability of the Flushing Bay Waterbody/Watershed Facility Plan to achieve the desired water quality goals will take place, with appropriate weight given to the various issues New York City identified during the evaluations documented in the annual reports. If it is determined that the desired results are not achieved, DEP will implement additional measures to improve levels of attainment under typical precipitation conditions. Alternatively, the water quality standards revision process may commence with a UAA that would likely rely in part on the findings of the post-construction compliance monitoring program. The approach to future improvements beyond the 10-year post-construction monitoring program will be dictated by the findings of that program as well as the input from DEC SPDES permit and CSO Consent Order administrators.

8.3.5 Reporting

Post-construction compliance monitoring will be added to the annual BMP report submitted by DEP in accordance with their SPDES permits. The monitoring report will include an overview of the performance of the Flushing Bay CSO Storage Facility, although the official facility overflow reporting will remain in the monthly operating report as required by the SPDES permits. Summary statistics on rainfall, the amount of combined sewage, and the proportions directed to the WWTP, and bypassed to the associated CSO outfalls will be provided in the Annual BMP Report. Verification and refinement of the model framework as necessary will be documented, and modeling results will be presented to assess water quality impacts in lieu of high-resolution sampling. Analyses of precipitation, temperature effects, and other conditions external to the CSO Facility performance will also be included in the Annual BMP Report.

In addition to the information to be provided in the Annual BMP Report, DEP will submit a summary of the monitoring and modeling, including the data, once every five years. DEC has acknowledged that the variability in precipitation dynamics may require more than five successive years of data to statistically validate the models used for evaluating compliance, but have nonetheless stated that this information will be used to identify areas of significant water quality non-compliance and gaps in the water quality modeling, and measure progress with the LTCP goals. They have also stated that they intend to verify the 1988 rainfall data as the "average" year.

8.4 OPERATIONAL PLAN

USEPA guidance specifies that municipalities should be required to develop and document programs for operating and maintaining the components of their combined sewer systems (EPA, 1995a). Prior to new facilities being placed into service, the municipality's operation and maintenance program should be modified to incorporate the facilities and operating strategies associated with selected controls. To this end, DEP has developed and submitted wet weather operating plans (WWOPs) for both the Tallman Island and Bowery Bay WPCPs. These WWOPs will be appended to the drainage basin specific Long Term Control Plan (LTCP) for Flushing Bay when it is developed.

Because this Waterbody/Watershed Facility Plan requires review and approval by DEC, the operational plan for the remaining components will be developed subsequent to that approval and after all components are designed.

Upon implementation of the Waterbody/Watershed Plan elements, DEP intends to operate the facilities as designed. However, it is both environmentally responsible and fiscally prudent to be responsive to changing and unforeseen limitations and conditions. An adaptive management approach will be employed to accomplish this flexibility. Post-construction compliance monitoring may trigger a sequence of more detailed investigations that, depending on the findings, could culminate in corrective actions. During the first nine post-construction years, the analysis will ultimately determine whether the performance of the CSO controls was adequate. If the performance is unacceptable, the finding will be verified, the causes will be identified, and reasonable corrective actions will be taken. Modifications and retrofits that are implemented and demonstrate improvement will be documented through the issuance of an LTCP update, subject to DEC approval.

8.5 SCHEDULE

Figure 8-2 presents the schedule for the elements of the Flushing Bay Waterbody/Watershed Plan, along with relevant aspects of the programmatic controls. It should be noted that elements shown in this schedule address the implementation of the recommended Waterbody/Watershed Facility Plan elements only. As noted in the Order on Consent (Section III.C.2) “once the DEC approves a WB/WS Facility Plan, the approved WB/WS Facility Plan is hereby incorporated by reference, and made an enforceable part of the Consent Order".

8.6 CONSISTENCY WITH FEDERAL CSO POLICY

The Flushing Bay Waterbody/Watershed Plan was developed so that it satisfies the requirements of the Federal CSO Control Policy. Through extensive water quality and sewer system modeling, data collection, community involvement and engineering analysis, DEP has adopted a plan that incorporates the findings of two decades of inquiry to achieve the highest reasonably attainable use of Flushing Bay. This Waterbody/Watershed Plan addresses each of the nine minimum elements of long-term CSO control as defined by federal policy and shown in Table 8-4. The CSO Consent Order requires submission of a Flushing Bay LTCP six months after approval of this WB/WS Facility Plan, but in accordance with ongoing discussions, this date will be extended.

Table 8-4. Nine Elements of Long-Term CSO Control

Element	Report Section	Summary
1. Characterization, Monitoring, and Modeling of the Combined Sewer System	3	Addressed during facility planning (1980s, 1990s), and supplemented during the USA Project (2000-2001), and current WWFP development (2006).
2. Public Participation	6	The WWFP was developed with active involvement from the affected public and other stakeholders during plan development and environmental quality assessments.
3. Consideration of Sensitive Areas	4	There are no sensitive areas identified within Flushing Bay that are directly impacted by CSO discharges.
4. Evaluation of Alternatives	7.0	A wide range of alternatives were considered.
5. Cost/Performance Considerations	7.0	Knee of the curve analyses were performed that compared % CSO reduction and receiving water quality improvement with cost.
6. Operational Plan	8.0	DEP will continue to satisfy the operational requirements of the BMPs for CSO control, including the Bowery Bay and Tallman Island WWTP Wet Weather Operating Plans. The BMPs satisfy the nine minimum control requirement of federal CSO policy. DEP will also continue implementation of other programmatic controls.
7. Maximizing Treatment at the Existing WPCP	7.0	Both the Bowery Bay and Tallman Island WWTPs will be upgraded to treat two times the design dry weather flows.
8. Implementation Schedule	8.0	Facility plan complete and all components operational within 21 years after approval of WB/WS facility plan by DEC
9. Post-Construction Compliance	8.0	Constructed facilities will be monitored per SPDES

Table 8-4. Nine Elements of Long-Term CSO Control

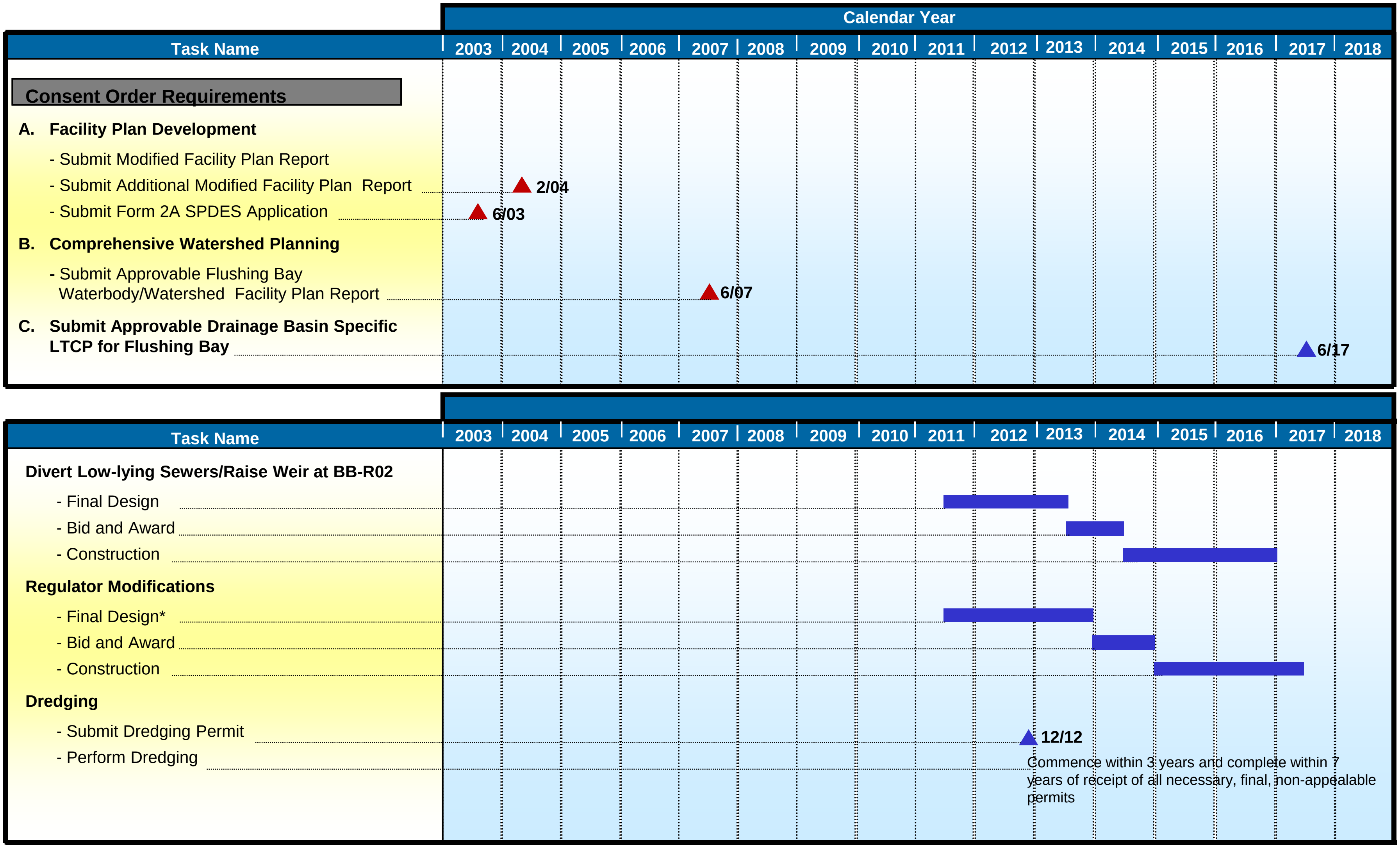
Element	Report Section	Summary
Monitoring		requirements; Monitoring data will be used to assess effectiveness, to optimize facility performance, and to trigger adaptive management alternatives.

8.7 ANTICIPATED WATER QUALITY IMPROVEMENTS

The selected alternative will reduce average annual CSO volumes from Baseline conditions as shown in Table 8-5; water quality conditions projected with implementation of the Waterbody/Watershed Facility Plan are presented in Figures 8-3 through 8-5. In addition to the reductions in overflow volumes, the implementation of the Waterbody/Watershed Facility Plan will improve water quality as follows:

- No excursions of the fecal coliform or total coliform monthly geometric mean numerical criteria in Flushing Bay.

- The recommended plan is projected to increase the minimum DO concentrations in the Bay from being greater than 4.0 mg/L 92 percent of the time annually to 93 percent of the time annually. During July (the most DO impaired month for Flushing Bay), the minimum percentage of the time that DO levels are at or greater than 4.0 mg/L will increase from 56 percent to 64 percent.



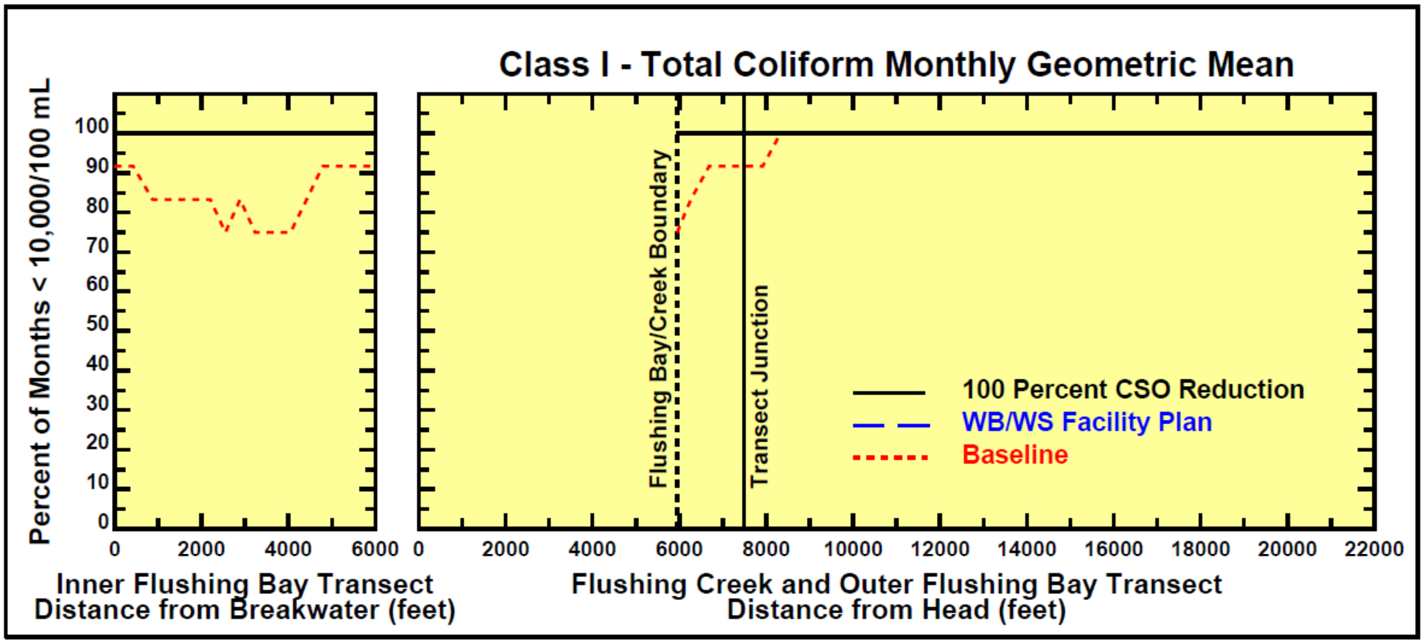
*Design of the regulator modifications will include an evaluation of passive floatables controls

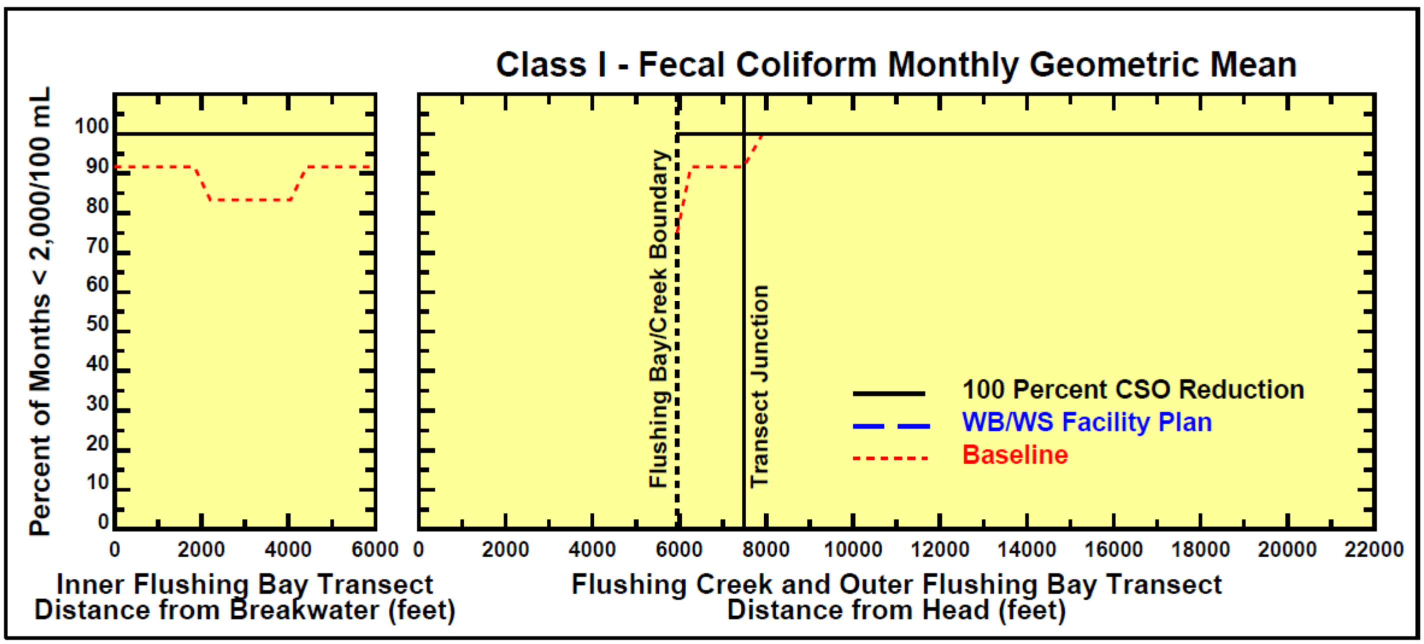
Legend: Completed | Not Completed | Milestones

NYC Environmental Protection

Flushing Bay WWFP Schedule

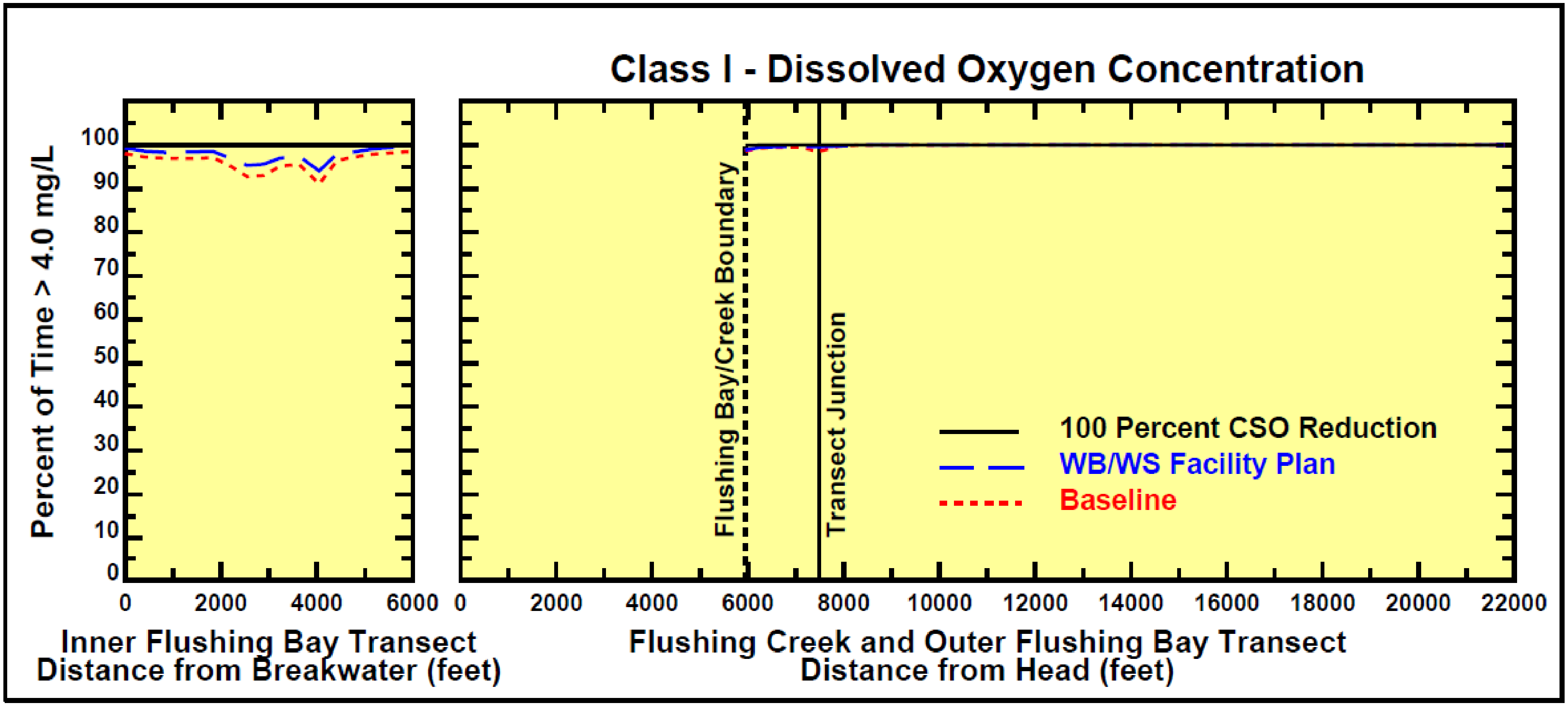
FIGURE 8-2





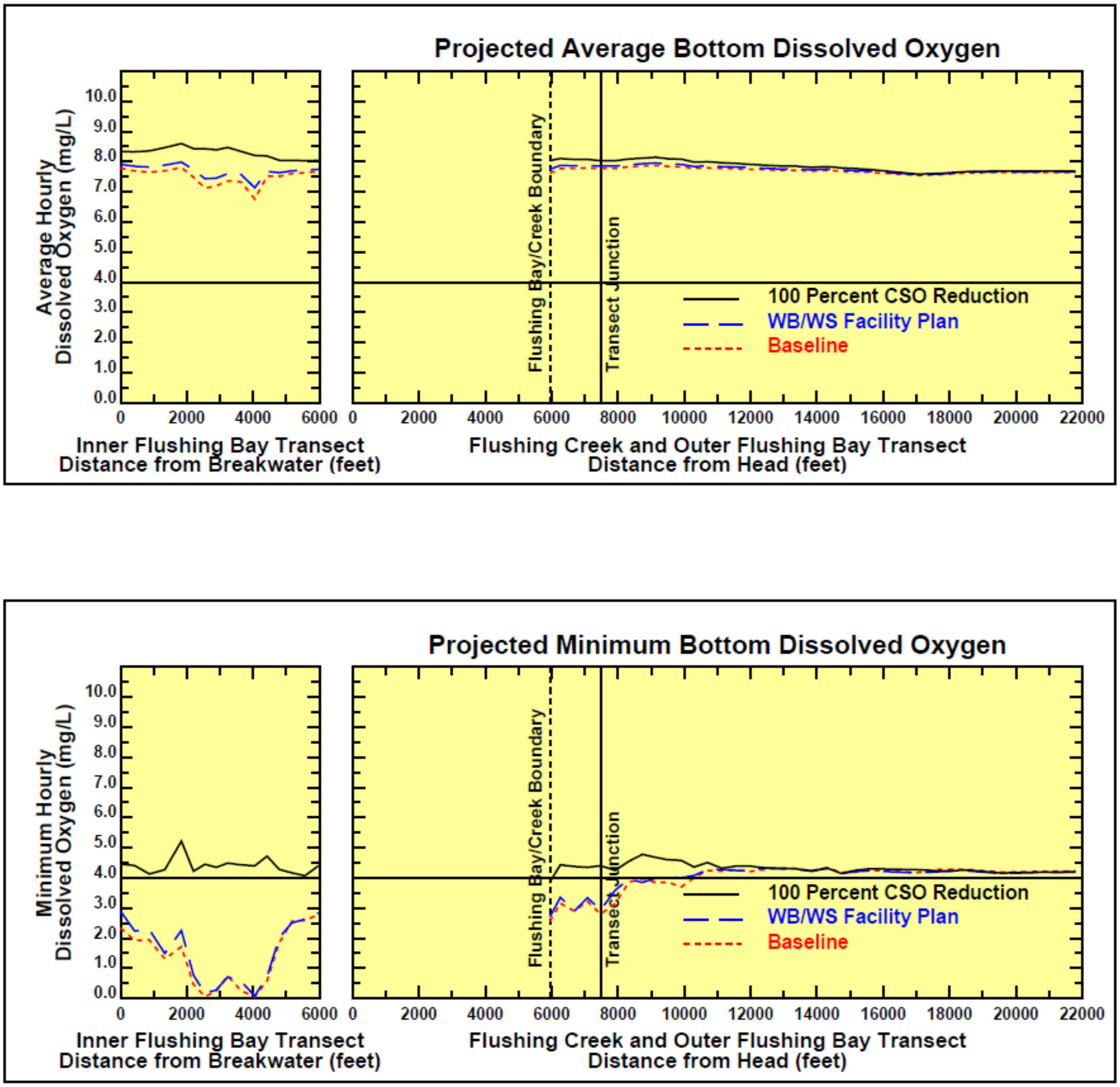
NYC Environmental Protection

Flushing Bay and Creek Total and Fecal Coliform Annual Projections



Environmental Protection

Projected Annual DO Above 4.0 mg/L



Environmental Protection

Flushing Bay and Creek Dissolved Oxygen Annual Projections

FIGURE 8-5

Table 8-5. Summary of Flushing Bay WB/WS Facility Plan Untreated Overflow Reductions

Outfall Number	Baseline Annual Overflow Volume (MG)	Waterbody/ Watershed Facility Plan Annual Overflow Volume (MG)	Percent Reduction
BB-006	1,539	1236	20%
BB-007	179	33	82%
BB-008	559	557	0%
TI-016	28	28	0%
TI-013	12	12	0%
TI-012	6	6	0%
TI-014	2	2	0%
TI-018	2	2	0%
TI-015	1	1	0%
TI-017	0	0	0%
TOTAL	**2,328**	**1,877**	**19%**
Note 1: Totals may not sum exactly due to rounding.			

In addition, there will be aesthetic improvements associated with dredging of the CSO mounds that emit hydrogen sulfide gas and reduction of the floatables as a result of the recommended plan. Discharges of CSO floatables to the Inner Bay will be reduced by 19 percent due to an in-kind reduction in discharge volume.

Dredging combined with a reduction in CSO volume would reduce TOC levels in the vicinity of the outfall improving sediment and water quality in these areas. A reduction in TOC has been shown to correlate well with an increase in benthic diversity in the substrate (DEP 2004). A review of organic enrichment of estuaries and marine waters by Pearson and Rosenberg (1978) and a recent review by Hyland et al. (2000) under the auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO) confirm the general applicability of the relationship of TOC to benthic diversity. The benefits of this reduction in sediment TOC would include a more diverse benthic community, but these benefits would be limited to the treatment area and would make a small contribution to the overall Harbor ecosystem.

Although the improvement in water quality conditions through CSO abatement will enhance aquatic life uses, other factors, primarily physical habitat, may become limiting. Even with DO near or above the regulatory limit, the historic loss of extensive fringing wetlands, diverse natural shorelines, and benthic habitat suitable for colonization have substantially reduced biological diversity. Improvement in DO and a reduction in the discharge of organic matter will result in an improvement in the sediments through reduction of the percentage of sediment TOC. However, as long as the substrate is dominated by fine grain material, many invertebrate species will be excluded. Although the productivity of soft sediments can be high, because of a lack of diversity in the benthic community, many fishes will make limited use of the habitat due to a lack of their preferred prey. The potential gain in aquatic life usage in Flushing Bay diminishes rapidly above the regulatory DO limit of 4.0 mg/L due to the limitations of physical habitat.

After implementation of this Waterbody/Watershed Facility Plan, Flushing Bay would provide conditions for aquatic life that could increase the number of species and duration of fishable conditions throughout the bay. However, the actual use of the Bay for fishing may be limited by access to the shoreline and the perception by the community that the water quality is still degraded. Seasonal non-compliance with DO standards in the Bay would not inhibit any habitat restoration programs or the development of waterfront amenities such as parkland and shoreline greenways that may be developed by other stakeholders. Use of these facilities for fishing or other recreational uses would not be contingent upon full compliance with water quality standards. Many of the target species for anglers in the NY/NJ Harbor, such as striped bass, bluefish, and weakfish, are transient on a daily time scale so that angling success is not closely tied to water quality once the regulatory limit is approached or slightly exceeded.

The extensive development of the shorelines for industrial, commercial and residential uses is a factor which places limits on both water quality and aquatic habitat availability and quality. In a highly modified system such as Flushing Bay, the protection and use of aquatic resources need to reflect that water quality and habitat will always be less than ideal due to irreversible changes in the watershed.

8.8 GREEN STRATEGY ASSESSMENTS AND IMPLEMENTATION

The *NYC Green Infrastructure Plan*, as described in section 5.8, included five key components: construct cost effective grey infrastructure; optimize the existing wastewater system through interceptor cleaning and other maintenance measures; control runoff from 10 percent of impervious surfaces through green infrastructure; institute an adaptive management approach to better inform decisions moving forward; and engage stakeholders in the development/implementation of these green strategies.

As part of the LTCP process, DEP will evaluate green infrastructure in combination with other LTCP strategies to better understand the extent to which green infrastructure would provide incremental benefits and would be cost-effective. DEP models will be refined by including new data collected from green infrastructure pilots, new impervious cover data and extending predictions to ambient water quality for the development of the LTCP. Based on these evaluations, and in combination with cost effective grey infrastructure, DEP will reassess the green infrastructure strategy.

9.0. Water Quality Standards Review

The Flushing Bay Waterbody/Watershed Facility Plan is a component of the New York City Department of Environmental Protection's Combined Sewer Overflow Long-Term Control Plan. This Plan is being prepared in a manner fully consistent with USEPA's CSO Control Policy, the Wet Weather Water Quality Act of 2000 and applicable USEPA guidance.

As noted in Section 1.2 and as stated in the Clean Water Act (CWA), it is a national goal to achieve "fishable/swimmable" water quality in the nation's waters wherever attainable. The CSO Policy also reflects the CWA's objectives to achieve high water quality standards (WQS) by controlling CSO impacts, but the Policy recognizes the site-specific nature of CSOs and their impacts and provides the necessary flexibility to tailor controls to local situations. The key principles of the CSO Policy were developed to ensure that CSO controls are cost-effective and meet the objectives of the CWA. In doing so, the Policy provides flexibility to municipalities to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements. The Policy also provides for the review and revision, as appropriate, of water quality standards when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs.

In 2001, USEPA published guidance for coordinating CSO long-term planning with water quality standards reviews. This guidance re-affirmed that USEPA regulations and guidance provide States with the opportunity to adapt their WQS to reflect site-specific conditions related to CSOs. The guidance encouraged the States to define more explicitly their recreational and aquatic life uses and then, if appropriate, modify the criteria accordingly to protect the designated uses.

The Flushing Bay Waterbody/Watershed Facility Plan was developed in a manner consistent with the CSO Policy and applicable guidance. Specifically, cost-effectiveness and knee-of-the-curve evaluations were performed for CSO load reduction evaluations using long-term rainfall records. Baseline and Waterbody/Watershed Facility Plan receiving water impact evaluations were performed for average annual rainfall conditions consistent with CSO Policy guidance. The plan resulting from following EPA regulations and guidance results in substantial benefits. However, it does not fully attain the "fishable/swimmable" goal. When the planning process has this result, the national policy calls for a review and, where appropriate, a revision to water quality standards. The purpose of this section therefore is to address the water quality standards review and revision guidance applicable to the CSO Policy.

9.1 WATER QUALITY STANDARDS REVIEW

9.1.1 Numeric Water Quality Standards

New York State waterbody classifications and numerical criteria which are or may become applicable to Flushing Bay are shown in Table 9-1. This waterbody is classified as Class I at present with its best use described as secondary contact recreation and fishing.

Although this classification and the dissolved oxygen criterion of never-less-than 4.0 mg/L is also considered to be suitable for fish propagation and survival, a goal of the CWA, the recreational classification of secondary contact is not consistent with the "swimmable" or primary contact use goal. Satisfaction of this goal would require reclassification of Flushing Bay to Class SB or SC which are suitable for primary contact recreation. Reclassification of Flushing Bay to the fishable/swimmable Class SB/SC requires more stringent numerical coliform bacteria criteria and also increases the minimum dissolved oxygen requirement to never-less-than 5.0 mg/L from 4.0 mg/L.

Table 9-1. New York State Numeric Surface Water Quality Standards (Saline)

Class	DO (mg/L)	Bacteria (Pathogens) Total Coliform[1,4] (per 100 mL)	Fecal Coliform[2,4] (per 100 mL)	Enterococci[3] (per 100 mL)
I	>4.0	<10,000	<2,000	NA
SB, SC	>5.0	<2,400 <5,000	<200	<35

Notes: (1) Total coliform criteria are based on monthly geometric means for Class I, and on monthly medians for Classes SB and SC; second criterion for SC and SB is for 80 percent of samples. (2) Fecal coliform criteria are based on monthly geometric means. (3) The enterococci standard is based on monthly geometric means per the USEPA Bacteria Rule and applies to the bathing season. The enterococci coastal recreation water infrequent use reference level (upper 95 percent confidence limit) = 501/100 mL. (4) Per 6 NYCRR 703.4(c), bacteria standards are only applicable when disinfection is practiced. n/a: not applicable.

The Interstate Environmental Commission (IEC) waterbody classifications applicable to waters within the Interstate Environmental District are shown in Table 9-2. The East River and its tidal tributaries including Flushing Bay are classified as Class B-1 with best intended uses of fishing and secondary contact recreation.

Table 9-2. Interstate Environmental Commission Classifications, Criteria and Best Uses

Class	Dissolved Oxygen	Best Intended Use
A	>5.0 mg/L	Suitable for all forms of primary and secondary contact recreation and for fish propagation. In designated areas, they also shall be suitable for shellfish harvesting.
B	>4.0 mg/L	Suitable for fishing and secondary contact recreation. They shall be suitable for the growth and maintenance of fish life and other forms of marine life naturally occurring therein, but may not be suitable for fish propagation.
C	>3.0 mg/L	Suitable for passage of anadromous fish and for the maintenance of fish life in a manner consistent with the criteria established in Sections 1.01 and 1.02 of these regulations.

IEC bacterial standards apply to effluent discharges from municipal and industrial wastewater treatment plants and do not apply to receiving waters.

9.1.2 Narrative Water Quality Standards

The New York State narrative water quality standards which are applicable to Flushing Bay and all waterbody classifications are shown in Table 1-2 and restated here in Table 9-3. The IEC narrative water quality regulations which are applicable to Flushing Bay and all waters of the Interstate Environmental District are shown in **Error! Reference source not found.**. Note that the DEC narrative water quality standards apply a limit of "no" or "none" and that these restrictions are conditioned on the impairment of waters for their best usages for only selected parameters.

Table 9-3. New York State Narrative Water Quality Standards

Parameters	Classes	Standard
Taste-, color-, and odor producing toxic and other deleterious substances	SA, SB, SC, I, SD A, B, C, D	None in amounts that will adversely affect the taste, color or odor thereof, or impair the waters for their best usages.
Turbidity	SA, SB, SC, I, SD A, B, C, D	No increase that will cause a substantial visible contrast to natural conditions.
Suspended, colloidal and settleable solids	SA, SB, SC, I, SD A, B, C, D	None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.
Oil and floating substances	SA, SB, SC, I, SD A, B, C, D	No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.
Garbage, cinders, ashes, oils, sludge and other refuse	SA, SB, SC, I, SD A, B, C, D	None in any amounts.
Phosphorus and nitrogen	SA, SB, SC, I, SD A, B, C, D	None in any amounts that will result in growth of algae, weeds and slimes that will impair the waters for their best usages.

Table 9-4. Interstate Environmental Commission Narrative Regulations

Classes	Regulation
A, B-1, B-2	All waters of the Interstate Environmental District (whether of Class A, Class B, or any subclass thereof) shall be of such quality and condition that they will be free from floating solids, settleable solids, oil, grease, sludge deposits, color or turbidity to the extent that none of the foregoing shall be noticeable in the water or deposited along the shore or on aquatic substrata in quantities detrimental to the natural biota; nor shall any of the foregoing be present in quantities that would render the waters in question unsuitable for use in accordance with their respective classifications.
A, B-1, B-2	No toxic or deleterious substances shall be present, either alone or in combination with other substances, in such concentrations as to be detrimental to fish or inhibit their natural migration or that will be offensive to humans or which would produce offensive tastes or odors or be unhealthful in biota used for human consumption.
A, B-1, B-2	No sewage or other polluting matters shall be discharged or permitted to flow into, or be placed in, or permitted to fall or move into the waters of the District, except in conformity with these regulations.

9.1.3 Attainability of Water Quality Standards

Section 8.7 summarizes water quality modeling analyses which were performed to evaluate attainability of water quality standards under Baseline and Waterbody/Watershed (WB/WS) Facility Plan conditions. The results of these analyses are summarized graphically in Appendix E and in tabular form in Table 9-6 through Table 9-13 for the various numerical criteria for dissolved oxygen and bacteria for current and fishable/swimmable classifications. Sampling locations are shown on Figure E-1 and in tabular form in Table 9-5. Sampling locations 1 and 2 are located within Flushing Creek and will not be discussed in this report.

Table 9-5. Sampling Locations in Flushing Bay and Creek

Waterbody	Location	Description
Flushing Creek	(1) Near Head End	1,000 ft from head end
	(2) Mid-Creek	4,000 ft from head end
Inner Flushing Bay	(3) Mouth of Flushing Creek	Confluence with Inner Flushing Bay
	(4) Breakwater	Near the Breakwater
	(5) Near CSO	Near CSO Outfall BB-006
Flushing Bay	(6) Mid-Bay	14,000 ft from head end of Flushing Creek
	(7) Near East River	18,000 ft from head end of Flushing Creek

Attainability of Currently Applicable Standards

Dissolved oxygen and coliform levels were modeled at seven locations throughout Flushing Creek, Inner Flushing Bay and Flushing Bay as shown on Figure E-1 in Appendix E and as tabulated below. Table 9-6 summarizes the projected percentage annual attainability of dissolved oxygen for current Class I and IEC Class B-1 criteria for Baseline and WB/WS Facility Plan conditions, as shown graphically in Figure 8-7.

In the Inner Flushing Bay, the WB/WS Facility Plan is projected to achieve very high levels of dissolved oxygen attainment annually with a minimum attainment of 95 percent near CSO Outfall BB-006. Complete annual attainment is expected in the remainder of Flushing Bay.

Table 9-6. Annual Attainability of Dissolved Oxygen Criteria for Design Year

		Classes I & IEC B-1 (>4.0 mg/L) Percent Attainment	
Waterbody	**Location**	**Baseline**	**WB/WS FP**
Inner Flushing Bay	(3) Mouth of Flushing Creek	100	100
	(4) Breakwater	99	99
	(5) Near CSO	92	93
Flushing Bay	(6) Mid-Bay	100	100
	(7) Near East River	100	100

Table 9-7 summarizes the projected annual percent attainability of total coliform for Class I criteria as shown graphically in Figure 8-9. The WB/WS Facility Plan is expected to completely attain the criteria for all of Flushing Bay.

Table 9-7. Annual Attainability of Total Coliform Criteria for Design Year

		Classes I GM <10,000 Percent Attainment	
Waterbody	**Location**	**Baseline**	**WB/WS FP**
Inner Flushing Bay	(3) Mouth of Flushing Creek	92	100
	(4) Breakwater	92	100
	(5) Near CSO	83	100
Flushing Bay	(6) Mid-Bay	100	100
	(7) Near East River	100	100

Table 9-8 shows similar conditions for fecal coliform as shown graphically in Figure 8-9. For current Class I secondary contact criteria, the WB/WS Facility Plan achieves complete attainment throughout Flushing Bay from Baseline conditions of non-attainment.

Table 9-8. Annual Attainability of Fecal Coliform Criteria for Design Year

		Classes I GM <2,000 Percent Attainment	
Waterbody	**Location**	**Baseline**	**WB/WS FP**
Inner Flushing Bay	(3) Mouth of Flushing Creek	100	100
	(4) Breakwater	100	100
	(5) Near CSO	92	100
Flushing Bay	(6) Mid-Bay	100	100
	(7) Near East River	100	100

Attainability of Potential Future Standards

DEC considers Class I dissolved oxygen standards supportive of aquatic life uses and consistent with the “fishable” goal of the CWA. Therefore, a standards reclassification would not be necessary for full use attainment in Flushing Bay. However, the Class I secondary contact use is not considered consistent with the “swimmable” goal. To revise the classification of Flushing Bay to be fully supportive of primary contact uses, it would be necessary to comply with Class SB/SC criteria for dissolved oxygen, total and fecal coliform, and to the enterococci criterion and reference level established by USEPA. Table 9-9 through Table 9-13 summarize projected percentage annual and recreation season attainability of these potential criteria.

Table 9-9 presents the annual attainability of Class SB/SC primary contact criteria for total coliform. This data is shown graphically in Figure E-2 in Appendix E. As shown, the WB/WS Facility Plan improves attainment of both the monthly median and upper limit from Baseline conditions but does not achieve either criterion. Table 9-10 shows geometric mean monthly attainment during the recreation season, the three summer months of June, July, and August which encompasses the official public bathing season at New York City's seven public bathing beaches, as shown graphically in Figure E-3 in Appendix E. The WB/WS Facility Plan achieves complete attainment of the primary contact median criterion and attains the upper limit criterion for two of the three months of the recreation season. Similar results are evident for fecal coliform as shown in Table 9-11 and Table 9-12: the WB/WS Facility Plan improves attainment from the Baseline but does not achieve full attainment as determined on an annual basis, and achieves attainment during the summer months.

Table 9-9. Annual Attainability of SB/SC Total Coliform Criteria

		Class SB/SC Percent Attainment			
		Median <2,400		80% <5,000	
Waterbody	**Location**	**Baseline**	**WB/WS FP**	**Baseline**	**WB/WS FP**
Inner Flushing Bay	(3) Mouth of Flushing Creek	58	92	25	42
	(4) Breakwater	58	92	17	50
	(5) Near CSO	58	92	8	50
Flushing Bay	(6) Mid-Bay	92	100	50	83
	(7) Near East River	100	100	83	100

Table 9-10. Recreation Season Attainability of SB/SC Total Coliform Criteria

		Class SB/SC Percent Attainment			
		Median <2,400		80% <5,000	
Waterbody	**Location**	**Baseline**	**WB/WS FP**	**Baseline**	**WB/WS FP**
Inner Flushing Bay	(3) Mouth of Flushing Creek	67	100	67	67
	(4) Breakwater	67	100	33	67
	(5) Near CSO	67	100	33	67
Flushing Bay	(6) Mid-Bay	100	100	67	67
	(7) Near East River	100	100	67	100

Table 9-11. Annual Attainability of SB/SC Fecal Coliform Criteria

		Class SB/SC GM <200 Percent Attainment	
Waterbody	**Location**	**Baseline**	**WB/WS FP**
Inner Flushing Bay	(3) Mouth of Flushing Creek	42	75
	(4) Breakwater	50	83
	(5) Near CSO	42	75
Flushing Bay	(6) Mid-Bay	75	92
	(7) Near East River	100	100

Table 9-12. Recreation Season Attainability of SB/SC Fecal Coliform Criteria

Waterbody	Location	Class SB/SC GM <200 Percent Attainment	
		Baseline	WB/WS FP
Inner Flushing Bay	(3) Mouth of Flushing Creek	67	100
	(4) Breakwater	67	100
	(5) Near CSO	67	100
Flushing Bay	(6) Mid-Bay	100	100
	(7) Near East River	100	100

Table 9-13 summarizes the projected attainability of potential enterococci criteria which could be applied to Flushing Bay for primary contact water use as shown graphically in Figure E-6 in Appendix E. It is noted that the attainment values shown on Table 9-13 are for the three month period of June, July and August as the enterococci criteria were developed specifically for the bathing season. The table shows that the WB/WS Facility Plan achieves 100% attainment of the seasonal geometric mean throughout Flushing Bay but does not completely attain the infrequent use coastal recreation water reference level (upper 95% confidence limit).

Table 9-13. Recreation Season Attainability of Enterococci Bacteria for Design Year

Waterbody	Location	Water Quality Criterion Geometric Mean <35		Infrequent Use Reference Level <501	
		Median <2,400		80% <5,000	
		Baseline	WB/WS FP	Baseline	WB/WS FP
Inner Flushing Bay	(3) Mouth of Flushing Creek	100	100	77	82
	(4) Breakwater	100	100	75	88
	(5) Near CSO	100	100	75	86
Flushing Bay	(6) Mid-Bay	100	100	87	91
	(7) Near East River	100	100	95	95

9.1.4 Attainment of Narrative Water Quality Standards

Table 9-3 summarizes DEC narrative water quality standards which are applicable to Flushing Bay and all waters of New York State. The existing CSO discharges to the area and the stormwater discharge measureable amounts of materials which affect some of the listed parameters. Periodic odors in Inner Flushing Bay are the result of deposition of organic solids, oil, floating substances and/or floatable materials.

The WB/WS Facility Plan will not completely eliminate, but will greatly reduce, the discharge of these materials to Flushing Bay. For Inner Flushing Bay, the storage tunnel, regulator improvements, bending weirs, and outfall improvements will reduce the volumetric loading of narrative materials by 50 percent. Further, floatable materials to Inner Flushing Bay will be 100 percent eliminated by netting systems installed on each local CSO outfall. The dredging of Inner Flushing Bay will remove the exposed mud flats which are the primary causes of odors at the present time. Consequently, the adverse impacts of the current CSO discharges will be greatly diminished although not completely eliminated as required by the narrative standards. Additionally, best management practices applied to the separate stormwater discharges cannot completely eliminate impacts from that source but will reduce loadings to the extent feasible.

The WB/WS Facility Plan, although not completely eliminating all of the parameters of concern, will virtually eliminate odors, greatly reduce the deposition of organic solids and floatable materials and restore the aesthetic uses of Flushing Bay to the maximum extent practicable.

9.1.5 Water Uses Restored

Fish and Aquatic Life Protection Use

Table 9-6 presents the expected improvements in dissolved oxygen to be attained by the WB/WS Facility Plan as compared to Baseline conditions for current DEC and IEC dissolved oxygen criteria. The plan is expected to achieve between 95 to 100 percent attainment through Inner Flushing Bay and Outer Flushing Bay for the current Class I and IEC Class B-1 dissolved oxygen criteria on an annual basis. This is considered to be a high level of attainment in terms of the protection of fish and aquatic life, various forms of which spawn throughout almost the entire year. Periodically, dissolved oxygen in Inner Flushing Bay is projected to continue to become depressed for short periods of time subsequent to overflows from facility plan components after very heavy rainfall events.

Flushing Bay in the future, after implementation of the Facility Plan, would provide conditions for aquatic life that could increase the number of species and duration of fishable conditions throughout the bay. However, the actual use of the Bay for fishing may be limited by access to the shoreline and the perception by the community that the Bay water quality is still degraded. Seasonal non-compliance with DO standards in the Bay would not inhibit any habitat restoration programs or the development of waterfront amenities such as parkland and shoreline greenways that may be developed by other stakeholders. Use of these facilities for fishing or other recreational uses would not be contingent upon full compliance with water quality standards. Many of the target species for anglers in the NY/NJ Harbor, such as striped bass, bluefish, and weakfish, are transient on a daily time scale so that angling success is not closely tied to water quality once the regulatory limit is approached or slightly exceeded.

Primary and Secondary Contact Recreation Use

Table 9-7 through Table 9-13 present expected attainment of various bacteriological water quality criteria under both annual and recreational season conditions for the Baseline and WB/WS Facility Plan conditions. It is observed from Table 9-7 (total coliform) and Table 9-8 (fecal coliform) that the WB/WS Facility Plan will almost completely achieve the current Class I secondary contact water quality criteria annually throughout Flushing Bay, which is not currently attained, thus restoring this important recreational use.

Table 9-9 and Table 9-11 indicate that, for a potential Class SB/SC primary contact designation, the WB/WS Facility Plan produces greater attainment of the criteria than exists under Baseline conditions, but that these primary contact water quality criteria would not be completely attained throughout the year.

For the summer recreation season, however, Table 9-10, Table 9-12, and Table 9-13 for total and fecal coliform and enterococci, respectively, indicate that the WB/WS Facility Plan would nearly achieve attainment of the required median or geometric mean requirement for primary contact for total coliform and enterococci throughout Flushing Bay. It is noted that the upper limit criterion for total coliform is exceeded for one of the three summer recreation period months, although not significantly in terms of the modeling calculations and within the limits of model uncertainty. For enterococci, the infrequent use coastal recreation water reference level (upper 95% confidence limit) of 501, relevant to Flushing Bay, is projected to be exceeded due to periodic overflows and stormwater discharges in response to rainfall events. However, the geometric mean enterococci criterion which is more relevant to health protection and which is the enforceable numerical limit for this indicator is expected to be attained.

From the results presented in Table 9-10, Table 9-12, and Table 9-13, it is considered that the WB/WS Facility Plan may achieve a level of bacteriological water quality during the summer recreation period sufficient to satisfy the numerical criteria supportive of primary contact.

Aesthetic Use

As discussed in Section 9.1.4, the WB/WS Facility Plan will not completely eliminate all regulated parameters in the DEC narrative water quality standards to zero discharge levels, but will greatly reduce the volumetric discharge of such substances. Settleable solids will be greatly reduced and the dredging of Inner Flushing Bay will effectively eliminate odors. The effect of floatable materials from CSOs will be virtually eliminated by the proposed positive floatables controls and the effect of materials from stormwater inputs will be reduced to the maximum extent practicable. Accordingly, the aesthetic conditions in Flushing Bay should improve to a level consistent with the other attained water uses and the nature of the adjacent shoreline uses.

9.1.6 Practical Considerations

The previous section describes the improvement in the level of attainment of the DEC Class I and IEC Class B-1 dissolved oxygen criteria which is expected to result from the WB/WS Facility Plan. As noted, the annual attainment is expected to be high in Inner Flushing Bay and Outer Flushing Bay.

During the periods when some criterion excursions are expected, it should be noted that any adverse impact on fish larval propagation may be limited. Fish larvae spawning in Flushing Bay will be exchanged with, and transported to, East River waters where dissolved oxygen will be greater. The organisms will therefore not be continuously exposed to depressed dissolved oxygen in Flushing Bay. Consequently, the impact on larval survival will be less than expected based on laboratory studies where organisms are confined and exposed continuously to the same depressed dissolved oxygen level. Because of the significant amount of larval transport which occurs in Flushing Bay, and the exposure of the organisms to continuously varying, rather than static, dissolved oxygen concentrations, it is considered to be reasonable to view the East River ecosystem in its entirety rather than by individual tributary or sub-region for purposes of fish and aquatic life protection.

For these reasons, it is considered that, for practical purposes, conditions in most of Flushing Bay will be supportive of the fishable goal of the CWA.

Section 9.1.5 also notes that during the summer recreation season, water quality may be supportive of numerical criteria for the swimmable (primary contact recreation) goal of the CWA within the uncertainty of modeling projections. However, swimming should not be considered as a best use due to periodic overflows from the WB/WS Facility Plan, other regional CSO discharges and continuing stormwater discharges. It is also noted that the bacteriological criteria for Flushing Bay is not applicable under State Water Quality Regulations unless disinfection is practiced to protect primary contact as a best use.

9.2 WATER QUALITY STANDARDS REVISION

9.2.1 Overview of Use Attainability and Recommendations

Section 9.1 summarized the existing and potential water quality standards for Flushing Bay and expected levels of attainment based on modeling calculations. For aquatic life protection, the attainment of the water use can be expected to be greater than that suggested by the attainability of numerical criteria during the summer period due to the limited larval residence time in the project area, organism transport to the East River and beyond and the appropriateness of considering the East River ecosystem, both open waters and tributaries, in its entirety rather than as individual components. In addition, the Flushing Bay habitat has been significantly altered by human activity throughout the last century thus limiting its attractiveness as a fish habitat.

For recreational activity, the currently designated use of secondary contact recreation is expected to be attained by the WB/WS Facility Plan. Further, numerical water quality conditions suitable to support primary contact may be attained possibly during the summer recreation season and would be achieved for the most relevant bacteriological indicator, enterococci, although bathing and swimming activities would not be considered the best use.

As a result of the water quality conditions and uses expected to be attained in Flushing Bay as a result of the WB/WS Facility Plan, it is recommended that the current waterbody classification, Class I, be retained at this time. The existing designated use cannot change until and unless a UAA is approved. A UAA would not take place until after project completion and post-construction monitoring data has been evaluated. The water use goals for the Class I classification are expected to be achieved, either numerically or for practical purposes, once the WB/WS Facility Plan is constructed and operational except periodically following overflows after heavy rainfall events. However, the attainment of the designated uses, while expected, should be demonstrated from long-term post construction water quality monitoring data and numerical modeling.

As noted previously, expected levels of water quality criteria compliance are based on modeling calculations which are subject to some level of uncertainty. In addition, calculations are based on a typical year with an average amount of annual rainfall. Therefore, it is recommended that the actual improvements in water quality conditions resulting from the WB/WS Facility Plan be assessed from the multi-year long-term post construction monitoring program described elsewhere in the WB/WS Facility Plan report. The monitoring program will document the actual attainment of uses: whether the current Class I uses are attained as expected; whether other levels of usage are actually achieved supporting a waterbody reclassification, for example, Class SC; or whether CWA "fishable/swimmable" goals are not attained therefore requiring a Use Attainability Analysis and subsequent water quality standards revision.

As described in this report, modeling calculations indicate that complete attainment throughout the Flushing Bay area of some Class I and Class SB/SC water quality criteria on an annual basis, both numerical and narrative, would require 100 percent retention of the area CSO discharges. This water quality based effluent limit (WQBEL) of zero annual overflows is not cost effective nor consistent with the CSO Control Policy. Therefore, until the long-term post-construction monitoring program is completed for Flushing Bay to document conditions actually attained, it is recommended that a variance to the WQBEL be applied for, and approved, for the Flushing Bay WB/WS Facility Plan for appropriate effluent variables.

9.2.2 DEC Requirements for Variances to Effluent Limitations

The requirements for variances to water quality based effluent limitations are described in Section 702.17 of DEC's Water Quality Regulations. The following is an abbreviated summary of the variance requirements which are considered applicable to Flushing Bay. The lettering and numbering are those used in Section 702.17 of DEC's Water Quality Regulations.

> *(a) The department may grant, to a SPDES permittee, a variance to a water quality-based effluent limitation included in a SPDES permit.*
>
> > *(1) A variance applies only to the permittee identified in such variance and only to the pollutant specified in the variance. A variance does not affect or require the department to modify a corresponding standard or guidance value.*
> >
> > *(5) A variance term shall not exceed the term of the SPDES permit. Where the term of the variance is the same as the permit, the variance shall stay in effect until the permit is reissued, modified or revoked.*

(b) A variance may be granted if the requester demonstrates that achieving the effluent limitation is not feasible because:

(1) Naturally occurring pollutant concentrations prevent attainment of the standard or guidance value;

(2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent attainment, unless these conditions may be compensated for by the discharge of sufficient volume of effluent to enable the standard or guidance value to be met without violating water conservation requirements.

(3) human-caused conditions or sources of pollution prevent attainment of the standard or guidance value and cannot be remedied or would cause more environmental damage to correct them to leave in place.

(4) Dams, diversions or other types of hydrologic modifications preclude attainment of the standard or guidance value, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in such attainment.

(5) Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate cover, flow, depth, pools, riffles, and the like, unrelated to chemical water quality, preclude attainment of the standard or guidance value; or

(6) Controls more stringent than those required by section 754.1(a)(1) and (2) of this Title would result in substantial and widespread economic and social impact.

(c) In addition to the requirements of subdivision (b) of this section, the requestor shall also characterize, using adequate and sufficient data and principles, any increased risk to human health and the environment associated with granting the variance compared with attainment of the standard or guidance value absent the variance, and demonstrate to the satisfaction of the department that the risk will not adversely affect the public health, safety and welfare.

(d) The requestor shall submit a written application for a variance to the department. The application shall include:

(1) all relevant information demonstrating that achieving the effluent limitation is not feasible based on subdivision (b) of this section; and

(2) All relevant information demonstrating compliance with the conditions is subdivision (c) of this section.

(e) Where a request for a variance satisfies the requirements of this section, the department shall authorize the variance through the SPDES permit. The variance request shall be available to the public for review during the public notice period for the permit. The permit shall contain all conditions needed to implement the variance. Such conditions shall, at minimum, include:

(1) Compliance with an initial effluent limitation that, at the time the variance is granted represents the level currently achievable by the requestor, and that is no less stringent than that achieved under the previous permit where applicable.

(2) that reasonable progress be made toward achieving the effluent limitations based on the standard or guidance value, including, where reasonable, an effluent limitation more stringent than the initial effluent limitations;

(3) Additional monitoring, biological studies and pollutant minimization measures as deemed necessary by the department.

(4) when the duration of a variance is shorter than the duration of a permit, compliance with an effluent limitation sufficient to meet the underlying standard or guidance value, upon the expiration of the variance; and

(5) A provision that allows the department to reopen and modify the permit for revisions to the variance.

(g) A variance may be renewed, subject to the requirements of this section. As part of any renewal application, the permittee shall again demonstrate that achieving the effluent limitation is not feasible based on the requirements of this section.

(i) The department will make available to the public a list of every variance that has been granted and that remains in effect.

9.2.3 Manner of Compliance with the Variance Requirements

Subdivision (a) authorizes DEC to grant a variance to a "water quality based effluent limitation…included in a SPDES permit." It is understood that the Flushing Bay WB/WS Facility Plan, when referenced in Bowery Bay and Tallman Island WWTP SPDES permits, along with other presumed actions necessary to attain Class I water quality standards, can be interpreted as the equivalent of an "effluent limitation" in accordance with the "alternative effluent control strategies" provision of Section 302(a) of the CWA.

Subdivision (a)(1) indicates that a variance will apply only to a specific permittee, in this case, DEP, and only to the pollutant specified in the variance. It is understood that "pollutant" can be interpreted in the plural, and one application and variance can be used for one or more relevant pollutants. In Flushing Bay, a variance would be needed for the following pollutants: oxygen demanding substances (BOD for dissolved oxygen attainability), and effluent constituents covered by narrative water quality standards (suspended, colloidal and settleable solids; oil and floating substances).

Subdivision (b) requires the permittee to demonstrate that achieving the water quality based effluent limitation is not feasible due to a number of factors. It is noted that these factors are the same as those in 40 CFR 131.10(g) which indicate federal requirements for a Use Attainability Analysis. As with the federal regulations, it is assumed that any one of the six factors is justification for the granting of a variance. The Flushing Bay and Flushing Creek Use Attainability Evaluation report documents the applicability of two of the six factors cited in Subdivision (b): (3) human caused conditions and (4) hydrologic modifications.

Subdivision (c) requires the applicant to demonstrate to the department any increased risk to human health associated with granting of the variance compared with attainment of the water quality standards absent the granting of the variance. As noted above, the variance application is needed for suspended, colloidal and settleable solids, and oil and floating substances in CSOs. Further, as described above in Section 9.1.4, 51 percent volumetric reduction is expected from Baseline CSO loadings to Flushing Bay with 100 percent capture of floatables to Inner Flushing Bay. As summarized above in Section 9.1, the Flushing Bay WB/WS Facility Plan is expected to achieve the current Class I secondary contact recreation criteria which are not attained under Baseline conditions. Therefore, no variance is requested for bacteriological conditions. The Flushing Bay WB/WS Facility Plan will achieve a high level of attainment of the current Class I DO criteria, and for the reasons described above in Section 9.1.5 and Section 9.1.6, very limited risk to the environment is expected absent attainment of the standard.

Subdivision (d) of the variance regulations requires that the requestor submit a written application for a variance to DEC which includes all relevant information pertaining to Subdivisions (b) and (c). DEP will submit a variance application for the Flushing Bay WB/WS Facility Plan to DEC six months before the plan is placed in operation. The application will be accompanied by the Flushing Bay WB/WS Facility Plan report, the Flushing Bay and Flushing Creek Use Attainability Evaluation, and all other supporting documentation pertaining to Subdivisions (b) and (c) and as required by any other subdivisions of the variance requirements.

Subdivision (e) stipulates that approved variances be authorized through the appropriate SPDES permit, be available to the public for review and contain a number of conditions:

- It is assumed that the initial effluent limitation achievable by the permittee at the time the variance becomes effective, after WB/WS Facility Plan construction, will be based upon the performance characteristics of the WB/WS Facility Plan as agreed upon between DEC and DEP. These interim operational conditions will be based on the WB/WS Facility Plan’s design specifications. It is expected that a fact sheet outlining the basis for the WQBEL and interim operational conditions will be appended to the SPDES permits.
- It is assumed that the requirement for demonstration of reasonable progress after construction as required in the permit will include DEP activities such as implementation of the long-term monitoring program and additional waterbody improvement projects as delineated in Section 5 of this WB/WS Facility Plan report. Such actions and projects

include: 14 best management practices, the City-wide CSO plan for floatables abatement, other long-term CSO control planning activities which may affect Flushing Bay, various East River water quality improvement projects, and various ecosystem restoration activities. These activities are also required under section (3) of the Subdivision.

- It is assumed that the SPDES permits authorizing the Flushing Bay WB/WS Facility Plan variance will contain a provision that allows the department to reopen and modify the permit for revisions to the variance.

Subdivision (g) indicates that a variance may be renewed. It is anticipated that a variance for the Flushing Bay WB/WS Facility Plan would require renewals to allow for sufficient long-term monitoring to assess the degree of water quality standards compliance. As appropriate, a variance renewal application will be submitted 180 days before SPDES permit expiration.

At the completion of the variance period(s), it is expected that the results of the long-term monitoring program will demonstrate each of the following:

- The degree to which the WB/WS Facility Plan attains the current Class I classification water quality criteria and uses;

- The degree to which the WB/WS Facility Plan achieves water quality criteria consistent with the fishable/swimmable goals of the CWA, whether any new cost-effective technology is available to enhance the WB/WS Facility Plan performance, if needed, whether Flushing Bay should be reclassified, or whether a Use Attainability Analysis should be approved.

In this manner, the approval of a WQBEL variance for Flushing Bay together with an appropriate long-term monitoring program can be considered as a step toward a determination of the following:

- Can Flushing Bay be reclassified in a manner which is wholly or partially compatible with the fishable/swimmable goals of the Clean Water Act; or

- Is a Use Attainability Analysis needed for Flushing Bay and for which water quality criteria?

Although Flushing Bay's current waterbody classification, Class I, is not wholly compatible with the goals of the Clean Water Act and would normally require reclassification or a UAA in the State's triennial review obligation, it is considered to be more appropriate to proceed with the more deliberative variance approval/monitoring procedure outlined above. The recommended procedure will determine actual improvements resulting from WB/WS Facility Plan implementation, enable a proper determination for the appropriate waterbody classification for Flushing Bay and perhaps avoid unnecessary, repetitive and possibly contradictory rulemaking.

9.2.4 Future Considerations

Urban Tributary Classification

The possibility is recognized that the long-term monitoring program recommended for Flushing Bay, and ultimately for other confined waterbodies throughout the City, may indicate that the highest attainable uses are not compatible with the use goals of the Clean Water Act and State Water Quality Regulations. It is therefore recommended that consideration be given to the development of a new waterbody classification in DEC Water Quality Regulations, that being "Urban Tributary". This classification would have the following attributes:

- Recognition of wet weather conditions in the designation of uses and water quality criteria;
- Application to urban confined waterbodies which satisfy any of the UAA criteria enumerated in 40CFR131.10(g);
- Definition of required baseline water uses;
- Fish and aquatic life survival (if attainable); and
- Secondary contact recreation (if attainable).

Other attainable higher uses would be waterbody specific and dependent upon the effectiveness of the site-specific CSO WB/WS Facility Plan and subsequent LTCP based upon knee-of-the-curve considerations, technical feasibility and ease of implementation.

The Urban Tributary classification could be implemented through the application of a generic UAA procedure for confined urban waterbodies based on the criteria of 40CFR131.10(g). This procedure could avoid the necessity for repeated UAAs on different waterbodies with similar characteristics. Those waterbodies which comply with the designation criteria can be identified at one time, and the reclassification completed in one rulemaking.

If either of the designated baseline uses of fish and aquatic life survival and secondary contact recreation did not appear to be attainable in a particular setting, then a site-specific UAA would be required.

Narrative Criteria

The recommendation for a WQBEL variance for the Flushing Bay WB/WS Facility Plan would apply with regard to the narrative water quality criteria previously cited as well as to the Class I water quality criterion for dissolved oxygen. However, a broad issue remains with the practical ability to attain the requirements of the narrative criteria in situations where wet weather discharges are unavoidable and will occasionally occur after controls. Therefore, it is recommended that DEC review the application of the narrative criteria, provide for a wet-weather exclusion with demonstrated need, or make all narrative criteria conditional upon the impairment of waters for their best usage.

Synopsis

Although this WB/WS Facility Plan is expected to result in significant improvements to the water quality in Flushing Bay, it is not expected to completely attain all applicable water quality criteria. As such, the SPDES Permit for the Bowery Bay and Tallman Island WWTPs may require a WQBEL variance for the Flushing Bay WB/WS Facility Plan if contravention of some criteria continues to occur. If water quality criteria are demonstrated to be unrealistic after a period of monitoring, DEP would request reclassification of portions of Flushing Bay based on a Use Attainability Analysis (UAA). Until the recommended UAAs and required regulatory processes are completed, the current DEC classification of Flushing Bay of Class I will be retained.

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11.0. Glossary

A Posteriori Classification: A classification based on the results of experimentation.

A Priori Classification: A classification made prior to experimentation.

ACO: Administrative Consent Order

Activated Sludge: The product that results when primary effluent is mixed with bacteria-laden sludge and then agitated and aerated to promote biological treatment, speeding the breakdown of organic matter in raw sewage undergoing secondary waste treatment.

Acute Toxicity: The ability of a substance to cause severe biological harm or death soon after a single exposure or dose. Also, any poisonous effect resulting from a single short-term exposure to a toxic substance (see chronic toxicity, toxicity).

Administrative Consent Order (ACO): A legal agreement between a regulatory authority and an individual, business, or other entity through which the violator agrees to pay for correction of violations, take the required corrective or cleanup actions, or refrain from an activity. It describes the actions to be taken, may be subject to a comment period, applies to civil actions, and can be enforced in court.

Administrative Law Judge (ALJ): An officer in a government agency with quasi-judicial functions including conducting hearings, making findings of fact, and making recommendations for resolution of disputes concerning the agency's actions.

Advanced Treatment: A level of wastewater treatment more stringent than secondary treatment; requires an 85-percent reduction in conventional pollutant concentration or a significant reduction in non-conventional pollutants. Sometimes called tertiary treatment.

Advanced Wastewater Treatment: Any treatment of sewage that goes beyond the secondary or biological water treatment stage and includes the removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids. (See primary, secondary treatment.)

Advection: Bulk transport of the mass of discrete chemical or biological constituents by fluid flow within a receiving water. Advection describes the mass transport due to the velocity, or flow, of the waterbody. Example: The transport of pollution in a river: the motion of the water carries the polluted water downstream.

ADWF: Average Dry Weather Flow

Aeration: A process that promotes biological degradation of organic matter in water. The process may be passive (as when waste is exposed to air), or active (as when a mixing or bubbling device introduces the air). Exposure to additional air may be by means of natural of engineered systems.

Aerobic: Environmental conditions characterized by the presence of dissolved oxygen; used to describe biological or chemical processes that occur in the presence of oxygen.

Algae: Simple rootless plants that live floating or suspended in sunlit water or may be attached to structures, rocks or other submerged surfaces. Algae grow in proportion to the amount of available nutrients. They can affect water quality adversely since their biological activities can appreciably affect pH and low dissolved oxygen of the water. They are food for fish and small aquatic animals.

Algal Bloom: A heavy sudden growth of algae in and on a body of water which can affect water quality adversely and indicate potentially hazardous changes in local water chemistry. The growth results from excessive nutrient levels or other physical and chemical conditions that enable algae to reproduce rapidly.

ALJ: Administrative Law Judge

Allocations: Allocations are that portion of a receiving water's loading capacity that is attributed to one of its existing or future sources (non-point or point) of pollution or to natural background sources. (Wasteload allocation (WLA) is that portion of the loading capacity allocated to an existing or future point source and a load allocation (LA) is that portion allocated to an existing or future non-point source or to a natural background source. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading.)

Ambient Water Quality: Concentration of water quality constituent as measured within the waterbody.

Ammonia (NH_3): An inorganic form of nitrogen, is contained in fertilizers, septic system effluent, and animal wastes. It is also a product of bacterial decomposition of organic matter. NH3-N becomes a concern if high levels of the un-ionized form are present. In this form NH3-N can be toxic to aquatic organisms.

Anaerobic: Environmental condition characterized by zero oxygen levels. Describes biological and chemical processes that occur in the absence of oxygen. Anoxia. No dissolved oxygen in water.

Anthropogenic: Pertains to the [environmental] influence of human activities.

Antidegradation: Part of federal water quality requirements. Calls for all existing uses to be protected, for deterioration to be avoided or at least minimized when water quality meets or exceeds standards, and for outstanding waters to be strictly protected.

Aquatic Biota: Collective term describing the organisms living in or depending on the aquatic environment.

Aquatic Community: An association of interacting populations of aquatic organisms in a given waterbody or habitat.

Aquatic Ecosystem: Complex of biotic and abiotic components of natural waters. The aquatic ecosystem is an ecological unit that includes the physical characteristics (such as flow or velocity and depth), the biological community of the water column and benthos, and the chemical characteristics such as dissolved solids, dissolved oxygen, and nutrients. Both living and nonliving components of the aquatic ecosystem interact and influence the properties and status of each component.

Aquatic Life Uses: A beneficial use designation in which the waterbody provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms.

Assemblage: An association of interacting populations of organisms in a given waterbody (e.g., fish assemblage or benthic macro-invertebrate assemblage).

Assessed Waters: Waters that states, tribes and other jurisdictions have assessed according to physical, chemical and biological parameters to determine whether or not the waters meet water quality standards and support designated beneficial uses.

Assimilation: The ability of a body of water to purify itself of pollutants.

Assimilative Capacity: The capacity of a natural body of water to receive wastewaters or toxic materials without deleterious efforts and without damage to aquatic life or humans who consume the water. Also, the amount of pollutant load that can be discharged to a specific waterbody without exceeding water quality standards. Assimilative capacity is used to define the ability of a waterbody to naturally absorb and use a discharged substance without impairing water quality or harming aquatic life.

Attribute: Physical and biological characteristics of habitats which can be measured or described.

Average Dry Weather Flow (ADWF): The average non-storm flow over 24 hours during the dry months of the year (May through September). It is composed of the average dry weather inflow/infiltration.

Bacteria: (Singular: bacterium) Microscopic living organisms that can aid in pollution control by metabolizing organic matter in sewage, oil spills or other pollutants. However, some types of bacteria in soil, water or air can also cause human, animal and plant health problems. Bacteria of the coliform group are considered the primary indicators of fecal contamination and are often used to assess water quality.

Measured in number of bacteria organisms per 100 milliliters of sample (No./mL or #/100 mL).

BASINS: Better Assessment Science Integrating Point and Non-point Sources

BEACH: Beaches Environmental Assessment and Coastal Health

Beaches Environmental Assessment and Coastal Health (BEACH): The BEACH Act requires coastal and Great Lakes States to adopt the 1986 USEPA Water Quality Criteria for Bacteria and to develop and implement beach monitoring and notification plans for bathing beaches.

Benthic: Refers to material, especially sediment, at the bottom of an aquatic ecosystem. It can be used to describe the organisms that live on, or in, the bottom of a waterbody.

Benthic Macroinvertebrates: See benthos.

Benthos: Animals without backbones, living in or on the sediments, of a size large enough to be seen by the unaided eye, and which can be retained by a U.S. Standard No. 30 sieve (28 openings/in, 0.595-mm openings). Also referred to as benthic macroinvertebrates, infauna, or macrobenthos.

Best Available Technology (BAT): The most stringent technology available for controlling emissions; major sources of emissions are required to use BAT, unless it can be demonstrated that it is unfeasible for energy, environmental, or economic reasons.

Best Management Practice (BMP): Methods, measures or practices that have been determined to be the most effective, practical and cost effective means of preventing or reducing pollution from non-point sources.

Better Assessment Science Integrating Point and Non-point Sources (BASINS): A computer tool that contains an assessment and planning component that allows users to organize and display geographic information for selected watersheds. It also contains a modeling component to examine impacts of pollutant loadings from point and non-point sources and to characterize the overall condition of specific watersheds.

Bioaccumulation: A process by which chemicals are taken up by aquatic organisms and plants directly from water as well as through exposure via other routes, such as consumption of food and sediment containing the chemicals.

Biochemical Oxygen Demand (BOD): A measure of the amount of oxygen per unit volume of water required to bacterially or chemically breakdown (stabilize) the organic matter in water. Biochemical oxygen demand measurements are usually conducted over specific time intervals (5,10,20,30 days). The term BOD generally refers to a standard 5-day BOD test. It is also considered a standard measure of the organic content in water and is expressed as mg/L. The greater the BOD, the greater the degree of pollution.

Bioconcentration: A process by which there is a net accumulation of a chemical directly from water into aquatic organisms resulting from simultaneous uptake (e.g., via gill or epithelial tissue) and elimination. In other words, the accumulation of a chemical in tissues of a fish or other organism to levels greater than the surrounding medium.

Biocriteria: A combination of narrative and numerical measures, such as the number and kinds of benthic, or bottom-dwelling, insects living in a stream, that describe the biological condition (structure and function) of aquatic communities inhabiting waters of a designated aquatic life use. Biocriteria are regulatory-based biological measurements and are part of a state's water quality standards.

Biodegradable: A substance or material that is capable of being decomposed (broken down) by natural biological processes.

Biodiversity: Refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the biological structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species and genes.

Biological Assemblage: A group of phylogenetically (e.g., fish) or ecologically (e.g., benthic macroinvertebrates) related organisms that are part of an aquatic community.

Biological Assessment or Bioassessment: An evaluation of the condition of a waterbody using biological surveys and other direct measures of the resident biota of the surface waters, in conjunction with biological criteria.

Biological Criteria or Biocriteria: Guidelines or benchmarks adopted by States to evaluate the relative biological integrity of surface waters. Biocriteria are narrative expressions or numerical values that describe biological integrity of aquatic communities inhabiting waters of a given classification or designated aquatic life use.

Biological Indicators: Plant or animal species or communities with a narrow range of environmental tolerances that may be selected for monitoring because their absence or presence and relative abundances serve as barometers of environmental conditions.

Biological Integrity: The condition of the aquatic community inhabiting unimpaired waterbodies of a specified habitat as measured by community structure and function.

Biological Monitoring or Biomonitoring: Multiple, routine biological surveys over time using consistent sampling and analysis methods for detection of changes in biological condition.

Biological Nutrient Removal (BNR): The removal of nutrients, such as nitrogen and/or phosphorous during wastewater treatment.

Biological Oxygen Demand (BOD): An indirect measure of the concentration of biologically degradable material present in organic wastes. It usually reflects the amount of oxygen consumed in five days by biological processes breaking down organic wastes.

Biological Survey or Biosurvey: Collecting, processing and analyzing representative portions of an estuarine or marine community to determine its structure and function.

Biological Magnification: Refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work their way into rivers and lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances become concentrated in tissues or internal organs as they move up the food chain. he result of the processes of bioconcentration and bioaccumulation by which tissue concentrations of bioaccumulated chemicals increase as the chemical passes up through two or more trophic levels in the food chain. (See bioaccumulation.)

Biota: Plants, animals and other living resources in a given area.

Biotic Community: A naturally occurring assemblage of plants and animals that live in the same environment and are mutually sustaining and interdependent.

BMP: Best Management Practice

BNR: Biological Nutrient Removal

BOD: Biological Oxygen Demand; Biochemical Demand

Borrow Pit: See Subaqueous Borrow Pit.

Brackish: Water with salt content ranging between that of sea water and fresh water; commonly used to refer to Oligohaline waters.

Brooklyn Sewer Datum (BSD): Coordinate system and origins utilized by surveyors in the Borough of Brooklyn, New York City.

BSD: Brooklyn Sewer Datum

CAC: Citizens Advisory Committee

Calcareous: Pertaining to or containing calcium carbonate; Calibration; The process of adjusting model parameters within physically defensible ranges until the resulting predictions give a best possible fit to observed data.

Calibration: The process of adjusting model parameters within physically defensible ranges until the resulting predictions give a best possible fit to observed data.

CALM: Consolidated Assessment and Listing Methodology

Capital Improvement Program (CIP): A budget and planning tool used to implement non-recurring expenditures or any expenditure for physical improvements, including costs for: acquisition of existing buildings, land, or interests in land; construction of new buildings or other structures, including additions and major alterations; construction of streets and highways or utility lines; acquisition of fixed equipment; landscaping; and similar expenditures.

Capture: The total volume of flow collected in the combined sewer system during precipitation events on a system-wide, annual average basis (not percent of volume being discharged).

Catch Basin: (1) A buried chamber, usually built below curb grates seen at the curbline of a street, to relieve street flooding, which admits surface water for discharge into the sewer system and/or a receiving waterbody. (2) A sedimentation area designed to remove pollutants from runoff before being discharged into a stream or pond.

Carbonaceous Biochemical Oxygen Demand ($CBOD_5$): The amount of oxygen required to oxidize any carbon containing matter present in water in five days.

CATI: Computer Assisted Telephone Interviews

$CBOD_5$: Carbonaceous Biochemical Oxygen Demand

CEA: Critical Environmental Area

CEQR: City Environmental Quality Review

CERCLIS: Comprehensive Environmental Response, Compensation and Liability Information System

CFR: Code of Federal Regulation

Channel: A natural stream that conveys water; a ditch or channel excavated for the flow of water.

Channelization: Straightening and deepening streams so water will move faster or facilitate navigation - a tactic that can interfere with waste assimilation capacity, disturb fish and wildlife habitats, and aggravate flooding.

Chemical Oxygen Demand (COD): A measure of the oxygen required to oxidize all compounds, both organic and inorganic, in water.

Chlorination: The application of chlorine to drinking water, sewage, or industrial waste to disinfect or to oxidize undesirable compounds. Typically employed as a final process in water and wastewater treatment.

Chrome+6 (Cr+6): Chromium is a steel-gray, lustrous, hard metal that takes a high polish, is fusible with difficulty, and is resistant to corrosion and tarnishing. The most common oxidation states of chromium are +2, +3, and +6, with +3 being the most stable. +4 and +5 are relatively rare. Chromium compounds of oxidation state 6 are powerful oxidants.

Chronic Toxicity: The capacity of a substance to cause long-term poisonous health effects in humans, animals, fish and other organisms (see acute toxicity).

CIP: Capital Improvement Program

Citizens Advisory Committee (CAC): Committee comprised of various community stakeholders formed to provide input into a planning process.

City Environmental Quality Review (CEQR): CEQR is a process by which agencies of the City of New York review proposed discretionary actions to identify the effects those actions may have on the environment.

Clean Water Act (CWA): The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The CWA contains a number of provisions to restore and maintain the quality of the nation's water resources. One of these provisions is section 303(d), which establishes the Total maximum Daily Load (TMDL) program.

Coastal Waters: Marine waters adjacent to and receiving estuarine discharges and extending seaward over the continental shelf and/or the edge of the U.S. territorial sea.

Coastal Zone Boundary (CZB): Generally, the part of the land affected by its proximity to the sea and that part of the sea affected by its proximity to the land as the extent to which man's land-based activities have a measurable influence on water chemistry and marine ecology. Specifically, New York's Coastal zone varies from region to region while incorporating the following conditions: The inland boundary is approximately 1,000 feet from the shoreline of the mainland. In urbanized and developed coastal locations the landward boundary is approximately 500 feet from the mainland's shoreline, or less than 500 feet where a roadway or railroad line runs parallel to the shoreline at a distance of under 500 feet and defines the boundary. In locations where major state-owned lands and facilities or electric power generating facilities abut the shoreline, the boundary extends inland to include them. In some areas, such as Long Island Sound and the Hudson River Valley, the boundary may extend inland up to 10,000 feet to encompass significant coastal resources, such as areas of exceptional scenic value, agricultural ore recreational lands, and major tributaries and headlands.

Coastal Zone: Lands and waters adjacent to the coast that exert an influence on the uses of the sea and its ecology, or whose uses and ecology are affected by the sea.

COD: Chemical Oxygen Demand

Code of Federal Regulations (CFR): Document that codifies all rules of the executive departments and agencies of the federal government. It is divided into fifty volumes, known as titles. Title 40 of the CFR (references as 40 CFR) lists most environmental regulations.

Coliform Bacteria: Common name for Escherichia coli that is used as an indicator of fecal contamination of water, measured in terms of coliform count. (See Total Coliform Bacteria)

Coliforms: Bacteria found in the intestinal tract of warm-blooded animals; used as indicators of fecal contamination in water.

Collection System: Pipes used to collect and carry wastewater from individual sources to an interceptor sewer that will carry it to a treatment facility.

Collector Sewer: The first element of a wastewater collection system used to collect and carry wastewater from one or more building sewers to a main sewer. Also called a lateral sewer.

Combined Sewage: Wastewater and storm drainage carried in the same pipe.

Combined Sewer Overflow (CSO): Discharge of a mixture of storm water and domestic waste when the flow capacity of a sewer system is exceeded during rainstorms. CSOs discharged to receiving water can result in contamination problems that may prevent the attainment of water quality standards.

Combined Sewer Overflow Event: The discharges from any number of points in the combined sewer system resulting from a single wet weather event that do not receive minimum treatment (i.e., primary clarification, solids disposal, and disinfection, where appropriate). For example, if a storm occurs that results in untreated overflows from 50 different CSO outfalls within the combined sewer system (CSS), this is considered one overflow event.

Combined Sewer System (CSS): A sewer system that carries both sewage and storm-water runoff. Normally, its entire flow goes to a waste treatment plant, but during a heavy storm, the volume of water may be so great as to cause overflows of untreated mixtures of storm water and sewage into receiving waters. Storm-water runoff may also carry toxic chemicals from industrial areas or streets into the sewer system.

Comment Period: Time provided for the public to review and comment on a proposed USEPA action or rulemaking after publication in the Federal Register.

Community: In ecology, any group of organisms belonging to a number of different species that co-occur in the same habitat or area; an association of interacting assemblages in a given waterbody. Sometimes, a particular subgrouping may be specified, such as the fish community in a lake.

Compliance Monitoring: Collection and evaluation of data, including self-monitoring reports, and verification to show whether pollutant concentrations and loads contained in permitted discharges are in compliance with the limits and conditions specified in the permit.

Compost: An aerobic mixture of decaying organic matter, such as leaves and manure, used as fertilizer.

Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS): Database that contains information on hazardous waste sites, potentially hazardous waste sites and remedial activities across the nation. The database includes sites that are on the National Priorities List or being considered for the List.

Comprehensive Waterfront Plan (CWP): Plan proposed by the Department of City Planning that provides a framework to guide land use along the city's entire 578-mile shoreline in a way that recognizes its value as a natural resource and celebrates its diversity. The plan presents a long-range vision that balances the needs of environmentally sensitive areas and the working port with opportunities for waterside public access, open space, housing and commercial activity.

Computer Assisted Telephone Interviews (CATI): CATI is the use of computers to automate and control the key activities of a telephone interview.

Conc: Abbreviation for "Concentration".

Concentration: Amount of a substance or material in a given unit volume of solution. Usually measured in milligrams per liter (mg/L) or parts per million (ppm).

Consolidated Assessment and Listing Methodology (CALM): USEPA framework for states and other jurisdictions to document how they collect and use water quality data and information for environmental decision making. The primary purposes of these data analyses are to determine the extent that all waters are attaining water quality standards, to identify waters that are impaired and need to be added to the 303(d) list, and to identify waters that can be removed from the list because they are attaining standards.

Contamination: Introduction into the water, air and soil of microorganisms, chemicals, toxic substances, wastes or wastewater in a concentration that makes the medium unfit for its next intended use.

Conventional Pollutants: Statutorily listed pollutants understood well by scientists. These may be in the form or organic waste, sediment, acid, bacteria, viruses, nutrients, oil and grease, or heat.

Cost-Benefit Analysis: A quantitative evaluation of the costs, which would be incurred by implementing an alternative versus the overall benefits to society of the proposed alternative.

Cost-Share Program: A publicly financed program through which society, as a beneficiary of environmental protection, allocates project funds to pay a percentage of the cost of constructing or implementing a best management practice. The producer pays the remainder of the costs.

Cr+6: Hexavalent chromium

Critical Condition: The combination of environmental factors that results in just meeting water quality criterion and has an acceptably low frequency of occurrence.

Critical Environmental Area (CEA): A CEA is a specific geographic area designated by a state or local agency as having exceptional or unique environmental characteristics. In establishing a CEA, the fragile or threatened environmental conditions in the area are identified so that they will be taken into consideration in the site-specific environmental review under the State Environmental Quality Review Act.

Cross-Sectional Area: Wet area of a waterbody normal to the longitudinal component of the flow.

Cryptosporidium: A protozoan microbe associated with the disease cryptosporidiosis in man. The disease can be transmitted through ingestion of drinking water, person-to-person contact, or other pathways, and can cause acute diarrhea, abdominal pain, vomiting, fever and can be fatal. (See protozoa).

CSO: Combined Sewer Overflow

CSS: Combined Sewer System

Cumulative Exposure: The summation of exposures of an organism to a chemical over a period of time.

Clean Water Act (CWA): Federal law stipulating actions to be carried out to improve water quality in U.S. waters.

CWA: Clean Water Act

CWP: Comprehensive Waterfront Plan

CZB: Coastal Zone Boundary

DDWF: design dry weather flow

Decay: Gradual decrease in the amount of a given substance in a given system due to various sink processes including chemical and biological transformation, dissipation to other environmental media, or deposition into storage areas.

Decomposition: Metabolic breakdown of organic materials; that releases energy and simple organics and inorganic compounds. (See Respiration)

Degradable: A substance or material that is capable of decomposition; chemical or biological.

Delegated State: A state (or other governmental entity such as a tribal government) that has received authority to administer an environmental regulatory program in lieu of a federal counterpart.

Demersal: Living on or near the bottom of a body of water (e.g., mid-water and bottom-dwelling fish and shellfish, as opposed to surface fish).

Department of Sanitation of New York (DSNY): New York City agency responsible for solid waste and refuse disposal in New York City

Design Capacity: The average daily flow that a treatment plant or other facility is designed to accommodate.

Design Dry Weather Flow (DDWF): The flow basis for design of New York City wastewater treatment plants. In general, the plants have been designed to treat 1.5 times this value to full secondary treatment standards and 2.0 times this value, through at least primary settling and disinfection, during stormwater events.

Designated Uses: Those water uses specified in state water quality standards for a waterbody, or segment of a waterbody, that must be achieved and maintained as required under the Clean Water Act. The uses, as defined by states, can include cold-water fisheries, natural fisheries, public water supply, irrigation, recreation, transportation, or mixed uses.

Deoxyribonucleic Acid (DNA): The genetic material of living organisms; the substance of heredity. It is a large, double-stranded, helical molecule that contains genetic instructions for growth, development, and replication.

Destratification: Vertical mixing within a lake or reservoir to totally or partially eliminate separate layers of temperature, plant, or animal life.

Deterministic Model: A model that does not include built-in variability: same input will always equal the same output.

Die-Off Rate: The first-order decay rate for bacteria, pathogens, and viruses. Die-off depends on the particular type of waterbody (i.e., stream, estuary , lake) and associated factors that influence mortality.

Dilution: Addition of less concentrated liquid (water) that results in a decrease in the original concentration.

Direct Runoff: Water that flows over the ground surface or through the ground directly into streams, rivers, and lakes.

Discharge Permits (NPDES): A permit issued by the USEPA or a state regulatory agency that sets specific limits on the type and amount of pollutants that a municipality or industry can discharge to a receiving water; it also includes a compliance schedule for achieving those limits. It is called the NPDES because the permit process was established under the National Pollutant Discharge Elimination System, under provisions of the Federal Clean Water Act.

Discharge: Flow of surface water in a stream or canal or the outflow of ground water from a flowing artesian well, ditch, or spring. It can also apply to discharges of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.

Discriminant Analysis: A type of multivariate analysis used to distinguish between two groups.

Disinfect (Disinfected): A water and wastewater treatment process that kills harmful microorganisms and bacteria by means of physical, chemical and alternative processes such as ultraviolet radiation.

Disinfectant: A chemical or physical process that kills disease-causing organisms in water, air, or on surfaces. Chlorine is often used to disinfect sewage treatment effluent, water supplies, wells, and swimming pools.

Dispersion: The spreading of chemical or biological constituents, including pollutants, in various directions from a point source, at varying velocities depending on the differential instream flow characteristics.

Dissolved Organic Carbon (DOC): All organic carbon (eg, compounds such as acids and sugars, leached from soils, excreted from roots, etc) dissolved in a given volume of water at a particular temperature and pressure.

Dissolved Oxygen (DO): The dissolved oxygen freely available in water that is vital to fish and other aquatic life and is needed for the prevention of odors. DO levels are considered a most important indicator of a water body’s ability to support desirable aquatic life. Secondary and advanced waste treatments are generally designed to ensure adequate DO in waste-receiving waters. It also refers to a measure of the amount of oxygen available for biochemical activity in a waterbody, and as an indicator of the quality of that water.

Dissolved Solids: The organic and inorganic particles that enter a waterbody in a solid phase and then dissolve in water.

DNA: deoxyribonucleic acid

DO: dissolved oxygen

DOC: Dissolved Organic Carbon

Drainage Area or Drainage Basin: An area drained by a main river and its tributaries (see Watershed).

Dredging: Dredging is the removal of mud from the bottom of waterbodies to facilitate navigation or remediate contamination. This can disturb the ecosystem and cause silting that can kill or harm aquatic life. Dredging of contaminated mud can expose biota to heavy metals and other toxics. Dredging activities are subject to regulation under Section 404 of the Clean Water Act.

Dry Weather Flow (DWF): Hydraulic flow conditions within a combined sewer system resulting from one or more of the following: flows of domestic sewage, ground water infiltration, commercial and industrial wastewaters, and any other non-precipitation event related flows (e.g., tidal infiltration under certain circumstances).

Dry Weather Overflow: A combined sewer overflow that occurs during dry weather flow conditions.

DSNY: Department of Sanitation of New York

DWF: Dry weather flow

Dynamic Model: A mathematical formulation describing the physical behavior of a system or a process and its temporal variability. Ecological Integrity. The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes.

E. Coli: Escherichia Coli.

Ecoregion: Geographic regions of ecological similarity defined by similar climate, landform, soil, natural vegetation, hydrology or other ecologically relevant variables.

Ecosystem: An interactive system that includes the organisms of a natural community association together with their abiotic physical, chemical, and geochemical environment.

Effects Range-Low: Concentration of a chemical in sediment below which toxic effects were rarely observed among sensitive species (10th percentile of all toxic effects).

Effects Range-Median: Concentration of a chemical in sediment above which toxic effects are frequently observed among sensitive species (50th percentile of all toxic effects).

Effluent: Wastewater, either municipal sewage or industrial liquid waste that flows out of a treatment plant, sewer or outfall untreated, partially treated, or completely treated.

Effluent Guidelines: Technical USEPA documents which set effluent limitations for given industries and pollutants.

Effluent Limitation: Restrictions established by a state or USEPA on quantities, rates, and concentrations in wastewater discharges.

Effluent Standard: See effluent limitation.

EIS: Environmental Impact Statement

EMAP: Environmental Monitoring and Assessment Program

EMC: Event Mean Concentration

Emergency Planning and Community Right-to-Know Act of 1986, The (SARA Title III): Law requiring federal, state and local governments and industry, which are involved in either emergency planning and/or reporting of hazardous chemicals, to allow public access to information about the presence of hazardous chemicals in the community and releases of such substances into the environment.

Endpoint: An endpoint is a characteristic of an ecosystem that may be affected by exposure to a stressor. Assessment endpoints and measurement endpoints are two distinct types of endpoints that are commonly used by resource managers. An assessment endpoint is the formal expression of a valued environmental characteristic and should have societal relevance. A measurement endpoint is the expression of an observed or measured response to a stress or disturbance. It is a measurable environmental characteristic that is related to the valued environmental characteristic chosen as the assessment endpoint. The numeric criteria that are part of traditional water quality standards are good examples of measurement endpoints.

Enforceable Requirements: Conditions or limitations in permits issued under the Clean Water Act Section 402 or 404 that, if violated, could result in the issuance of a compliance order or initiation of a civil or criminal action under federal or applicable state laws.

Enhancement: In the context of restoration ecology, any improvement of a structural or functional attribute.

Enteric: Of or within the gastrointestinal tract.

Enterococci: A subgroup of the fecal streptococci that includes S. faecalis and S. faecium. The enterococci are differentiated from other streptococci by their ability to grow in 6.5% sodium chloride, at pH 9.6, and at 10°C and 45°C. Enterococci are a valuable bacterial indicator for determining the extent of fecal contamination of recreational surface waters.

Environment: The sum of all external conditions and influences affecting the development and life of organisms.

Environmental Impact Statement (EIS): A document required of federal agencies by the National Environmental Policy Act for major projects or legislative proposals significantly affecting the environment. A tool for decision making, it describes the positive and negative effects of the undertaking and cites alternative actions.

Environmental Monitoring and Assessment Program (EMAP): The Environmental Monitoring and Assessment Program (EMAP) is a research program to develop the tools necessary to monitor and assess the status and trends of national ecological resources. EMAP's goal is to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into assessments of current ecological condition and forecasts of future risks to our natural resources.

Epibenthic: Those animals/organisms located at the surface of the sediments on the bay bottom, generally referring to algae.

Epibenthos: Those animals (usually excluding fishes) living on the top of the sediment surface.

Epidemiology: All the elements contributing to the occurrence or non-occurrence of a disease in a population; ecology of a disease.

Epifauna: Benthic animals living on the sediment or on and among rocks and other structures.

EPMC: Engineering Program Management Consultant

Escherichia Coli: A subgroup of the fecal coliform bacteria. E. coli is part of the normal intestinal flora in humans and animals and is, therefore, a direct indicator of fecal contamination in a waterbody. The O157 strain, sometimes transmitted in contaminated waterbodies, can cause serious infection resulting in gastroenteritis. (See Fecal coliform bacteria)

Estuarine Number: Nondimensional parameter accounting for decay, tidal dispersion, and advection velocity. Used for classification of tidal rivers and estuarine systems.

Estuarine or Coastal Marine Classes: Classes that reflect basic biological communities and that are based on physical parameters such as salinity, depth, sediment grain size, dissolved oxygen and basin geomorphology.

Estuarine Waters: Semi-enclosed body of water which has a free connection with the open sea and within which seawater is measurably diluted with fresh water derived from land drainage.

Estuary: Region of interaction between rivers and near-shore ocean waters, where tidal action and river flow mix fresh and salt water. Such areas include bays, mouths of rivers, salt marshes, and lagoons. These brackish water ecosystems shelter and feed marine life, birds, and wildlife (see wetlands).

Eutrophication: A process in which a waterbody becomes rich in dissolved nutrients, often leading to algal blooms, low dissolved oxygen and changes in the composition of plants and animals in the waterbody. This occurs naturally, but can be exacerbated by human activity which increases nutrient inputs to the waterbody.

Event Mean Concentration (EMC): Input data, typically for urban areas, for a water quality model. EMC represents the concentration of a specific pollutant contained in stormwater runoff coming from a particular land use type within a watershed.

Existing Use: Describes the use actually attained in the waterbody on or after November 28, 1975, whether or not it is included in the water quality standards (40 CFR 131.3).

Facility Plan: A planning project that uses engineering and science to address pollution control issues and will most likely result in the enhancement of existing water pollution control facilities or the construction of new facilities.

Facultative: Capable of adaptive response to varying environments.

Fecal Coliform Bacteria: A subset of total coliform bacteria that are present in the intestines or feces of warm-blooded animals. They are often used as indicators of the sanitary quality of water. They are measured by running the standard total coliform test at an elevated temperature (44.5EC). Fecal coliform is approximately 20 percent of total coliform. (See Total Coliform Bacteria)

Fecal Streptococci: These bacteria include several varieties of streptococci that originate in the gastrointestinal tract of warm-blooded animals such as humans (Streptococcus faecalis) and domesticated animals such as cattle (Streptococcus bovis) and horses (Streptococcus equinus).

Feedlot: A confined area for the controlled feeding of animals. The area tends to concentrate large amounts of animal waste that cannot be absorbed by the soil and, hence, may be carried to nearby streams or lakes by rainfall runoff.

FEIS: Final Environmental Impact Statement

Field Sampling and Analysis Program (FSAP): Biological sampling program undertaken to fill-in ecosystem data gaps in New York Harbor.

Final Environmental Impact Statement (FEIS): A document that responds to comments received on the Draft EIS and provides updated information that has become available after publication of the Draft EIS.

Fish Kill: A natural or artificial condition in which the sudden death of fish occurs due to the introduction of pollutants or the reduction of the dissolved oxygen concentration in a waterbody.

Floatables: Large waterborne materials, including litter and trash, that are buoyant or semi-buoyant and float either on or below the water surface. These materials, which are generally man-made and sometimes characteristic of sanitary wastewater and storm runoff, may be transported to sensitive environmental areas such as bathing beaches where they can become an aesthetic nuisance. Certain types of floatables also cause harm to marine wildlife and can be hazardous to navigation.

Flocculation: The process by which suspended colloidal or very fine particles are assembled into larger masses or floccules that eventually settle out of suspension.

Flux: Movement and transport of mass of any water quality constituent over a given period of time. Units of mass flux are mass per unit time.

FOIA: Freedom of Information Act

Food Chain: A sequence of organisms, each of which uses the next, lower member of the sequence as a food source.

Freedom of Information Act (FOIA): A federal statute which allows any person the right to obtain federal agency records unless the records (or part of the records) are protected from disclosure by any of the nine exemptions in the law.

FSAP: Field Sampling and Analysis Program

gallons per day (gpd): unit of measure of flow

gallons per minute (gpm): unit of measure

Gastroenteritis: An inflammation of the stomach and the intestines.

General Permit: A permit applicable to a class or category of discharges.

Geochemical: Refers to chemical reactions related to earth materials such as soil, rocks, and water.

Geographical Information System (GIS): A computer system that combines database management system functionality with information about location. In this way it is able to capture, manage, integrate, manipulate, analyse and display data that is spatially referenced to the earth's surface.

Giardia lamblia: Protozoan in the feces of humans and animals that can cause severe gastrointestinal Ailments. It is a common contaminant of surface waters. (See protozoa).

GIS: Geographical Information System

Global Positioning System (GPS): A GPS comprises a group of satellites orbiting the earth (24 are now maintained by the U.S. Government) and a receiver, which can be highly portable. The receiver can generate accurate coordinates for a point, including elevation, by calculating its own position relative to three or more satellites that are above the visible horizon at the time of measurement.

gpd: Gallons per Day

gpd/ft: gallons per day per foot

gpd/sq ft: gallons per day per square foot

gpm: Gallons per minute

GPS: Global Positioning System

Gradient: The rate of decrease (or increase) of one quantity with respect to another; for example, the rate of decrease of temperature with depth in a lake.

Groundwater: The supply of fresh water found beneath the earth's surface, usually in aquifers, which supply wells and springs. Because groundwater is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants and leaking underground storage tanks.

H_2S: Hydrogen Sulfide

Habitat Conservation Plans (HCPs): As part of the Endangered Species Act, Habitat Conservation Plans are designed to protect a species while allowing development. HCP's give the U.S. Fish and Wildlife Service the authority to permit "taking" of endangered or threatened species as long as the impact is reduced by conservation measures. They allow a landowner to determine how best to meet the agreed-upon fish and wildlife goals.

Habitat: A place where the physical and biological elements of ecosystems provide an environment and elements of the food, cover and space resources needed for plant and animal survival.

Halocline: A vertical gradient in salinity.

HCP: Habitat Conservation Plan

Heavy Metals: Metallic elements with high atomic weights (e.g., mercury, chromium, cadmium, arsenic, and lead); can damage living things at low concentrations and tend to accumulate in the food chain.

High Rate Treatment (HRT): A traditional gravity settling process enhanced with flocculation and settling aids to increase loading rates and improve performance.

Holding Pond: A pond or reservoir, usually made of earth, built to store polluted runoff.

Holoplankton: An aggregate of passively floating, drifting or somewhat motile organisms throughout their entire life cycle; Hot spot locations in waterbodies or sediments where hazardous substances have accumulated to levels which may pose risks to aquatic life, wildlife, fisheries, or human health.

HRT: High Rate Treatment

Hydrogen Sulfide (H_2S): A flammable, toxic, colorless gas with an offensive odor (similar to rotten eggs) that is a byproduct of degradation in anaerobic conditions.

Hydrology: The study of the distribution, properties, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hypoxia: The condition of low dissolved oxygen in aquatic systems (typically with a dissolved oxygen concentration less than 3.0 mg/L).

Hypoxia/Hypoxic Waters: Waters with dissolved oxygen concentrations of less than 2 ppm, the level generally accepted as the minimum required for most marine life to survive and reproduce.

I/I: Inflow/Infiltration

Index of Biotic Integrity: A fish community assessment approach that incorporates the zoogeographic, ecosystem, community and population aspects of fisheries biology into a single ecologically-based index of the quality of a water resource.

IBI: Indices of Biological Integrity

IDNP: Illegal Dumping Notification Program

IEC: Interstate Environmental Commission

IFCP: Interim Floatables Containment Program

Illegal Dumping Notification Program (IDNP): New York City program wherein the NYCDEP field personnel report any observed evidence of illegal shoreline dumping to the Sanitation Police section of DSNY, who have the authority to arrest dumpers who, if convicted, are responsible for proper disposal of the material.

Impact: A change in the chemical, physical or biological quality or condition of a waterbody caused by external sources.

Impaired Waters: Waterbodies not fully supporting their designated uses.

Impairment: A detrimental effect on the biological integrity of a waterbody caused by an impact.

Impermeable: Impassable; not permitting the passage of a fluid through it.

In situ: Measurements taken in the natural environment.

in.: Abbreviation for "Inches".

Index Period: A sampling period, with selection based on temporal behavior of the indicator(s) and the practical considerations for sampling.

Indicator Organism: Organism used to indicate the potential presence of other (usually pathogenic) organisms. Indicator organisms are usually associated with the other organisms, but are usually more easily sampled and measured.

Indicator Taxa or Indicator Species: Those organisms whose presence (or absence) at a site is indicative of specific environmental conditions.

Indicator: Measurable quantity that can be used to evaluate the relationship between pollutant sources and their impact on water quality. Abiotic and biotic indicators can provide quantitative information on environmental conditions.

Indices of Biological Integrity (IBI): A usually dimensionless numeric combination of scores derived from biological measures called metrics.

Industrial Pretreatment Programs (IPP): Program mandated by USEPA to control toxic discharges to public sewers that are tributary to sewage treatment plants by regulating Significant Industrial Users (SIUs). NYCDEP enforces the IPP through Chapter 19 of Title 15 of the Rules of the City of New York (Use of Public Sewers).

Infauna: Animals living within submerged sediments. (See benthos.)

Infectivity: Ability to infect a host. Infiltration. 1. Water other than wastewater that enters a wastewater system and building sewers from the ground through such means as defective pipes, pipe joints, connections or manholes. (Infiltration does not include inflow.) 2. The gradual downward flow of water from the ground surfaces into the soil.

Infiltration: The penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.

Infiltration/Inflow (I/I): The total quantity of water entering a sewer system from both infiltration and inflow.

Inflow: Water other than wastewater that enters a wastewater system and building sewer from sources such as roof leaders, cellar drains, yard drains, foundation drains, drains from springs and swampy areas, manhole covers, cross connections between storm drains and sanitary sewers, catch basins, cooling towers, stormwaters, surface runoff, street wash waters or drainage. (Inflow does not include infiltration.)

Influent: Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant.

Initial Mixing Zone: Region immediately downstream of an outfall where effluent dilution processes occur. Because of the combined effects of the effluent buoyancy, ambient stratification, and current, the prediction of initial dilution can be involved.

Insolation: Exposure to the sun's rays.

Instream Flow: The amount of flow required to sustain stream values, including fish, wildlife, and recreation.

Interceptor Sewers: Large sewer lines that, in a combined system, collect and carry sewage flows from main and trunk sewers to the treatment plant for treatment and discharge. The sewer has no building sewer connections. During some storm events, their capacity is exceeded and regulator structures relieve excess flow to receiving waters to prevent flooding basements, businesses and streets.

Interim Floatables Containment Program (IFCP): A New York City Program that includes containment booms at 24 locations, end-of-pipe nets, skimmer vessels that pick up floatables and transports them to loading stations.

Interstate Environmental Commission (IEC): The Interstate Environmental Commission is a joint agency of the States of New York, New Jersey, and Connecticut. The IEC was established in 1936 under a Compact between New York and New Jersey and approved by Congress. The State of Connecticut joined the Commission in 1941. The mission of the IEC is to protect and enhance environmental quality through cooperation, regulation, coordination, and mutual dialogue between government and citizens in the tri-state region.

Intertidal: The area between the high- and low-tide lines.

IPP: Industrial Pretreatment Programs

Irrigation: Applying water or wastewater to land areas to supply the water and nutrient needs of plants.

JABERRT: Jamaica Bay Ecosystem Research and Restoration Team

Jamaica Bay Ecosystem Research and Restoration Team (JABERRT): Team established by the Army Corps of Engineers to conduct a detailed inventory and biogeochemical characterization of Jamaica Bay for the 2000-2001 period and to compile the most detailed literature search established.

Jamaica Eutrophication Model (JEM): Model developed for Jamaica Bay in 1996 as a result of a cost-sharing agreement between the NYCDEP and US Army Corps of Engineers.

JEM: Jamaica Eutrophication Model

Karst Geology: Solution cavities and closely-spaced sinkholes formed as a result of dissolution of carbonate bedrock.

Knee-of-the-Curve: The point where the incremental change in the cost of the control alternative per change in performance of the control alternative changes most rapidly.

Kurtosis: A measure of the departure of a frequency distribution from a normal distribution, in terms of its relative peakedness or flatness.

LA: Load Allocation

Land Application: Discharge of wastewater onto the ground for treatment or reuse. (See irrigation)

Land Use: How a certain area of land is utilized (examples: forestry, agriculture, urban, industry).

Landfill: A large, outdoor area for waste disposal; landfills where waste is exposed to the atmosphere (open dumps) are now illegal; in constructed landfills, waste is layered, covered with soil, and is built upon impermeable materials or barriers to prevent contamination of surroundings.

lb/day/cf: pounds per day per cubic foot

lbs/day: pounds per day

LC: Loading Capacity

Leachate: Water that collects contaminants as it trickles through wastes, pesticides, or fertilizers. Leaching can occur in farming areas, feedlots, and landfills and can result in hazardous substances entering surface water, groundwater, or soil.

Leaking Underground Storage Tank (LUST): An underground container used to store gasoline, diesel fuel, home heating oil, or other chemicals that is damaged in some way and is leaking its contents into the ground; may contaminate groundwater.

LID: Low Impact Development

LID-R: Low Impact Development - Retrofit

Limiting Factor: A factor whose absence exerts influence upon a population or organism and may be responsible for no growth, limited growth (decline) or rapid growth.

Littoral Zone: The intertidal zone of the estuarine or seashore; i.e., the shore zone between the highest and lowest tides.

Load Allocation (LA): The portion of a receiving water's loading capacity that is attributed either to one of its existing or future non-point sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and non-point source loads should be distinguished. (40 CFR 130.2(g))

Load, Loading, Loading Rate: The total amount of material (pollutants) entering the system from one or multiple sources; measured as a rate in mass per unit time.

Loading Capacity (LC): The greatest amount of loading that a water can receive without violating water quality standards.

Long-Term Control Plan (LTCP): A document developed by CSO communities to describe existing waterway conditions and various CSO abatement technologies that will be used to control overflows.

Low-Flow: Stream flow during time periods where no precipitation is contributing to runoff to the stream and contributions from groundwater recharge are low. Low flow results in less water available for dilution of pollutants in the stream. Due to the limited flow, direct discharges to the stream dominate during low flow periods. Exceedences of water quality standards during low flow conditions are likely to be caused by direct discharges such as point sources, illicit discharges, and livestock or wildlife in the stream.

Low Impact Development (LID): A sustainable storm water management strategy implemented in response to burgeoning infrastructural costs of new development and redevelopment projects, more rigorous environmental regulations, concerns about the urban heat island effect, and the impacts of natural resources due to growth and development. The LID strategy controls water at the source—both rainfall and storm water runoff—which is known as 'source-control' technology. It is a decentralized system that distributes storm water across a project site in order to replenish groundwater supplies rather than sending it into a system of storm drain pipes and channelized networks that control water downstream in a large storm water management facility. The LID approach promotes the use of various devices that filter water and infiltrate water into the ground. It promotes the use of roofs of buildings, parking lots, and other horizontal surfaces to convey water to either distribute it into the ground or collect it for reuse.

Low Impact Development – Retrofit (LID-R): Modification of an existing site to accomplish LID goals.

LTCP: Long-Term CSO Control Plan

LUST: leaking underground storage tank

Macrobenthos: Benthic organisms (animals or plants) whose shortest dimension is greater than or equal to 0.5 mm. (See benthos.)

Macrofauna: Animals of a size large enough to be seen by the unaided eye and which can be retained by a U.S. Standard No. 30 sieve (28 meshes/in, 0.595-mm openings).

Macro-invertebrate: Animals/organism without backbones (Invertebrate) that is too large to pass through a No. 40 Screen (0.417mm) but can be retained by a U.S. Standard No. 30 sieve (28 meshes/in, 0.595-mm openings). The organism size is of sufficient size for it to be seen by the unaided eye and which can be retained

Macrophytes: Large aquatic plants that may be rooted, non-rooted, vascular or algiform (such as kelp); including submerged aquatic vegetation, emergent aquatic vegetation, and floating aquatic vegetation.

Major Oil Storage Facilities (MOSF): Onshore facility with a total combined storage capacity of 400,000 gallons or more of petroleum and/or vessels involved in the transport of petroleum on the waters of New York State.

Margin of Safety (MOS): A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody (CWA section 303(d)(1)(C)). The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by USEPA either individually or in state/EPA agreements. If the MOS needs to be larger than that which is allowed through the conservative assumptions, additional MOS can be added as a separate component of the TMDL (in this case, quantitatively, a TMDL = LC = WLA + LA + MOS).

Marine Protection, Research and Sanctuaries Act of 1972, The Ocean Dumping Act: Legislation regulating the dumping of any material in the ocean that may adversely affect human health, marine environments or the economic potential of the ocean.

Mass Balance: A mathematical accounting of substances entering and leaving a system, such as a waterbody, from all sources. A mass balance model for a waterbody is useful to help understand the relationship between the loadings of a pollutant and the levels in the water, biota and sediments, as well as the amounts that can be safely assimilated by the waterbody.

Mass Loading: The quantity of a pollutant transported to a waterbody.

Mathematical Model: A system of mathematical expressions that describe the spatial and temporal distribution of water quality constituents resulting from fluid transport and the one, or more, individual processes and interactions within some prototype aquatic ecosystem. A mathematical water quality model is used as the basis for wasteload allocation evaluations.

Mean Low Water (MLW): A tidal level. The average of all low waters observed over a sufficiently long period.

Median Household Income (MHI): The median household income is one measure of average household income. It divides the household income distribution into two equal parts: one-half of the cases fall below the median household income, and one-half above it.

Meiofauna: Small interstitial; i.e., occurring between sediment particles, animals that pass through a 1-mm mesh sieve but are retained by a 0.1-mm mesh.

Memorandum of Understanding (MOU): An agreement between two or more public agencies defining the roles and responsibilities of each agency in relation to the other or others with respect to an issue over which the agencies have concurrent jurisdiction.

Meningitis: Inflammation of the meninges, especially as a result of infection by bacteria or viruses.

Meroplankton: Organisms that are planktonic only during the larval stage of their life history.

Mesohaline: The estuarine salinity zone with a salinity range of 5-18-ppt.

Metric: A calculated term or enumeration which represents some aspect of biological assemblage structure, function, or other measurable characteristic of the biota that changes in some predictable way in response to impacts to the waterbody.

mf/L: Million fibers per liter – A measure of concentration.

MG: Million Gallons – A measure of volume.

mg/L: Milligrams Per Liter – A measure of concentration.

MGD: Million Gallons Per Day – A measure of the rate of water flow.

MHI: Median Household Income

Microgram per liter (ug/L): A measure of concentration

Microorganisms: Organisms too small to be seen with the unaided eye, including bacteria, protozoans, yeasts, viruses and algae.

milligrams per liter (mg/L): This weight per volume designation is used in water and wastewater analysis. 1 mg/L=1 ppm.

milliliters (mL): A unit of length equal to one thousandth (10^{-3}) of a meter, or 0.0394 inch.

Million fibers per liter (mf/L): A measure of concentration.

million gallons (MG): A unit of measure used in water and wastewater to express volume. To visualize this volume, if a good-sized bath holds 50 gallons, so a million gallons would be equal to 20,000 baths.

million gallons per day (MGD): Term used to express water-use data. Denotes the volume of water utilized in a single day.

Mitigation: Actions taken to avoid, reduce, or compensate for the effects of environmental damage. Among the broad spectrum of possible actions are those which restore, enhance, create, or replace damaged ecosystems.

Mixing Zone: A portion of a waterbody where water quality criteria or rules are waived in order to allow for dilution of pollution. Mixing zones have been allowed by states in many NPDES permits when discharges were expected to have difficulty providing enough treatment to avoid violating standards for the receiving water at the point of discharge.

mL: milliliters

MLW: mean low water

Modeling: An investigative technique using a mathematical or physical representation of a system or theory, usually on a computer, that accounts for all or some of its known properties. Models are often used to test the effect of changes of system components on the overall performance of the system.

Monitoring: Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

Monte Carlo Simulation: A stochastic modeling technique that involves the random selection of sets of input data for use in repetitive model runs. Probability distributions of receiving water quality concentrations are generated as the output of a Monte Carlo simulation.

MOS: Margin of Safety

MOSF: major oil storage facilities

MOU: Memorandum of Understanding

MOUSE: Computer model developed by the Danish Hydraulic Institute used to model the combined sewer system.

MS4: municipal separate storm sewer systems

Multimetric Approach: An analysis technique that uses a combination of several measurable characteristics of the biological assemblage to provide an assessment of the status of water resources.

Multivariate Community Analysis: Statistical methods (e.g., ordination or discriminant analysis) for analyzing physical and biological community data using multiple variables.

Municipal Separate Storm Sewer Systems (MS4): A conveyance or system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains) that is 1) Owned or operated by a state, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage districts, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges to waters of the United States; 2) Designed or used for collecting or conveying stormwater; 3) Which is not a combined sewer; and 4) Which is not part of a publicly owned treatment works.

Municipal Sewage: Wastes (mostly liquid) originating from a community; may be composed of domestic wastewater and/or industrial discharges.

National Estuary Program: A program established under the Clean Water Act Amendments of 1987 to develop and implement conservation and management plans for protecting estuaries and restoring and maintaining their chemical, physical, and biological integrity, as well as controlling point and non-point pollution sources.

National Marine Fisheries Service (NMFS): A federal agency - with scientists, research vessels, and a data collection system - responsible for managing the nation's saltwater fish. It oversees the actions of the Councils under the Fishery Conservation and Management Act.

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318, and 405 of the Clean Water Act. The program imposes discharge limitations on point sources by basing them on the effluent limitation capabilities of a control technology or on local water quality standards. It prohibits discharge of pollutants into water of the United States unless a special permit is issued by USEPA, a state, or, where delegated, a tribal government on an Indian reservation.

National Priorities List (NPL): USEPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. The list is based primarily on the score a site receives from the Hazard Ranking System. USEPA is required to update the NPL at least once a year. A site must be on the NPL to receive money from the Trust Fund for remedial action.

National Wetland Inventory (NWI): The National Wetlands Inventory (NWI) of the U.S. Fish & Wildlife Service produces information on the characteristics, extent, and status of the Nation's wetlands and deepwater habitats. The National Wetlands Inventory information is used by Federal, State, and local agencies, academic institutions, U.S. Congress, and the private sector. Congressional mandates in the Emergency Wetlands Resources Act requires the Service to map wetlands, and to digitize, archive and distribute the maps.

Natural Background Levels: Natural background levels represent the chemical, physical, and biological conditions that would result from natural geomorphological processes such as weathering or dissolution.

Natural Waters: Flowing water within a physical system that has developed without human intervention, in which natural processes continue to take place.

Navigable Waters: Traditionally, waters sufficiently deep and wide for navigation; such waters in the United States come under federal jurisdiction and are protected by the Clean Water Act.

New York City Department of City Planning (NYCDCP): New York City agency responsible for the city's physical and socioeconomic planning, including land use and environmental review; preparation of plans and policies; and provision of technical assistance and planning information to government agencies, public officials, and community boards.

New York City Department of Environmental Protection (NYCDEP): New York City agency responsible for addressing the environmental needs of the City's residents in areas including water, wastewater, air, noise and hazmat.

New York City Department of Parks and Recreation (NYCDPR): The New York City Department of Parks and Recreation is the branch of government of the City of New York responsible for maintaining the city's parks system, preserving and maintaining the ecological diversity of the city's natural areas, and furnishing recreational opportunities for city's residents.

New York City Department of Transportation (NYCDOT): New York City agency responsible for maintaining and improving New York City's transportation network.

New York City Economic Development Corporation (NYCEDC): City's primary vehicle for promoting economic growth in each of the five boroughs. NYCEDC works to stimulate investment in New York and broaden the City's tax and employment base, while meeting the needs of businesses large and small. To realize these objectives, NYCEDC uses its real estate and financing tools to help companies that are expanding or relocating anywhere within the city.

New York District (NYD): The local division of the United States Army Corps of Engineers,

New York State Code of Rules and Regulations (NYCRR): Official statement of the policy(ies) that implement or apply the Laws of New York.

New York State Department of Environmental Conservation (NYSDEC): New York State aagency that *conserves, improves, and protects New York State's natural resources and environment, and controls water, land and air pollution, in order to enhance the health, safety and welfare of the people of the state and their overall economic and social well being.*

New York State Department of State (NYSDOS): Known as the "keeper of records" for the State of New York. Composed of two main divisions including the Office of Business and Licensing Services and the Office of Local Government Services. The latter office includes the Division of Coastal Resources and Waterfront Revitalization.

NH_3: Ammonia

Nine Minimum Controls (NMC): Controls recommended by the USEPA to minimize CSO impacts. The controls include: (1) proper operation and maintenance for sewer systems and CSOs; (2) maximum use of the collection system for storage; (3) review pretreatment requirements to minimize CSO impacts; (4) maximize flow to treatment facility; (5) prohibit combines sewer discharge during dry weather; (6) control solid and floatable materials in CSOs; (7) pollution prevention; (8) public notification of CSO occurrences and impacts; and, (9) monitor CSOs to characterize impacts and efficacy of CSO controls.

NMC: nine minimum controls

NMFS: National Marine Fisheries Service

No./mL (or #/mL): number of bacteria organisms per milliliter – measure of concentration

Non-Compliance: Not obeying all promulgated regulations, policies or standards that apply.

Non-Permeable Surfaces: Surfaces which will not allow water to penetrate, such as sidewalks and parking lots.

Non-Point Source (NPS): Pollution that is not released through pipes but rather originates from multiple sources over a relatively large area (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by storm water. Non-point sources can be divided into source activities related to either land or water use including failing septic tanks, improper animal-keeping practices, forest practices, and urban and rural runoff. Common non-point sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets.

NPDES: National Pollution Discharge Elimination System

NPL: National Priorities List

NPS: Non-Point Source

Numeric Targets: A measurable value determined for the pollutant of concern which is expected to result in the attainment of water quality standards in the listed waterbody.

Nutrient Pollution: Contamination of water resources by excessive inputs of nutrients. In surface waters, excess algal production as a result of nutrient pollution is a major concern.

Nutrient: Any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

NWI: National Wetland Inventory

NYCDCP: New York City Department of City Planning

NYCDEP: New York City Department of Environmental Protection

NYCDOT: New York City Department of Transportation

NYCDPR: New York City Department of Parks and Recreation

NYCEDC: New York City Economic Development Corporation

NYCRR: New York State Code of Rules and Regulations

NYD: New York District

NYSDEC: New York State Department of Environmental Conservation

NYSDOS: New York State Department of State

O&M: Operation and Maintenance

Oligohaline: The estuarine salinity zone with a salinity range of 0.5-5-ppt.

ONRW: Outstanding National Resource Waters

Operation and Maintenance (O&M): Actions taken after construction to ensure that facilities constructed will be properly operated and maintained to achieve normative efficiency levels and prescribed effluent eliminations in an optimum manner.

Optimal: Most favorable point, degree, or amount of something for obtaining a given result; in ecology most natural or minimally disturbed sites.

Organic Chemicals/Compounds: Naturally occurring (animal or plant-produced or synthetic) substances containing mainly carbon, hydrogen, nitrogen, and oxygen.

Organic Material: Material derived from organic, or living, things; also, relating to or containing carbon compounds.

Organic Matter: Carbonaceous waste (organic fraction) that includes plant and animal residue at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population originating from domestic or industrial sources. It is commonly determined as the amount of organic material contained in a soil or water sample.

Organic: (1) Referring to other derived from living organisms. (2) In chemistry, any compound containing carbon.

Ortho P: Ortho Phosphorus

Ortho Phosphorus: Soluble reactive phosphorous readily available for uptake by plants. The amount found in a waterbody is an indicator of how much phosphorous is available for algae and plant growth. Since aquatic plant growth is typically limited by phosphorous, added phosphorous especially in the dissolved, bioavailable form can fuel plant growth and cause algae blooms.

Outfall: Point where water flows from a conduit, stream, or drain into a receiving water.

Outstanding National Resource Waters (ONRW): Outstanding national resource waters (ONRW) designations offer special protection (i.e., no degradation) for designated waters, including wetlands. These are areas of exceptional water quality or recreational/ecological significance. State antidegradation policies should provide special protection to wetlands designated as outstanding national resource waters in the same manner as other surface waters; see Section 131.12(a)(3) of the WQS regulation and USEPA guidance (Water Quality Standards Handbook (USEPA 1983b), and Questions and Answers on: Antidegradation (USEPA 1985a)).

Overflow Rate: A measurement used in wastewater treatment calculations for determining solids settling. It is also used for CSO storage facility calculations and is defined as the flow through a storage basin divided by the surface area of the basin. It can be thought of as an average flow rate through the basin. Generally expressed as gallons per day per square foot (gpd/sq.ft.).

Oxidation Pond: A relatively shallow body of wastewater contained in an earthen basin; lagoon; stabilization pond.

Oxidation: The chemical union of oxygen with metals or organic compounds accompanied by a removal of hydrogen or another atom. It is an important factor for soil formation and permits the release of energy from cellular fuels.

Oxygen Demand: Measure of the dissolved oxygen used by a system (microorganisms) in the oxidation of organic matter. (See also biochemical oxygen demand)

Oxygen Depletion: The reduction of dissolved oxygen in a waterbody.

PAH: Polycyclic Aromatic Hydrocarbons

Partition Coefficients: Chemicals in solution are partitioned into dissolved and particulate adsorbed phase based on their corresponding sediment-to-water partitioning coefficient.

Parts per Million (ppm): The number of "parts" by weight of a substance per million parts of water. This unit is commonly used to represent pollutant concentrations. Large concentrations are expressed in percentages.

Pathogen: Disease-causing agent, especially microorganisms such as bacteria, protozoa, and viruses.

PCBs: Polychlorinated biphenyls

PCS: Permit Compliance System

PE: Primary Effluent

Peak Flow: The maximum flow that occurs over a specific length of time (e.g., daily, hourly, instantaneous).

Pelagic Zone: The area of open water beyond the littoral zone.

Pelagic: Pertaining to open waters or the organisms which inhabit those waters.

Percent Fines: In analysis of sediment grain size, the percent of fine (.062-mm) grained fraction of sediment in a sample.

Permit Compliance System (PCS): Computerized management information system which contains data on NPDES permit-holding facilities. PCS keeps extensive records on more than 65,000 active water-discharge permits on sites located throughout the nation. PCS tracks permit, compliance, and enforcement status of NPDES facilities.

Permit: An authorization, license, or equivalent control document issued by USEPA or an approved federal, state, or local agency to implement the requirements of an environmental regulation; e.g., a permit to operate a wastewater treatment plant or to operate a facility that may generate harmful emissions.

Petit Ponar Grab Sampler: Dredge designed to take samples from all types of benthos sediments on all varieties of waterbody bottoms, except those of the hardest clay. When the jaws contact the bottom they obtain a good penetration with very little sample disturbance. Can be used in both fresh and salt water.

pH: An expression of the intensity of the basic or acid condition of a liquid. The pH may range from 0 to 14, where 0 is most acid, 14 most basic and 7 neutral. Natural waters usually have a pH between 6.5 and 8.5.

Phased Approach: Under the phased approach to TMDL development, load allocations (LAs) and wasteload allocations (WLAs) are calculated using the best available data and information recognizing the need for additional monitoring data to accurately characterize sources and loadings. The phased approach is typically employed when non-point sources dominate. It provides for the implementation of load reduction strategies while collecting additional data.

Photic Zone: The region in a waterbody extending from the surface to the depth of light penetration.

Photosynthesis: The process by which chlorophyll-containing plants make carbohydrates from water, and from carbon dioxide in the air, using energy derived from sunlight.

Phytoplankton: Free-floating or drifting microscopic algae with movements determined by the motion of the water.

Point Source: (1) A stationary location or fixed facility from which pollutant loads are discharged. (2) Any single identifiable source of pollutants including pipes, outfalls, and conveyance channels from either municipal wastewater treatment systems or industrial waste treatment facilities. (3) Point sources can also include pollutant loads contributed by tributaries to the main receiving water stream or river.

Pollutant: Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water. (CWA Section 502(6)).

Pollution: Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, chemical, and radiological integrity of water.

Polychaete: Marine worms of the class Polychaeta of the invertebrate worm order Annelida. Polychaete species dominate the marine benthos, with dozens of species present in natural marine environments. These worms are highly diversified, ranging from detritivores to predators, with some species serving as good indicators of environmental stress.

Polychlorinated Biphenyls (PCBs): A group of synthetic polychlorinated aromatic hydrocarbons formerly used for such purposes as insulation in transformers and capacitors and lubrication in gas pipeline systems. Production, sale and new use was banned by law in 1977 following passage of the Toxic Substances Control Act. PCBs have a strong tendency to bioaccumulate. They are quite stable, and therefore persist in the environment for long periods of time. They are classified by USEPA as probable human carcinogens.

Polycyclic Aromatic Hydrocarbons (PAHs): A group of petroleum-derived hydrocarbon compounds, present in petroleum and related materials, and used in the manufacture of materials such as dyes, insecticides and solvents.

Population: An aggregate of interbreeding individuals of a biological species within a specified location.

POTW: Publicly Owned Treatment Plant

pounds per day per cubic foot: lb/day/cf

pounds per day: lbs/day; unit of measure

ppm: parts per million

Precipitation Event: An occurrence of rain, snow, sleet, hail, or other form of precipitation that is generally characterized by parameters of duration and intensity (inches or millimeters per unit of time).

Pretreatment: The treatment of wastewater from non-domestic sources using processes that reduce, eliminate, or alter contaminants in the wastewater before they are discharged into Publicly Owned Treatment Works (POTWs).

Primary Effluent (PE): Partially treated water (screened and undergoing settling) passing from the primary treatment processes a wastewater treatment plant.

Primary Treatment: A basic wastewater treatment method, typically the first step in treatment, that uses skimming, settling in tanks to remove most materials that float or will settle. Usually chlorination follows to remove pathogens from wastewater. Primary treatment typically removes about 35 percent of biochemical oxygen demand (BOD) and less than half of the metals and toxic organic substances.

Priority Pollutants: A list of 129 toxic pollutants including metals developed by the USEPA as a basis for defining toxics and is commonly referred to as "priority pollutants".

Probable Total Project Cost (PTPC): Probable Total Project Cost represents the realistic total of all hard costs, soft costs, and ancillary costs associated with a particular CSO abatement technology per the definitions provided in O'Brien & Gere, April 2006. All PTPCs shown in this report are adjusted to January 2009.

Protozoa: Single-celled organisms that reproduce by fission and occur primarily in the aquatic environment. Waterborne pathogenic protozoans of primary concern include Giardia lamblia and Cryptosporidium, both of which affect the gastrointestinal tract.

PS: Pump Station or Pumping Station

Pseudoreplication: The repeated measurement of a single experimental unit or sampling unit, with the treatment of the measurements as if they were independent replicates of the sampling unit.

PTPC: Probable Total Project Cost

Public Comment Period: The time allowed for the public to express its views and concerns regarding action by USEPA or states (e.g., a Federal Register notice of a proposed rule-making, a public notice of a draft permit, or a Notice of Intent to Deny).

Publicly Owned Treatment Works (POTW): Any device or system used in the treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature that is owned by a state or municipality. This definition includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment.

Pump Station or Pumping Station: Sewer pipes are generally gravity driven. Wastewater flows slowly downhill until it reaches a certain low point. Then pump, or "lift," stations push the wastewater back uphill to a high point where gravity can once again take over the process.

Pycnocline: A zone of marked density gradient.

Q: Symbol for Flow (designation when used in equations)

R.L: Reporting Limit

Rainfall Duration: The length of time of a rainfall event.

Rainfall Intensity: The amount of rainfall occurring in a unit of time, usually expressed in inches per hour.

Raw Sewage: Untreated municipal sewage (wastewater) and its contents.

RCRAInfo: Resource Conservation and Recovery Act Information

Real-Time Control (RTC): A system of data gathering instrumentation used in conjunction with control components such as dams, gates and pumps to maximize storage in the existing sewer system.

Receiving Waters: Creeks, streams, rivers, lakes, estuaries, groundwater formations, or other bodies of water into which surface water and/or treated or untreated waste are discharged, either naturally or in man-made systems.

Red Tide: A reddish discoloration of coastal surface waters due to concentrations of certain toxin producing algae.

Reference Condition: The chemical, physical or biological quality or condition exhibited at either a single site or an aggregation of sites that represents the least impaired condition of a classification of waters to which the reference condition applies.

Reference Sites: Minimally impaired locations in similar waterbodies and habitat types at which data are collected for comparison with test sites. A separate set of reference sites are defined for each estuarine or coastal marine class.

Regional Environmental Monitoring and Assessment Program (REMAP): The Environmental Monitoring and Assessment Program (EMAP) is a research program to develop the tools necessary to monitor and assess the status and trends of national ecological resources. EMAP's goal is to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into assessments of current ecological condition and forecasts of future risks to our natural resources.

Regulator: A device in combined sewer systems for diverting wet weather flows which exceed downstream capacity to an overflow.

REMAP: Regional Environmental Monitoring and Assessment Program

Replicate: Taking more than one sample or performing more than one analysis.

Reporting Limit (RL): The lowest concentration at which a contaminant is reported.

Residence Time: Length of time that a pollutant remains within a section of a waterbody. The residence time is determined by the streamflow and the volume of the river reach or the average stream velocity and the length of the river reach.

Resource Conservation and Recovery Act Information (RCRAinfo): Database with information on existing hazardous materials sites. USEPA was authorized to develop a hazardous waste management system, including plans for the handling and storage of wastes and the licensing of treatment and disposal facilities. The states were required to implement the plans under authorized grants from the USEPA. The act generally encouraged "cradle to grave" management of certain products and emphasized the need for recycling and conservation.

Respiration: Biochemical process by means of which cellular fuels are oxidized with the aid of oxygen to permit the release of the energy required to sustain life; during respiration, oxygen is consumed and carbon dioxide is released.

Restoration: Return of an ecosystem to a close approximation of its condition prior to disturbance. Re-establishing the original character of an area such as a wetland or forest.

Riparian Zone: The border or banks of a stream. Although this term is sometimes used interchangeably with floodplain, the riparian zone is generally regarded as relatively narrow compared to a floodplain. The duration of flooding is generally much shorter, and the timing less predictable, in a riparian zone than in a river floodplain.

Ribonucleic acid (RNA): RNA is the generic term for polynucleotides, similar to DNA but containing ribose in place of deoxyribose and uracil in place of thymine. These molecules are involved in the transfer of information from DNA, programming protein synthesis and maintaining ribosome structure.

Riparian Habitat: Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands.

Riparian: Relating to or living or located on the bank of a natural watercourse (as a river) or sometimes of a lake or a tidewater.

RNA: ribonucleic acid

RTC: Real-Time Control

Runoff: That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

Safe Drinking Water Act: The Safe Drinking Water Act authorizes USEPA to set national health-based standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water. USEPA, states, and water systems then work together to make sure these standards are met.

Sanitary Sewer Overflow (SSO): When wastewater treatment systems overflow due to unforseen pipe blockages or breaks, unforseen structural, mechanical, or electrical failures, unusually wet weather conditions, insufficient system capacity, or a deteriorating system.

Sanitary Sewer: Underground pipes that transport only wastewaters from domestic residences and/or industries to a wastewater treatment plant. No stormwater is carried.

Saprobien System: An ecological classification of a polluted aquatic system that is undergoing self-purification. Classification is based on relative levels of pollution, oxygen concentration and types of indicator microorganisms; i.e., saprophagic microorganisms – feeding on dead or decaying organic matter.

SCADA: Supervisory Control and Data Acquisition

scfm: standard cubic feet per minute

Scoping Modeling: Involves simple, steady-state analytical solutions for a rough analysis of the problem.

Scour: To abrade and wear away. Used to describe the weathering away of a terrace or diversion channel or streambed. The clearing and digging action of flowing water, especially the downward erosion by stream water in sweeping away mud and silt on the outside of a meander or during flood events.

Secchi Disk: Measures the transparency of water. Transparency can be affected by the color of the water, algae and suspended sediments. Transparency decreases as color, suspended sediments or algal abundance increases.

Secondary Treatment: The second step in most publicly owned waste treatment systems in which bacteria consume the organic parts of the waste. It is accomplished by bringing together waste, bacteria, and oxygen in trickling filters or in the activated sludge process. This treatment removes floating and settleable solids and about 90 percent of the oxygen-demanding substances and suspended solids. Disinfection is the final stage of secondary treatment. (See primary, tertiary treatment.)

Sediment Oxygen Demand (SOD): A measure of the amount of oxygen consumed in the biological process that breaks down organic matter in the sediment.

Sediment: Insoluble organic or inorganic material often suspended in liquid that consists mainly of particles derived from rocks, soils, and organic materials that eventually settles to the bottom of a waterbody; a major non-point source pollutant to which other pollutants may attach.

Sedimentation: Deposition or settling of suspended solids settle out of water, wastewater or other liquids by gravity during treatment.

Sediments: Soil, sand, and minerals washed from land into water, usually after rain. They pile up in reservoirs, rivers and harbors, destroying fish and wildlife habitat, and clouding the water so that sunlight cannot reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to wash off the land after rainfall.

Seiche: A wave that oscillates (for a period of a few minutes to hours) in lakes, bays, lagoons or gulfs as a result of seismic or atmospheric disturbances (e.g., "wind tides").

Sensitive Areas: Areas of particular environmental significance or sensitivity that could be adversely affected by discharges, including Outstanding National Resource Waters, National Marine Sanctuaries, waters with threatened or endangered species, waters with primary contact recreation, public drinking water intakes, shellfish beds, and other areas identified by State or Federal agencies.

Separate Sewer System: Sewer systems that receive domestic wastewater, commercial and industrial wastewaters, and other sources but do not have connections to surface runoff and are not directly influenced by rainfall events.

Separate Storm Water System (SSWS): A system of catch basin, pipes, and other components that carry only surface run off to receiving waters.

Septic System: An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent (sludge) that remains after decomposition of the solids by bacteria in the tank; must be pumped out periodically.

SEQRA: State Environmental Quality Review Act

Settleable Solids: Material heavy enough to sink to the bottom of a wastewater treatment tank.

Settling Tank: A vessel in which solids settle out of water by gravity during drinking and wastewater treatment processes.

Sewage: The waste and wastewater produced by residential and commercial sources and discharged into sewers.

Sewer Sludge: Sludge produced at a Publicly Owned Treatment Works (POTW), the disposal of which is regulated under the Clean Water Act.

Sewer: A channel or conduit that carries wastewater and storm-water runoff from the source to a treatment plant or receiving stream. "Sanitary" sewers carry household, industrial, and commercial waste. "Storm" sewers carry runoff from rain or snow. "Combined" sewers handle both.

Sewerage: The entire system of sewage collection, treatment, and disposal.

Sewershed: A defined area that is tributary to a single point along an interceptor pipe (a community connection to an interceptor) or is tributary to a single lift station. Community boundaries are also used to define sewer-shed boundaries.

SF: Square foot, unit of area

Significant Industrial User (SIU): A Significant Industrial User is defined by the USEPA as an industrial user that discharges process wastewater into a publicly owned treatment works and meets at least one of the following: (1) All industrial users subject to *Categorical Pretreatment Standards* under the Code of Federal Regulations - Title 40 (40 CFR) Part 403.6, and CFR Title 40 Chapter I, Subchapter N-Effluent Guidelines and Standards; and (2) Any other industrial user that discharges an average of 25,000 gallons per day or more of process wastewater to the treatment plant (excluding sanitary, non-contact cooling and boiler blowdown wastewater); or contributes a process waste stream which makes up 5 percent or more of any design capacity of the treatment plant; or is designated as such by the municipal Industrial Waste Section on the basis that the industrial user has a reasonable potential for adversely affecting the treatment plants operation or for violating any pretreatment standard or requirement.

Siltation: The deposition of finely divided soil and rock particles upon the bottom of stream and river beds and reservoirs.

Simulation Models: Mathematical models (logical constructs following from first principles and assumptions), statistical models (built from observed relationships between variables), or a combination of the two.

Simulation: Refers to the use of mathematical models to approximate the observed behavior of a natural water system in response to a specific known set of input and forcing conditions. Models that have been validated, or verified, are then used to predict the response of a natural water system to changes in the input or forcing conditions.

Single Sample Maximum (SSM): A maximum allowable enterococci or E. Coli density for a single sample.

Site Spill Identifier List (SPIL): Federal database with information on existing Superfund Sites.

SIU: Significant Industrial User

Skewness: The degree of statistical asymmetry (or departure from symmetry) of a population. Positive or negative skewness indicates the presence of a long, thin tail on the right or left of a distribution respectively.

Slope: The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating one unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04); degrees (2 degrees 18 minutes), or percent (4 percent).

Sludge: Organic and Inorganic solid matter that settles to the bottom of septic or wastewater treatment plant sedimentation tanks, must be disposed of by bacterial digestion or other methods or pumped out for land disposal, incineration or recycled for fertilizer application.

SNWA: Special Natural Waterfront Area

SOD: Sediment Oxygen Demand

SOP: Standard Operating Procedure

Sorption: The adherence of ions or molecules in a gas or liquid to the surface of a solid particle with which they are in contact.

SPDES: State Pollutant Discharge Elimination System

Special Natural Waterfront Area (SNWA): A large area with concentrations of important coastal ecosystem features such as wetlands, habitats and buffer areas, many of which are regulated under other programs.

SPIL: Site Spill Identifier List

SRF: State Revolving Fund

SSM: single sample maximum

SSO: Sanitary Sewer Overflow

SSWS: Separate Storm Water System

Stakeholder: One who is interested in or impacted by a project.

Standard Cubic Feet per Minute (SCFM): A standard measurement of airflow that indicates how many cubic feet of air pass by a stationary point in one minute. The higher the number, the more air is being forced through the system. The volumetric flow rate of a liquid or gas in cubic feet per minute. 1 CFM equals approximately 2 liters per second.

State Environmental Quality Review Act (SEQRA): New York State program requiring all local government agencies to consider environmental impacts equally with social and economic factors during discretionary decision-making. This means these agencies must assess the environmental significance of all actions they have discretion to approve, fund or directly undertake. SEQR requires the agencies to balance the environmental impacts with social and economic factors when deciding to approve or undertake an action.

Standard Operating Procedure (SOP): Document describing a procedure or set of procedures to perform a given operation or evolutions or in reaction to a given event.

State Pollutant Discharge Elimination System (SPDES): New York State has a state program which has been approved by the United States Environmental Protection Agency for the control of wastewater and stormwater discharges in accordance with the Clean Water Act. Under New York State law the program is known as the State Pollutant Discharge Elimination System (SPDES) and is broader in scope than that required by the Clean Water Act in that it controls point source discharges to groundwaters as well as surface waters.

State Revolving Fund (SRF): Revolving funds are financial institutions that make loans for specific water pollution control purposes and use loan repayment, including interest, to make new loans for additional water pollution control activities. The SRF program is based on the 1987 Amendments to the Clean Water Act, which established the SRF program as the CWA's original Construction Grants Program was phased out.

Steady-State Model: Mathematical model of fate and transport that uses constant values of input variables to predict constant values of receiving water quality concentrations.

Storage: Treatment holding of waste pending treatment or disposal, as in containers, tanks, waste piles, and surface impoundments.

STORET: U.S. Environmental Protection Agency (USEPA) national water quality database for STORage and RETrieval (STORET). Mainframe water quality database that includes physical, chemical, and biological data measured in waterbodies throughout the United States.

Storm Runoff: Stormwater runoff, snowmelt runoff, and surface runoff and drainage; rainfall that does not evaporate or infiltrate the ground because of impervious land surfaces or a soil infiltration rate lower than rainfall intensity, but instead flows onto adjacent land or waterbodies or is routed into a drain or sewer system.

Storm Sewer: A system of pipes (separate from sanitary sewers) that carries waste runoff from buildings and land surfaces.

Storm Sewer: Pipes (separate from sanitary sewers) that carry water runoff from buildings and land surfaces.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, channels or pipes into a defined surface water channel, or a constructed infiltration facility.

Stormwater Management Models (SWMM): USEPA mathematical model that simulates the hydraulic operation of the combined sewer system and storm drainage sewershed.

Stormwater Protection Plan (SWPP): A plan to describe a process whereby a facility thoroughly evaluates potential pollutant sources at a site and selects and implements appropriate measures designed to prevent or control the discharge of pollutants in stormwater runoff.

Stratification (of waterbody): Formation of water layers each with specific physical, chemical, and biological characteristics. As the density of water decreases due to surface heating, a stable situation develops with lighter water overlaying heavier and denser water.

Stressor: Any physical, chemical, or biological entity that can induce an adverse response.

Subaqueous Burrow Pit: An underwater depression left after the mining of large volumes of sand and gravel for projects ranging from landfilling and highway construction to beach nourishment.

Substrate: The substance acted upon by an enzyme or a fermenter, such as yeast, mold or bacteria.

Subtidal: The portion of a tidal-flat environment that lies below the level of mean low water for spring tides. Normally it is covered by water at all stages of the tide.

Supervisory Control and Data Acquisition (SCADA): System for controlling and collecting and recording data on certain elements of WASA combined sewer system.

Surcharge Flow: Flow in which the water level is above the crown of the pipe causing pressurized flow in pipe segments.

Surface Runoff: Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of non-point source pollutants in rivers, streams, and lakes.

Surface Water: All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other groundwater collectors directly influenced by surface water.

Surficial Geology: Geology relating to surface layers, such as soil, exposed bedrock, or glacial deposits.

Suspended Loads: Specific sediment particles maintained in the water column by turbulence and carried with the flow of water.

Suspended Solids or Load: Organic and inorganic particles (sediment) suspended in and carried by a fluid (water). The suspension is governed by the upward components of turbulence, currents, or colloidal suspension. Suspended sediment usually consists of particles <0.1 mm, although size may vary according to current hydrological conditions. Particles between 0.1 mm and 1 mm may move as suspended or bedload. It is a standard measure of the concentration of particulate matter in wastewater, expressed in mg/L. Technology-Based Standards. Minimum pollutant control standards for numerous categories of industrial discharges, sewage discharges and for a growing number of other types of discharges. In each industrial category, they represent levels of technology and pollution control performance that the USEPA expects all discharges in that category to employ.

SWEM: System-wide Eutrophication Model

SWMM: Stormwater Management Model

SWPP: Stormwater Protection Plan

System-wide Eutrophication Model (SWEM): Comprehensive hydrodynamic model developed for the New York/New Jersey Harbor System.

Taxa: The plural of taxon, a general term for any of the hierarchical classification groups for organisms, such as genus or species.

TC: Total coliform

TDS: Total Dissolved Solids

Technical and Operational Guidance Series (TOGS): Memorandums that provide information on determining compliance with a standard.

Tertiary Treatment: Advanced cleaning of wastewater that goes beyond the secondary or biological stage, removing nutrients such as phosphorus, nitrogen, and most biochemical oxygen demand (BOD) and suspended solids.

Test Sites: Those sites being tested for biological impairment.

Threatened Waters: Water whose quality supports beneficial uses now but may not in the future unless action is taken.

Three-Dimensional Model (3-D): Mathematical model defined along three spatial coordinates where the water quality constituents are considered to vary over all three spatial coordinates of length, width, and depth.

TKN: Total Kjeldahl Nitrogen

TMDL: Total Maximum Daily Loads

TOC: Total Organic Carbon

TOGS: Technical and Operational Guidance Series

Topography: The physical features of a surface area including relative elevations and the position of natural and man-made features.

Total Coliform Bacteria: A particular group of bacteria, found in the feces of warm-blooded animals, that are used as indicators of possible sewage pollution. They are characterized as aerobic or facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35°. Note that many common soil bacteria are also total coliforms, but do not indicate fecal contamination. (See also fecal coliform bacteria)

Total Coliform (TC): The coliform bacteria group consists of several genera of bacteria belonging to the family *enterobacteriaceae*. These mostly harmless bacteria live in soil, water, and the digestive system of animals. Fecal coliform bacteria, which belong to this group, are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals, and can enter water bodies from human and animal waste. If a large number of fecal coliform bacteria (over 200 colonies/100 milliliters (mL) of water sample) are found in water, it is possible that pathogenic (disease- or illness-causing) organisms are also present in the water. Swimming in waters with high levels of fecal coliform bacteria increases the chance of developing illness (fever, nausea or stomach cramps) from pathogens entering the body through the mouth, nose, ears, or cuts in the skin.

Total Dissolved Solids (TDS): Solids that pass through a filter with a pore size of 2.0 micron or smaller. They are said to be non-filterable. After filtration the filtrate (liquid) is dried and the remaining residue is weighed and calculated as mg/L of Total Dissolved Solids.

Total Kjeldahl Nitrogen (TKN): The sum of organic nitrogen and ammonia nitrogen.

Total Maximum Daily Load (TMDL): The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for non-point sources and natural background, and a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.

Total Organic Carbon (TOC): A measure of the concentration of organic carbon in water, determined by oxidation of the organic matter into carbon dioxide (CO_2). TOC includes all the carbon atoms covalently bonded in organic molecules. Most of the organic carbon in drinking water supplies is dissolved organic carbon, with the remainder referred to as particulate organic carbon. In natural waters, total organic carbon is composed primarily of nonspecific humic materials.

Total P: Total Phosphorus

Total Phosphorus (Total P): A nutrient essential to the growth of organisms, and is commonly the limiting factor in the primary productivity of surface water bodies. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particle form. Agricultural drainage, wastewater, and certain industrial discharges are typical sources of phosphorus, and can contribute to the eutrophication of surface water bodies. Measured in milligrams per liter (mg/L).

Total Suspended Solids (TSS): See Suspended Solids Toxic Substances. Those chemical substances which can potentially cause adverse effects on living organisms. Toxic substances include pesticides, plastics, heavy metals, detergent, solvent, or any other materials that are poisonous, carcinogenic, or otherwise directly harmful to human health and the environment as a result of dose or exposure concentration and exposure time. The toxicity of toxic substances is modified by variables such as temperature, chemical form, and availability.

Total Volatile Suspended Solids (VSS): Volatile solids are those solids lost on ignition (heating to 550 degrees C.) They are useful to the treatment plant operator because they give a rough approximation of the amount of organic matter present in the solid fraction of wastewater, activated sludge and industrial wastes.

Toxic Pollutants: Materials that cause death, disease, or birth defects in organisms that ingests or absorbs them. The quantities and exposures necessary to cause these effects can vary widely.

Toxicity: The degree to which a substance or mixture of substances can harm humans or animals. Acute toxicity involves harmful effects in an organism through a single or short-term exposure. Chronic toxicity is the ability of a substance or mixture of substances to cause harmful effects over an extended period, usually upon repeated or continuous exposure sometimes lasting for the entire life of the exposed organism.

Treated Wastewater: Wastewater that has been subjected to one or more physical, chemical, and biological processes to reduce its potential of being a health hazard.

Treatment Plant: Facility for cleaning and treating freshwater for drinking, or cleaning and treating wastewater before discharging into a water body.

Treatment: (1) Any method, technique, or process designed to remove solids and/or pollutants from solid waste, waste-streams, effluents, and air emissions. (2) Methods used to change the biological character or composition of any regulated medical waste so as to substantially reduce or eliminate its potential for causing disease.

Tributary: A lower order stream compared to a receiving waterbody. "Tributary to" indicates the largest stream into which the reported stream or tributary flows.

Trophic Level: The functional classification of organisms in an ecological community based on feeding relationships. The first trophic level includes green plants; the second trophic level includes herbivores; and so on.

TSS: Total Suspended Solids

Turbidity: The cloudy or muddy appearance of a naturally clear liquid caused by the suspension of particulate matter. It can be measured by the amount of light that is scattered or absorbed by a fluid.

Two-Dimensional Model (2-D): Mathematical model defined along two spatial coordinates where the water quality constituents are considered averaged over the third remaining spatial coordinate. Examples of 2-D models include descriptions of the variability of water quality properties along: (a) the length and width of a river that incorporates vertical averaging or (b) length and depth of a river that incorporates lateral averaging across the width of the waterbody.

U.S. Army Corps of Engineers (USACE): The United States Army Corps of Engineers, or USACE, is made up of some 34,600 civilian and 650 military men and women. The Corps' mission is to provide engineering services to the United States, including: Planning, designing, building and operating dams and other civil engineering projects ; Designing and managing the construction of military facilities for the Army and Air Force; and, Providing design and construction management support for other Defense and federal agencies

United States Environmental Protection Agency (USEPA): The Environmental Protection Agency (EPA or sometimes USEPA) is an agency of the United States federal government charged with protecting human health and with safeguarding the natural environment: air, water, and land. The USEPA began operation on December 2, 1970. It is led by its Administrator, who is appointed by the President of the United States. The USEPA is not a cabinet agency, but the Administrator is normally given cabinet rank.

U.S. Fish and Wildlife Service (USFWS): The United States Fish and Wildlife Service is a unit of the United States Department of the Interior that is dedicated to managing and preserving wildlife. It began as the U.S. Commission on Fish and Fisheries in the United States Department of Commerce and the Division of Economic Ornithology and Mammalogy in the United States Department of Agriculture and took its present form in 1939.

U.S. Geological Survey (USGS): The USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

UAA: Use Attainability Analysis

ug/L: Microgram per liter – A measure of concentration

Ultraviolet Light (UV): Similar to light produced by the sun; produced in treatment processes by special lamps. As organisms are exposed to this light, they are damaged or killed.

ULURP: Uniform Land Use Review Procedure

Underground Storage Tanks (UST): Buried storage tank systems that store petroleum or hazardous substances that can harm the environment and human health if the USTs release their stored contents.

Uniform Land Use Review Procedure (ULURP): New York City program wherein a standardized program would be used to publicly review and approve applications affecting the land use of the city would be publicly reviewed. The program also includes mandated time frames within which application review must take place.

Unstratified: Indicates a vertically uniform or well-mixed condition in a waterbody. (See also Stratification)

Urban Runoff: Storm water from city streets and adjacent domestic or commercial properties that carries pollutants of various kinds into the sewer systems and receiving waters.

Urban Runoff: Water containing pollutants like oil and grease from leaking cars and trucks; heavy metals from vehicle exhaust; soaps and grease removers; pesticides from gardens; domestic animal waste; and street debris, which washes into storm drains and enters receiving waters.

USA: Use and Standards Attainability Project

USACE: United States Army Corps of Engineers

Use and Standards Attainability Project (USA): A NYCDEP program that supplements existing Harbor water quality achievements. The program involves the development of a four-year, expanded, comprehensive plan (the Use and Standards Attainment or "USA" Project) that is to be directed towards increasing water quality improvements in 26 specific bodies of water located throughout the entire City. These waterbodies were selected by NYCDEP based on the City's drainage patterns and on New York State Department of Environmental Conservation (NYSDEC) waterbody classification standards.

Use Attainability Analysis (UAA): An evaluation that provides the scientific and economic basis for a determination that the designated use of a water body is not attainable based on one or more factors (physical, chemical, biological, and economic) proscribed in federal regulations.

Use Designations: Predominant uses each State determines appropriate for a particular estuary, region, or area within the class.

USEPA: United States Environmental Protection Agency

USFWS: U.S. Fish and Wildlife Service

USGS: United States Geological Survey

UST: underground storage tanks

UV: ultraviolet light

Validation (of a model): Process of determining how well the mathematical representation of the physical processes of the model code describes the actual system behavior.

Verification (of a model): Testing the accuracy and predictive capabilities of the calibrated model on a data set independent of the data set used for calibration.

Viewsheds: The major segments of the natural terrain which are visible above the natural vegetation from designated scenic viewpoints.

Virus: Submicroscopic pathogen consisting of a nucleic acid core surrounded by a protein coat. Requires a host in which to replicate (reproduce).

VSS: Total Volatile Suspended Solids

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)).

Wastewater Treatment Plant (WWTP): A facility that receives wastewaters (and sometimes runoff) from domestic and/or industrial sources, and by a combination of physical, chemical, and biological processes reduces (treats) the wastewaters to less harmful byproducts; known by the acronyms, STP (sewage treatment plant), POTW (publicly owned treatment works), WPCP (water pollution control plant) and WWTP.

Wastewater Treatment: Chemical, biological, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water in order to remove, reduce, or neutralize contaminants.

Wastewater: The used water and solids from a community (including used water from industrial processes) that flows to a treatment plant. Stormwater, surface water and groundwater infiltration also may be included in the wastewater that enters a wastewater treatment plant. The term sewage usually refers to household wastes, but this word is being replaced by the term wastewater.

Water Pollution Control Plant (WPCP): A facility that receives wastewaters (and sometimes runoff) from domestic and/or industrial sources, and by a combination of physical, chemical, and biological processes reduces (treats) the wastewaters to less harmful byproducts; known by the acronyms, STP (sewage treatment plant), POTW (publicly owned treatment works), WWTP (wastewater treatment) and WPCP.

Water Pollution: The presence in water of enough harmful or objectionable material to damage water quality.

Water Quality Criteria: Levels of water quality expected to render a body of water suitable for its designated use. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

Water Quality Standard (WQS): State or federal law or regulation consisting of a designated use or uses for the waters of the United States, water quality criteria for such waters based upon such uses, and an antidegradation policy and implementation procedures. Water quality standards protect the public health or welfare, enhance the quality of water and serve the purposes of the Clean Water Act. Water Quality Standards may include numerical or narrative criteria.

Water Quality: The biological, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial uses.

Water Quality-Based Limitations: Effluent limitations applied to discharges when mere technology-based limitations would cause violations of water quality standards.

Water Quality-Based Permit: A permit with an effluent limit more stringent than technologybased standards. Such limits may be necessary to protect the designated uses of receiving waters (e.g., recreation, aquatic life protection).

Waterbody/Watershed (WB/WS) Facility Plan: A predecessor document to the LTCP defined by the Administrative Consent Order. A waterbody/watershed facility plan supports the long-term CSO control planning process by describing the status of implementation of the nine USEPA recommended elements of an LTCP and by providing the technical framework to complete facility planning.

Waterbody Inventory/Priority Waterbody List (WI/PWL): The WI/PWL incorporates monitoring data, information from state and local communities and public participation. The Waterbody Inventory portion refers to the listing of all waters, identified as specific individual waterbodies, within the state that are assessed. The Priority Waterbodies List is the subset of waters in the Waterbody Inventory that have documented water quality impacts, impairments or threats.

Waterbody Segmentation: Implementation of a more systematic approach to defining the bounds of individual waterbodies using waterbody type, stream classification, hydrologic drainage, waterbody length/size and homogeneity of land use and watershed character as criteria.

Waterfront Revitalization Program (WRP): New York City's principal coastal zone management tool. As originally adopted in 1982 and revised in 1999, it establishes the city's policies for development and use of the waterfront and provides the framework for evaluating the consistency of all discretionary actions in the coastal zone with those policies. When a proposed project is located within the coastal zone and it requires a local, state, or federal discretionary action, a determination of the project's consistency with the policies and intent of the WRP must be made before the project can move forward.

Watershed Approach: A coordinated framework for environmental management that focuses public and private efforts on the highest priority problems within hydrologically-defined geographic area taking into consideration both ground and surface water flow.

Watershed: A drainage area or basin that drains or flows toward a central collector such as a stream, river, estuary or bay: the watershed for a major river may encompass a number of smaller watersheds that ultimately combined at a common point.

Weir: (1) A wall or plate placed in an open channel to measure the flow of water. (2) A wall or obstruction used to control flow from settling tanks and clarifiers to ensure a uniform flow rate and avoid short-circuiting.

Wet Weather Flow: Hydraulic flow conditions within a combined sewer system resulting from a precipitation event. Flow within a combined sewer system under these conditions may include street runoff, domestic sewage, ground water infiltration, commercial and industrial wastewaters, and any other non-precipitation event related flows. In a separately sewered system, this type of flow could result from dry weather flow being combined with inflow.

Wet Weather Operating Plan (WWOP): Document required by a permit holder's SPDES permit that optimizes the plant's wet weather performance.

Wetlands: An area that is constantly or seasonally saturated by surface water or groundwater with vegetation adapted for life under those soil conditions, as in swamps, bogs, fens, marshes, and estuaries. Wetlands form an interface between terrestrial (land-based) and aquatic environments; include freshwater marshes around ponds and channels (rivers and streams), brackish and salt marshes.

WI/PWL: Waterbody Inventory/Priority Waterbody List

WLA: Waste Load Allocation

WPCP: Water Pollution Control Plant

WQS: Water Quality Standards

WRP: Waterfront Revitalization Program

WWOP: Wet Weather Operating Plan

WWTP: Wastewater Treatment Plant

Zooplankton: Free-floating or drifting animals with movements determined by the motion of the water.

APPENDIX A

TALLMAN ISLAND
WATER POLLUTION CONTROL PLANT
WET WEATHER OPERATING PLAN

Tallman Island
Wastewater Treatment Plant
Wet Weather Operating Plan

Prepared by:
New York City Department of Environmental Protection
Bureau of Wastewater Treatment

July 2010

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1.0 INTRODUCTION

The Nitrogen Administrative Order on Consent, DEC Case # CO2-20010131-7 (“the Order”) entered into by the City of New York (“City”) and the New York State Department of Environmental Conservation (“DEC”) was effective as of April 22, 2002. This Order has been superseded by a Consent Judgment, Index No. 04-402174 (Supreme Court of New York County, Feinman, J.) effective Feb. 1, 2006 (the “Judgment”). Pursuant to Appendix A of the Order: “Upper East River WWTPs Upgrade Schedule and Compliance Deadlines”, the City submitted a Wet Weather Operating Plan (WWOP) for the Tallman Island Water Pollution Control Plant (WWTP) July 20, 2003. Pursuant to the Order, the WWOP describes procedures to maximize treatment during wet weather events while the Tallman Island WWTP is under construction. The WWOP specifies procedures for the operation of each unit process to treat maximum flows, without materially diminishing effluent quality or destabilizing treatment upon return to dry weather operation. The WWOP establishes process control procedures and set points to maintain stability and efficiency of the biological nutrient removal (BNR) process. The WWOP specifies the treatment facilities that will be available during the construction period. The WWOP is based on operations of process units that are available during the construction period operated at their peak hydraulic loading rate. The actual process control set points are established by the WWOP. Pursuant to the Judgment, upon completion of construction, the WWOP shall be revised to reflect the operation of the fully upgraded Facility. The revised WWOP for Tallman Island shall be submitted to DEC within 18 months of the completion of the construction at the Facility.

This document contains the WWOP for Tallman Island WWTP operation during construction.

1.1 FACILITY BACKGROUND

The New York City Department of Environmental Protection (NYCDEP) owns and operates the Tallman Island WWTP located in the College Point section of the Borough of Queens. The facility serves a drainage area of approximately 17,100 acres and an estimated population of nearly 400,000 residents in the northeast portion of the Borough of Queens.

The New York City Department of Public Works designed the original Tallman Island WWTP in the early 1930s. The plant began operations in time to treat wastewater from the 1939 World’s Fair held at Flushing Meadows Park. The original plant was designed to serve an estimated population of 300,000 people with a wastewater flow of 40 million gallons per day (MGD). Several major expansions and upgrades were completed in 1964 and 1979. The plant now consists of two parallel treatment batteries (East and West) and is designed to treat an average flow of 80 MGD, a peak primary treatment capacity of 160 MGD and a peak secondary treatment capacity of 120 MGD. The capacity of the secondary treatment bypass channel is 68 MGD. The maximum capacity of the interceptors delivering flow to the plant has been estimated at approximately 200 MGD. This estimate may be revised since modeling of the drainage area is currently being performed (by others) to determine the capacity of interceptor to the plant.

During dry weather conditions wastewater is collected by the combined and sanitary sewers and transported by gravity or pump stations through the regulators and interceptors to the plant for treatment and subsequent discharge into the Long Island Sound. During wet weather, storm water runoff combines with the wastewater in the combined collection system, producing an increase in flow. The Tallman Island WWTP is designed, and required by its SPDES permit, to process up to 160 MGD during wet weather, which is twice its Design Dry Weather Flow (DDWF). Flow in excess of 160 MGD is discharged through combined sewer outfalls (CSO). The amount of flow discharged through the CSO's is controlled by the regulators and is dependent upon interceptor capacities, WWTP operations and rainfall characteristics (intensity, duration and location). Additionally, the Flushing Bay CSO Retention Facility is available to retain and return combine sewage in excess of Tallman Island's capacity. The Alley Creek CSO Retention Facility, currently under construction, will also be available to retain and return CSO to Tallman Island once completed.

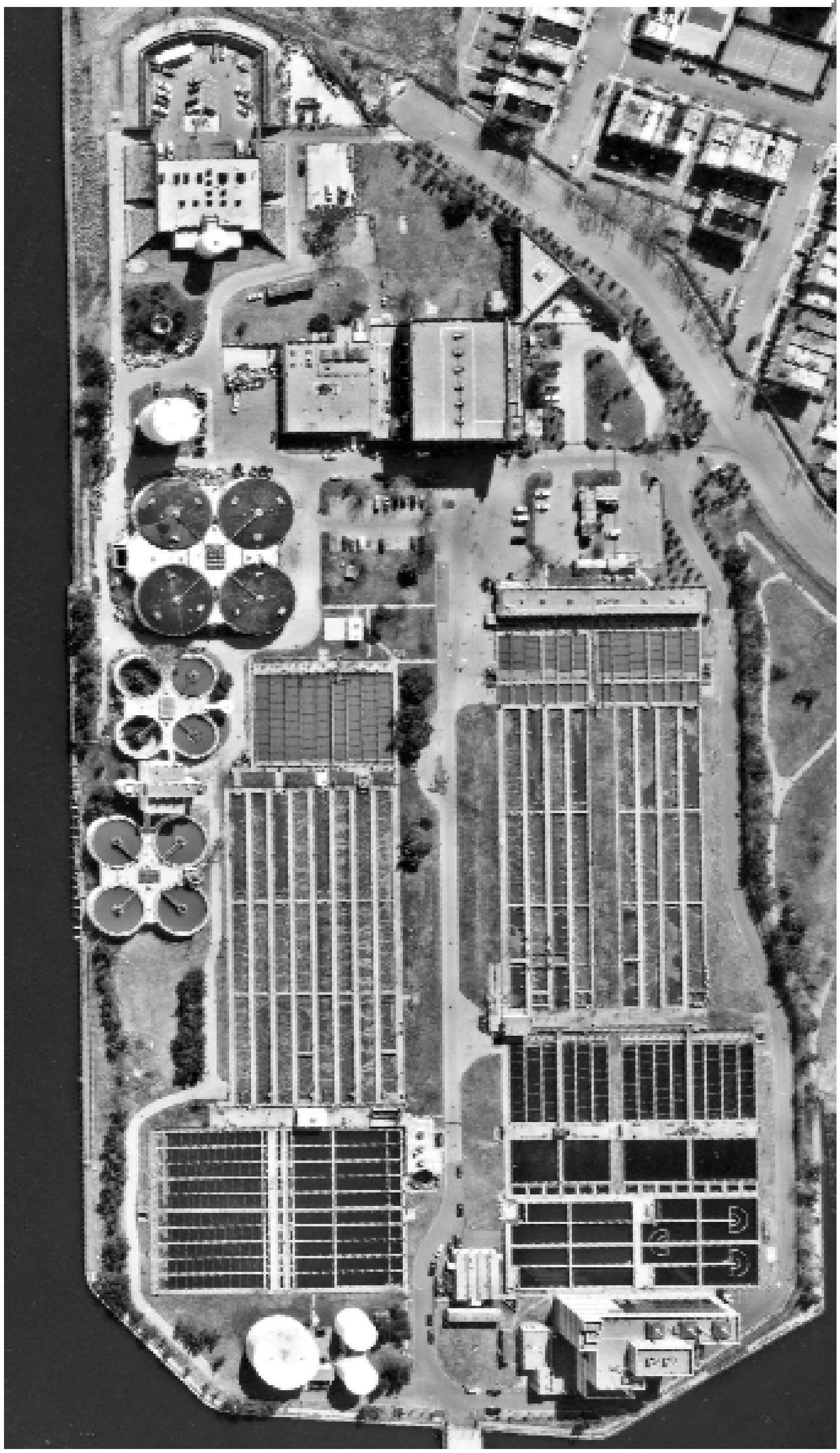
While the Tallman Island WWTP has a twice design capacity of 160 MGD for wet weather flow, the plant operators can control the amount of flow received by the plant through use of the plant's influent throttling gates. The plant operators use the throttling gates to maintain reliable plant performance during and after a wet weather event. The objective of this Wet Weather Operating Plan is to establish an operating procedure that will maximize treatment of wet weather flows, and if possible, consistently achieve or exceed two times DDWF. The current unit processes include screening, preliminary settling, grit removal, activated sludge treatment (step aeration), final settling and chlorination. Sludge treatment includes gravity thickening, anaerobic digestion, and off-site sludge dewatering and disposal of the dewatered sludge. The Dewatering Facility has been temporarily decommissioned as of July 1, 2009 as per the Nitrogen Consent Judgment. Figure 1-1 presents aerial view of the Tallman Island WWTP.

1.1.1 Drainage Area

The drainage area tributary to the Tallman Island WWTP is estimated to be approximately 17,100 acres and is generally bounded by Flushing Bay, Nassau County Line, Grand Central Parkway, and the East River. Figure 1-2 presents the plant location, drainage area, and locations of major elements of the collection system.

The total drainage area is divided into three smaller areas served by an interceptor collection system which include:

- Flushing Main Interceptor-Collector (13,300 acres);
- Whitestone Interceptor-Collector (3,300 acres); and
- College Point Interceptor (500 acres).



AERIAL VIEW OF TALLMAN ISLAND WPCP

FIGURE 1-1

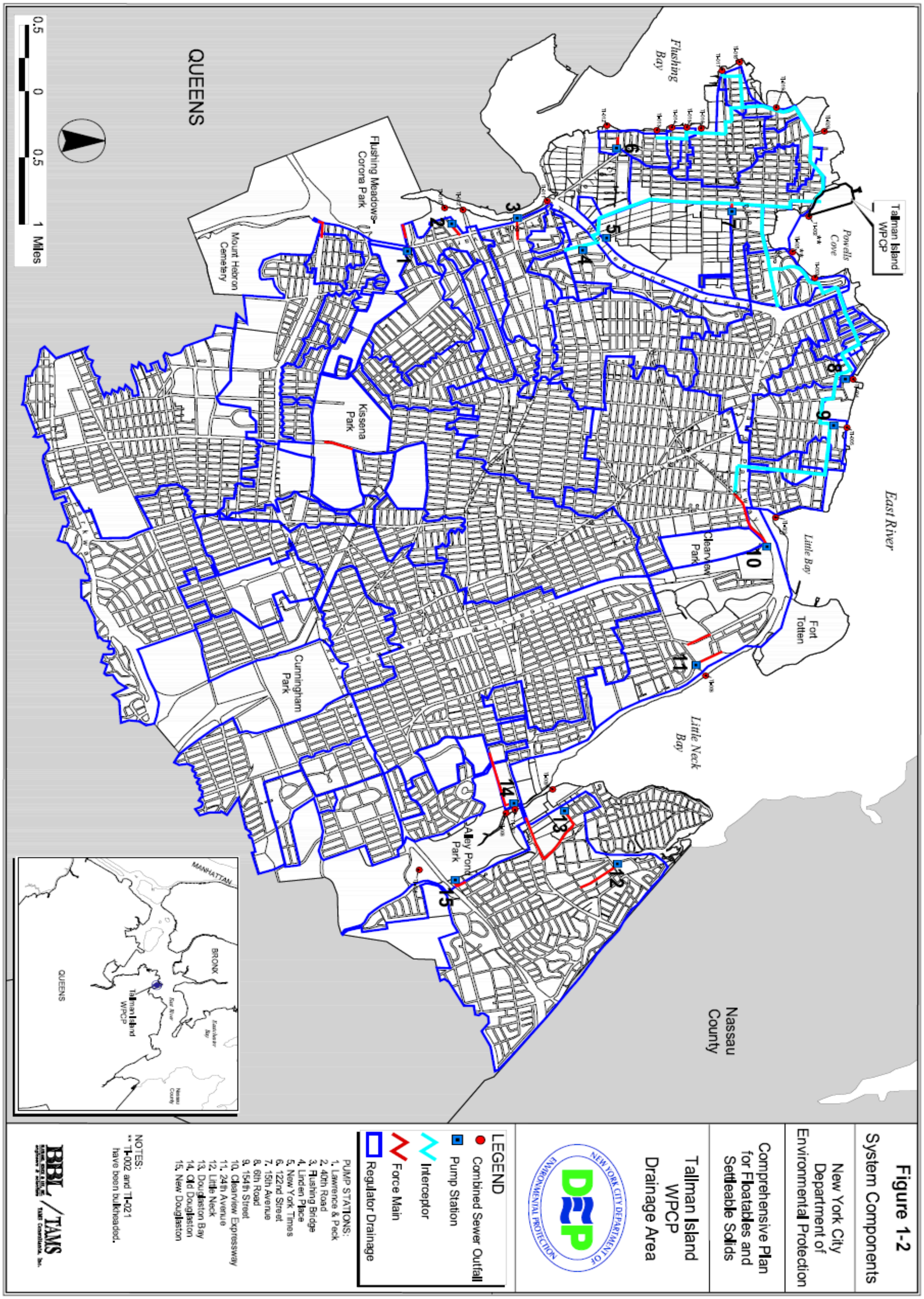


Figure 1-2
System Components
New York City
Department of
Environmental Protection
Comprehensive Plan
for Floatables and
Settleable Solids
Tallman Island
WPCP
Drainage Area
LEGEND
Combined Sewer Outfall
Pump Station
Interceptor
Force Main
Regulator Drainage
PUMP STATIONS:
1. Lawrence & Peck
2. 40th Road
3. Flushing Bridge
4. Linden Place
5. New York Times
6. 122nd Street
7. 15th Avenue
8. 6th Road
9. 154th Street
10. Clearview Expressway
11. 24th Avenue
12. Little Neck
13. Douglaston Bay
14. Old Douglaston
15. New Douglaston
NOTES:
** TI-002 and TI-021
have been bulkheaded.
QUEENS
Flushing Meadows-
Corona Park
Mount Hebron
Cemetery
Kissena
Park
Cunningham
Park
Alley Pond
Park
Clearview
Park
Fort
Totten
Tallman Island
WPCP
Flushing
Bay
Powells
Cove
East River
Little Bay
Little Neck
Bay
Nassau
County
0.5
0
0.5
1 Miles
MANHATTAN
BRONX

There are 15 pumping stations within the area tributary to the Tallman Island WWTP, not including the Powell's Cove Station which is located onsite in the Pump and Blower Building and pumps the flow from the College Point Interceptor to the plant headworks. Five of the 15 pumping stations have three pumps each, and the remaining stations have two pumps each. Table 1-1 provides a listing of all the pumping stations within the Tallman Island WWTP tributary and their rated pump capacity.

Table 1-1. Location of Pump Stations

Pump Station	Pump Station Location	Type	Capacity (MGD)
Clearview	Willets Point. Boulevard. Cross-Island Parkway & Roe Place, Bayside, NY 11368	Combined	13.00
24th Avenue	NE corner of 24th Avenue & 217th Street, Bayside, NY 11360	Sanitary	4.30
New Douglaston	Parkland North of LIE, Cross-Island Parkway, Douglaston, NY 11362	Sanitary	3.30
Doug Bay	41st Avenue & 233rd Street, Douglaston, NY 11364	Sanitary	1.00
Linden Place	NE Corner of Linden Place & 31st Road, Flushing, NY 11356	Combined	5.00
6th Road	6th Road & 151st Street, Whitestone, NY 11357	Sanitary	0.72
15th Avenue	SW Corner of 15 Avenue & 131 Street, College Point, NY 11356	Sanitary	2.90
Old Douglaston	Parkland, Northern Boulevard & 234 Street, Douglaston, NY 11362	Sanitary	6.50
Little Neck	40th Avenue & 248th Street	Sanitary	1.40
122nd Street	S-E Corner of 122 Street & 28 Avenue, College Point, NY 11354	Sanitary	1.50
Flushing Bridge.	Lawrence Street & Northern Boulevard., Flushing, NY 11354	Sanitary	1.20
40th Road	40th Road, West of College Point Boulevard, Flushing, NY 11354	Sanitary	2.00
154th Street	Powell Cove's Boulevard. & 154th Street, Whitestone, NY 11357	Combined	2.30
Lawrence & Peck	50-01 College Point Boulevard., Flushing, NY 11355	Combined	14.00
New York Times	Whitestone Expressway West Service Road N/O Linden Place	Sanitary	0.64

There are 61 regulators in the combined sewer system within the area tributary to the Tallman Island WWTP. Forty-four regulators use diversion weirs, 11 use hydraulic sluice gates, 5 use manual sluice gates, and 1 uses an adjustable hydraulic weir gate to regulate flow to the plant. The purpose of the regulators is to allow all dry weather flow to reach the plant, but to limit the amount of flow entering the plant during wet weather conditions. Table 1-2 provides a listing of all regulators and outfall locations within the Tallman Island WWTP drainage area.

Table 1-2. Location of Regulators and Outfalls

Regulator No.	Regulator Location	Outfall Location	Outfall Size (W x H)
1	120th Street and 5th Avenue.	College Place and East River	24" dia.
2	115th Street and 9th Avenue	9th Avenue and East River	12" dia.
3	110th Street and 14th Avenue	14th Avenue and Flushing Bay	1'-6" x 1'-2"
4	110th Street and 15th Avenue	15th Avenue and Flushing Bay	12" dia.
5	119th Street and 20th Avenue	20th Avenue and Flushing Bay	60" dia.
6	119th Street and 22nd Avenue	22nd Avenue and Flushing Bay	1'-3" x 1'-10"
7	119th Street and 23rd Avenue	23rd Avenue and Flushing Bay	12" dia.
9	Linden Place and 32nd Avenue	32nd Avenue and Flushing Bay	8'-0" x 8'-0"
10	138th Street and 11th Avenue	None	N/A
10A	144th Street and 7th Avenue	W/O 7th Avenue and East River	8'-0" x 8'-0"
10B	144th Street E/O Malba Drive	None	N/A
11	151st Street and 7th Avenue	151st Street and East River	72" dia.
12	154th Street and Powell's Cove Blvd.	154th Street and East River	24" dia.
13	15th Drive and Willets Pt. Boulevard	9th Avenue and Little Bay	13'-6" x 8'-0"
14	162nd Street and Cryders Lane	None	N/A
15	162nd Street and 10th Avenue	None	N/A
16	162nd Street and Powell's Cove Blvd.	None	N/A
17	157th Street and Powell's Cove Blvd.	None	N/A
18	150th Place and 6th Avenue	None	N/A
19	150th Street and 6th Avenue	None	N/A
20	150th Street S/O 5th Avenue	None	N/A
21	150th Street S/O 3rd Avenue	None	N/A
22	149th Place and 3rd Avenue	None	N/A

Table 1-2. Location of Regulators and Outfalls			
Regulator No.	**Regulator Location**	**Outfall Location**	**Outfall Size (W x H)**
23	149th Street and 3rd Avenue	None	N/A
24	148th Street and 3rd Avenue	None	N/A
25	147th Place and 3rd Avenue	None	N/A
26	147th Street and 3rd Avenue	None	N/A
27	3rd Avenue E/O Parsons Boulevard	None	N/A
28	Parsons Boulevard and 5th Avenue	None	N/A
29	Oak Avenue and Colden Street	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
30	Quince Avenue and Kissena Boulevard	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
31	Lawrence Street and Blossom Avenue	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
32	137th Street and Peck Avenue	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
33	138th Street and Peck Avenue	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
34	Main Street S/O Peck Avenue	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
35	56th Road and 146th Street	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
36	150th Street and Booth Memorial Parkway.	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
37	150th Street and 60th Avenue	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
38	Parsons Boulevard. and Booth Memorial Parkway.	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
39	159th Street and Booth Memorial Parkway.	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
40	Fresh Meadow Lane and Peck Avenue	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
40A	Gladwin Avenue and Fresh Meadow Lane.	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
41	188th Street and LIE (N.S.)	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
43	192nd Street and 56th Avenue	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
44	Peck Avenue and LIE (S.S.)	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
45	73rd Avenue and Utopia	Roosevelt Avenue and	18'-6" x 10'-0"

Table 1-2. Location of Regulators and Outfalls

Regulator No.	Regulator Location	Outfall Location	Outfall Size (W x H)
	Parkway.	Flushing River	
45A	69th Avenue and Fresh Meadow Lane	None	N/A
46	210th Street and LIE (N.S.)	46th Avenue and Alley Creek	10'-0" x 7'-6"
47	218th Street and LIE (N.S.)	46th Avenue and Alley Creek	10'-0" x 7'-6"
48	Springfield Boulevard and LIE (S.S.)	46th Avenue and Alley Creek	10'-0" x 7'-6"
49	220th Place and 46th Avenue	46th Avenue and Alley Creek	10'-0" x 7'-6"
50	157th Street and 43rd Avenue	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
51	Parsons Boulevard and 32nd Avenue	32nd Street and Flushing Bay	8'-0" x 8'-0"
52	Union Street and 32nd Avenue	32nd Street and Flushing Bay	8'-0" x 8'-0"
53	137th Street and 32nd Avenue	32nd Street and Flushing Bay	8'-0" x 8'-0"
54	Downing Street and 32nd Avenue	32nd Street and Flushing Bay	8'-0" x 8'-0"
55	College Pt. Blvd. and Roosevelt Avenue	40th Road. and Flushing River	7'-0" x 6'-6"
56	Main Street and 40th Road	40th Road and Flushing River	7'-0" x 6'-6"
57	41st Avenue E/O Lawrence Street	40th Road and Flushing River	7'-0" x 6'-6"
58	Sanford Avenue and Frame Place	40th Road and Flushing River	7'-0" x 6'-6"
59	58th Avenue and Lawrence Street	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"
60	Booth Memorial Parkway. and Lawrence Street	Roosevelt Avenue and Flushing River	18'-6" x 10'-0"

The Tallman Island WWTP drainage area has two in-line CSO storage facilities – the Alley Creek Retention Facility and the Flushing Creek Retention Facility. The Alley Creek CSO Retention Facility was designed to capture and store 5 MG of combined sewage at peak design flow; flows in excess of this will be discharged to Alley Creek via outfall TI-008. The WWOP for the Alley Creek facility is in Appendix A. The Alley Creek Retention Facility is under construction pursuant to the CSO Order, DEC case# C02-20000107-8 (the "CSO Order"). The Flushing Creek CSO Retention Facility is a 43.4 MG storage facility with flow-through capacity. The facility is comprised of a 28.4 MG CSO storage tank and a 15 MG in-line storage component. It captures and stores the combined sewage that normally overflows to outfall TI-010. The WWOP for the Flushing Creek facility is in Appendix B. The WWOP for the Alley Creek Retention Facility presents anticipated operating procedures that will be modified and optimized as Tallman Island WWTP and the CSO facility operating staff gain experience in the operation and maintenance of the facility. The WWOP for the Flushing Bay CSO Facility was updated for this revision to include faster pump back rates and emptying of the CSO facility storage tanks, pursuant to DEC's December 30th, 2009 letter authorizing the use of interim limits.

1.1.2 Influent Flow Control Structures

The Tallman Island WWTP was designed with the following influent flow control structures:

- Four automated sluice gates to regulate influent flow to the screen channels;
- Four heavy duty, front raked, mechanically cleaned, non-jamming bar screens provided with shear pins and motor overload protection, automatic timing devices and alarms to warn of high water in the screen channels or screen malfunction;
- Four manually operated screen channel velocity gates that are used to regulate the velocity of the wastewater flow in the screen channels; and
- Four automated effluent gates to isolate the screens and to permit cleaning of individual channels.

Figure 1-3 presents the floor plan of the influent chamber throttling gates and screening facility.

1.1.3 Facility Description

The following describes major treatment components at the Tallman Island WWTP. A schematic of the Tallman Island WWTP process is provided on Figure 1-4, and the site plan is provided on Figure 1-5. Table 1-3 lists the unit process equipment available for service and the corresponding minimum hydraulic capacity associated with the equipment.

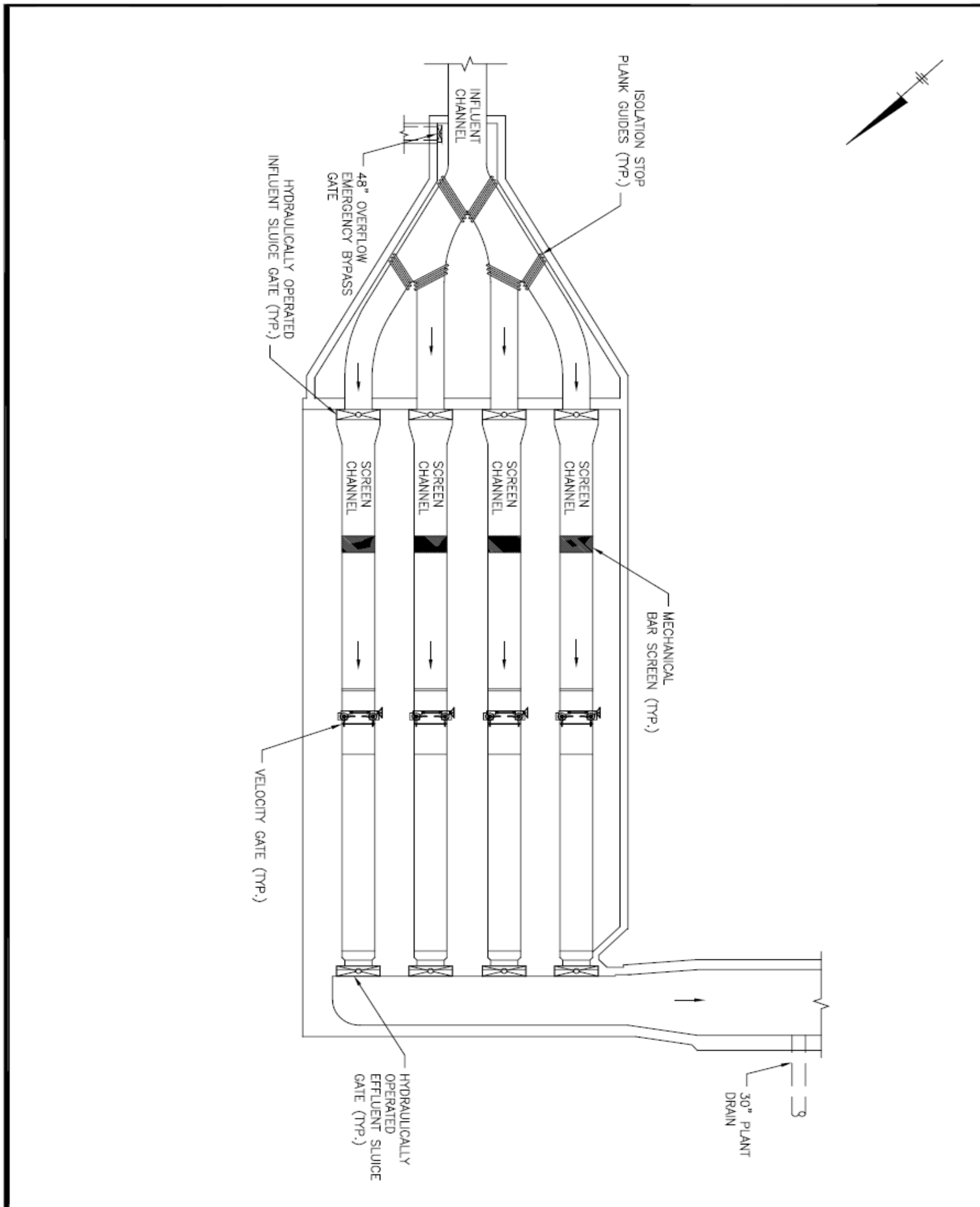


FIGURE 1-3

TALLMAN ISLAND WPCP INFLUENT CHAMBER THROTTLING GATES AND SCREENING FACILITY

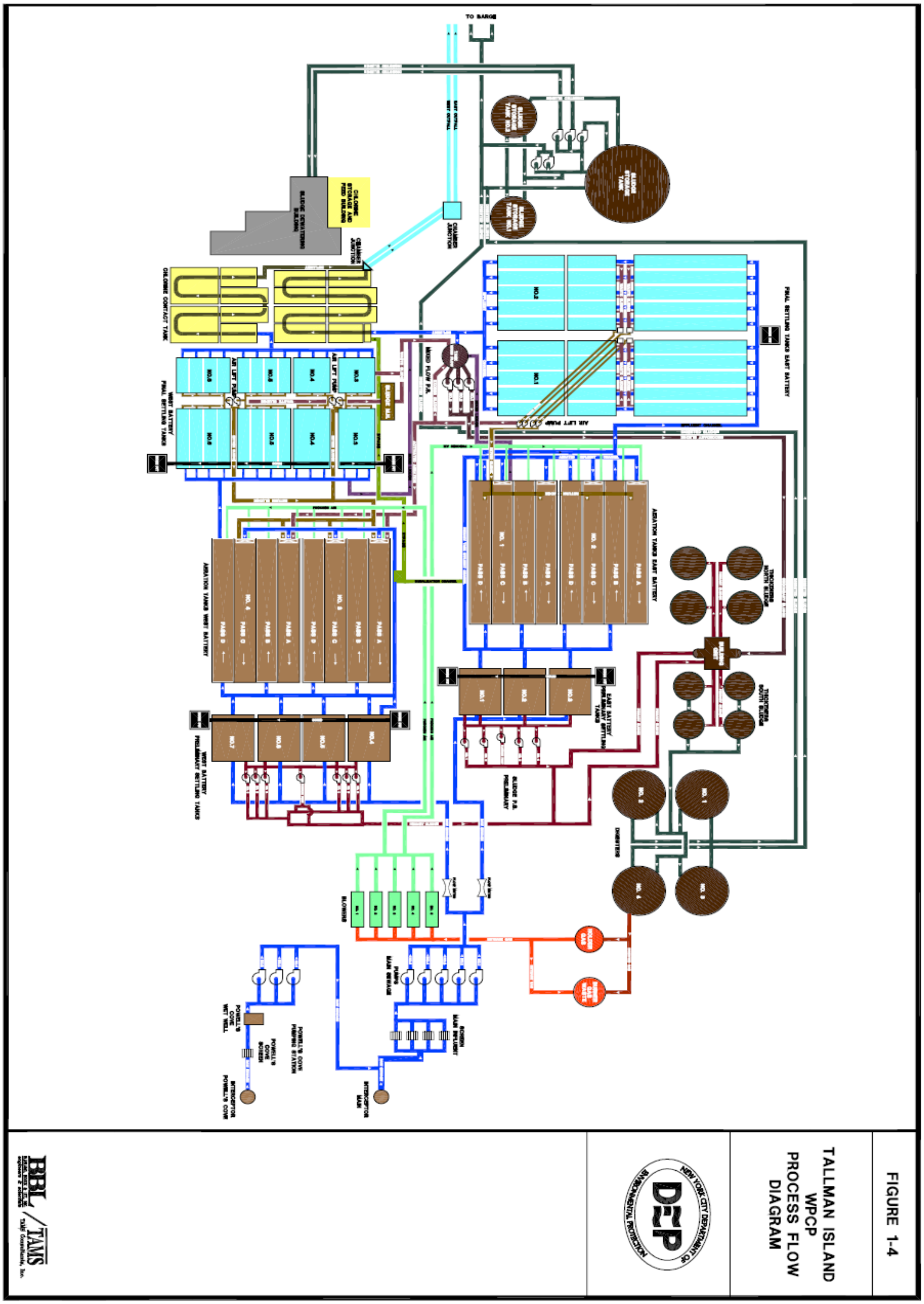


FIGURE 1-4
TALLMAN ISLAND
WPCP
PROCESS FLOW
DIAGRAM
NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DEP
BBL
TAMS

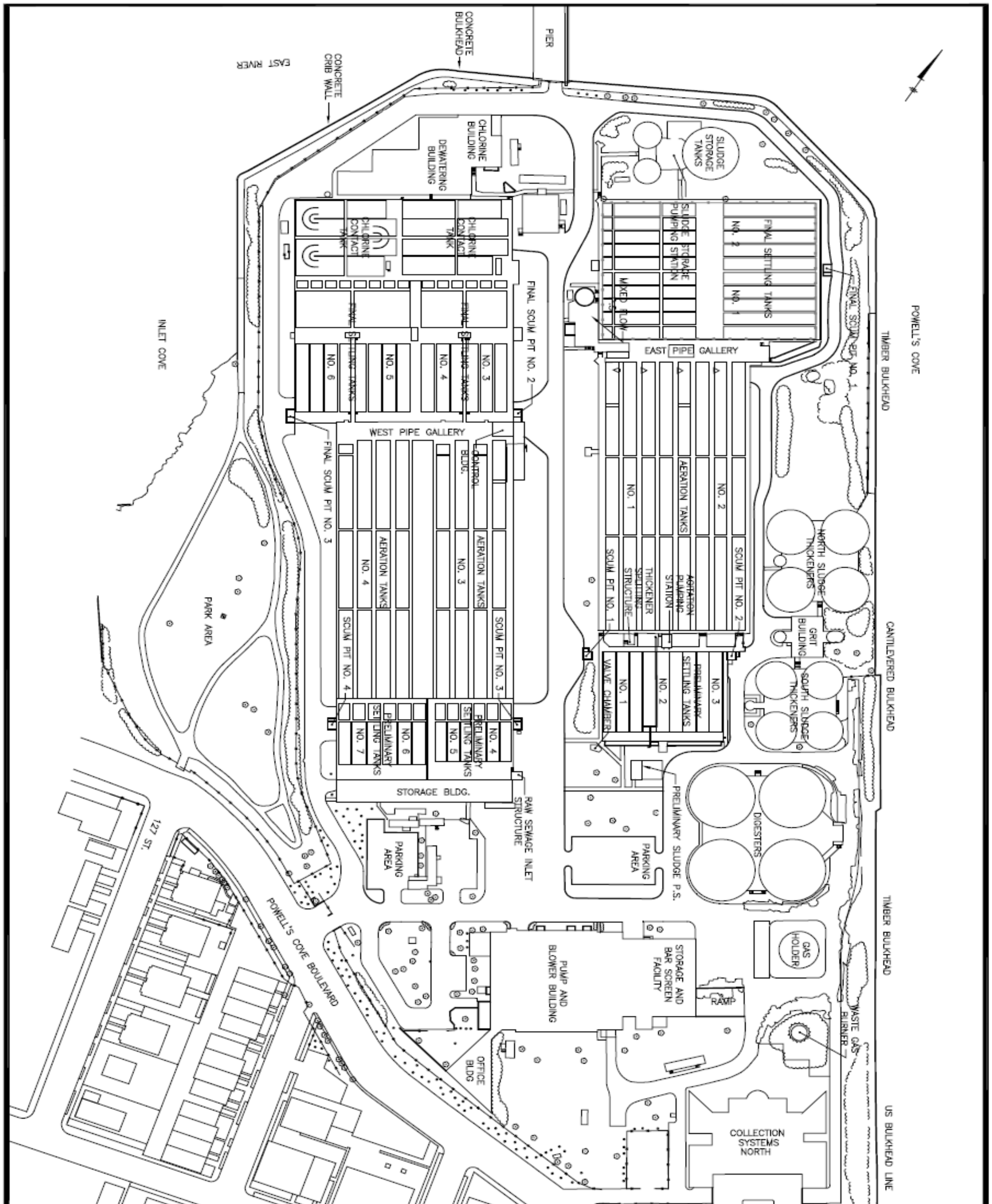


FIGURE 1-5

TALLMAN ISLAND WPCP SITE PLAN

Table 1-3. Minimum Hydraulic Capacity of Equipment

Process Equipment	Number of Units in Service		Minimum Plant Influent Flow	Minimum Secondary Treatment Flow
Screens	4		160 MGD	
	3		160 MGD	
	2		110 MGD	
Main Sewage Pumps	3		160 MGD	
	2		100 MGD	
Primary Settling Tanks	East Battery	West Battery		
	3	4	160 MGD	
	2	4	160 MGD	
	3	3	160 MGD	
	2	3	160 MGD	
	1	3	120 MGD	
	2	2	120 MGD	
Aeration Tanks	2	2		104 MGD (1.3 times design flow)
	2	1		90MGD
	1	2		90 MGD
Final Settling Tanks	2	4		104 MGD (1.3 times design flow)
	2	3		104 MGD (1.3 times design flow)
	2	2		90 MGD
	1	4		90 MGD
	1	3		90 MGD
	0	4	*128 MGD	**60 MGD
Chlorine Contact Tanks	2			160 MGD
	1			80 MGD

Note: * Maximum Plant flow restricted due to limitation of secondary bypass of 68 MGD.
**If an entire battery is out of service, the flow to the secondary system is limited to half of its design flow (120 MGD).

1.1.3.1 Plant Influent

Wastewater from the Flushing Main Interceptor-Collector and the Whitestone Interceptor-Collector discharges to the plant influent channel by gravity while wastewater from the College Point Interceptor discharges to the Powell's Cove Pumping Station which is located within the Tallman Island WWTP in the Pump and Blower Building. In the Powell's Cove Pumping Station, raw wastewater passes through a mechanically cleaned bar screen channel before discharging to the interceptor before the wet-well. The bar screen channel is a concrete pit approximately 20 feet below grade. From the wet-well, the wastewater is pumped through a 24-inch diameter cast iron force main to the plant main interceptor by three variable-speed centrifugal pumps.

1.1.3.2 Screening

Raw wastewater from the three interceptors enters the Tallman Island WWTP through a set of four mechanically cleaned bar screens located in the lower level of the Pump and Blower Building. Hydraulically operated influent sluice gates regulate flow to the four bar screen influent channels. The velocity through each channel is controlled by manually operated velocity gates. These gates are locked in a fixed position and do not affect the plant's ability to achieve 2xDDWF. The screened wastewater then passes through automated sluice gates to the main sewage pumping wet-well. Mechanical scrapers remove the screenings from the bar screens to a belt conveyor on the ground floor of the Bar Screen Building for storage in containers prior to off-site disposal.

1.1.3.3 Main Sewage Pumping Station

Following the bar screens, the wastewater flows by gravity to the main sewage pumping station wet-well. The main sewage pumping station consists of five variable-speed centrifugal pumps. Three of the pumps have a maximum capacity of 60 MGD each and the other two have a maximum capacity of 55 MGD each. Each pump is driven by direct drive, dual-fuel engine.

Wastewater is pumped from the wet-well to a 72-inch-diameter force main. The 72-inch-diameter force main splits into two separate 54-inch-diameter force mains that serve the East and West Batteries. Each force main has a fabricated venturi meter to measure flow.

1.1.3.4 Preliminary Settling Tanks

There are seven preliminary settling tanks: four on the West Battery and three on the East Battery. Two West Battery preliminary tanks are 96 ft. long by 50 ft. wide and the other two are 96 ft. long by 54 ft. wide. The East Battery consists of three identically sized preliminary settling tanks 124 ft. long by 50 ft. wide. Flow is distributed to the seven preliminary settling tanks through 24-inch by 24-inch sluice gates. Each settling tank has six sluice gates. Primary effluent flows over weirs at the end of each tank into the preliminary settling tanks effluent channel. Scum is removed from each tank by a manually operated rotating scum collectors and is temporarily stored in four scum concentration pits prior to off-site disposal.

Each preliminary settling tank has a chain and flight mechanism to direct settled sludge to the cross-collector channel at the bottom of the influent end of the settling tank. Cross-collectors direct the sludge to a sludge pit and it is then pumped to the primary sludge degritters. Sludge is pumped from the East Battery via four variable-speed torque flow pumps. Sludge is pumped from the West Battery via six variable-speed torque flow pumps. In addition, each battery has a triplex plunger pump for auxiliary service.

Primary sludge from both batteries is pumped through cyclone degritters to remove grit. The degritted sludge is discharged to the gravity thickeners. Grit flows to the grit classifiers/washers where the grit is washed and separated from liquid and stored in containers prior to be disposed of off-site.

Primary effluent from both batteries are connected with an equalization channel that can equalize the flow between the two batteries. The equalization channel is separated from the secondary bypass channel by precalibrated weirs to engage the secondary bypass channel when the plant flow reaches 1.3xDDWF. The secondary bypass channel can accept a maximum flow of 68 MGD.

1.1.3.5 Aeration

From the preliminary settling tanks, the wastewater flows by gravity to the aeration tanks for secondary or biological treatment. The East and West Batteries both have two aeration tanks, each with four passes (A through D). Primary effluent from the East Battery flows into the East Battery aeration tanks through inlet conduits. Wastewater can be fed to the influent of each of the four passes. In passes A and C, primary effluent enters through 48-inch by 36-inch sluice gates. Passes B and C have 30-inch-diameter sluice gates. Return Activated Sludge (RAS) can be conveyed to passes A and/or C through 18-inch-diameter telescoping valves. At the end of pass D, mixed liquor overflows into weir troughs to an effluent channel, which leads directly to the final settling tanks influent channel.

Primary effluent from the West Battery flows into the West Battery aeration tanks through 48-inch by 48-inch sluice gates at the beginning of each pass. RAS is conveyed to the beginning of pass A through 24-inch by 24-inch sluice gates. At the end of pass D, effluent overflows to weir troughs that discharge into 48-inch-diameter effluent pipe. The effluent pipe connects to the final settling tank influent channel.

1.1.3.6 Final Settling Tanks

In the East Battery, aeration tank effluent enters the final settling tank influent channel directly from the aeration tank effluent channel. The East Battery has two rectangular final settling tanks each with five bays. Each bay has a chain and flight mechanism that directs sludge to a cross-collector channel. Cross-collectors direct the sludge to an airlift pump chamber. RAS is lifted and then flows by gravity to the aeration tanks. Waste activated sludge (WAS) is drawn off from the airlift pump chamber to the mixed flow pumping station. Effluent from the East Battery is directed to the chlorine contact tanks.

In the West Battery, aeration tank effluent discharges to the final settling tank influent channel from the 48-inch-diameter aeration tank effluent pipe. The West Battery has two rectangular final settling tanks each with three bays, and two rectangular final settling tanks, each with four bays. Each bay has a chain and flight mechanism that directs sludge to a cross-collector channel. Cross-collectors move the sludge to the airlift pit where RAS is pumped by four airlift pumps. WAS is removed by draw-off lines at waste sludge manholes. From the manholes, the WAS flows by gravity to the mixed flow pumping station. Effluent from the West Battery is directed to the chlorine contact tanks.

1.1.3.7 Chlorination

Effluent from the East and West Battery final tanks discharge to two chlorine contact tanks. Each tank consists of four bays of approximately 25 feet in width and 10 feet in depth. The East Battery tank is 143 feet long and the West Battery is 130 feet long. Sodium hypochlorite solution is pumped to the influent through diffusers. A detention time of approximately 37 minutes is provided in both tanks under dry-weather design flow conditions. Baffles just downstream of the diffusers promote mixing of the sodium hypochlorite and the wastewater. Flow into each tank is controlled through influent sluice gates and stop planks. Effluent then flows by gravity into the plant outfall.

1.1.3.8 Gravity Sludge Thickening

The Tallman Island WWTP has two sets of four (8 total) circular, conical-bottomed gravity thickeners. The north gravity thickeners are 60 feet in diameter and the south gravity thickeners are 50 feet in diameter. Each thickener contains a picket-type stirring mechanism that aids thickening and directs sludge to the center pit where it is pumped to anaerobic digesters. For each thickener, two plunger pumps directly below the tank pump the sludge into the digester-heating loop.

1.1.3.9 Sludge Digestion

The Tallman Island WWTP sludge digestion facilities consist of four fixed-cover digesters, heat exchangers, draft tube mixers, gas flare, sludge and gas storage facilities, and ancillary equipment.

Thickened sludge is pumped into the heat exchanger return line to the digesters. Sludge is mixed within each digester by three draft tube mixers. To heat the digester contents, sludge is pumped from the digesters through external heat exchangers. Each digester has a dedicated heat exchanger. The main heat source for the heat exchangers is the engine jacket cooling water system.

Sludge is removed from each digester using four pipes at various depths and locations within the digester. The pipes are manifolded to four sludge transfer pumps. The pumps can either pump sludge to two of the three storage tanks or return it to the digester for further digestion. Currently the sludge is transported by boat to a dewatering facility off-site.

1.2 EFFLUENT PERMIT LIMITS

The Tallman Island WWTP effluent discharge requirements are regulated under SPDES Permit No. NY0026239. The permit requirements are summarized on Table 1-4.

Table 1-4. Effluent Permit Limits

Parameter	Limit
Flow, 12 month rolling average	80 mgd
CBOD5, 30-day arithmetic mean	25 mg/l (1)
	17,000 lb/day (1)
CBOD5, 7-day arithmetic mean	40 mg/l
	27,000 lb/day
CBOD5, 6-consecutive-hour average	50 mg/l (4)
TSS, 30-day arithmetic mean	30 mg/l (1)
	20,000 lb/day (1)
TSS, 7-day arithmetic mean	45 mg/l
	30, 000 lb/day
TSS, daily maximum	50 mg/l (2)
TSS, 6-consecutive-hour average	50 mg/l (4)
Effluent Disinfection	All Year
Fecal Coliform, 30-day geometric mean	200/100 ml
Fecal Coliform, 7-day geometric mean	400/100 ml
Fecal Coliform, 6-hour geometric mean	800/100 ml (4)
Fecal Coliform, Instantaneous Maximum	2400/100 ml (4)
Total Chlorine Residual, daily maximum	2.0 mg/l (3)
pH, range	6.0 to 9.0 SU
Total Nitrogen, Aggregate	See footnote 5

(1) Effluent values shall not exceed 15 percent of influent values for CBOD5 and TSS. During periods of wet weather which causes plant flows over the permitted flow for a calendar day, the CBOD5 and TSS influent and effluent results for the day shall not be used to calculate the 30-day arithmetic mean percent removal limitations. However, all concentrations shall be used in the calculation of the arithmetic mean value concentration limitations. All other effluent limitations remain in full effect.

(2) During periods of wet weather, which results in an instantaneous plant influent flow that is equal to or greater than twice the permitted flow, the TSS Daily Maximum limit of 50 mg/l shall not apply for the day of measured flow nor for the succeeding day.

(3) This is an interim limit of 2.0 mg/l, which shall be in effect until completion of construction of facilities necessary to achieve compliance with the final water quality based effluent limit.

(4)This is an Interstate Environmental Commission (IEC) requirement. The permittee is not required to perform this sampling but shall be required to meet the permit limit at all times. EPA, DEC or IEC may perform the sampling.

(5) Upper and Lower East River Interim and Final, LIS TMDL-derived Total Nitrogen Limits are as follows:

Effective Date of Consent Judgment: 108,375 lbs/day
December 1, 2009: 101,075 lbs/day
July 1, 2010: 86,375 lbs/day
July 1, 2012: 77,275 lbs/day
August 1, 2014: 52,275 lbs/day
January 1, 2017: 44,325 lbs/day

1.3 PERFORMANCE GOALS FOR WET WEATHER EVENTS

The goal of this WWOP is to maximize the treatment of wet weather flows at the Tallman Island WWTP and reduce the volume of Combined Sewer Overflows (CSO) released to the East River and Flushing Bay.

There are three primary objectives in maximizing treatment for wet weather flows including:

- Consistently achieve primary treatment and disinfection standards for wet weather flows up to 160 Million Gallons per Day (MGD). In doing so, this plant will satisfy the level of treatment required under the State Pollution Discharge Elimination System (SPDES) permit.

- Consistently provide secondary treatment for wet weather flows up to 104 MGD before bypassing the secondary treatment system in order to satisfy the level of treatment required under the SPDES permit.

- Consistently maintain effluent water quality standards upon return to dry weather operations.

1.4 PURPOSE OF THIS WWOP

The purpose of this WWOP is to provide a set of operating guidelines to assist Tallman Island WWTP staff in making operational decisions which will best meet the performance goals stated in Section 1.3 and the requirements of the SPDES discharge permit. During a wet weather event, numerous operational decisions must be made to effectively manage and optimize treatment of wet weather flows. Plant flow is controlled through influent pump operations and adjustment of the four main interceptor-throttling gates. Flow rates at which the secondary bypass is used are dependant upon a complex set of factors, including conditions within specific treatment processes and anticipated storm intensity and duration. Each storm event produces a unique combination of flow patterns and plant conditions. No WWOP can describe the decision making process for every possible wet weather scenario which will be encountered at the Tallman Island WWTP. This WWOP can, however, serve as a useful reference that operators can utilize during wet weather events. The manual can be useful in preparing for a coming wet weather event, a source of ideas for controlling specific processes during the storm, and a checklist to avoid missing critical steps in monitoring and controlling processes during wet weather.

1.5 USING THE WWOP

This manual is designed to allow use as a reference during wet weather events. Section 2 is broken down into sub-sections that cover major unit processes at the Tallman Island WWTP. Each protocol for the unit process includes the following information:

- List of unit processes and equipment covered in the section;
- Steps to take before a wet weather event and who is responsible for these steps;
- Steps to take during a wet weather event and who is responsible for these steps;
- Steps to take after a wet weather event and who is responsible for these steps;
- Discussion of why the recommended control steps are performed;
- Identification of specific circumstances that trigger the recommended changes; and
- Identification of things that can go wrong with the process.

The WWOP is a living document. Users of the WWOP are encouraged to identify new steps, procedures, and recommendations to further the objectives of the manual. Modifications which improve the procedures outlined in this WWOP are encouraged. With continued input from the experienced operations staff, this WWOP will become a useful and effective tool.

1.6 REVISIONS TO THIS WWOP

In addition to the revisions based on plant operating experience, this manual will be revised as upgrade work is completed that affects the plants ability to treat wet weather flows. The TI WWTP is currently undergoing a BNR upgrade pursuant to the Judgment. As required, a revised WWOP will be issued for operating procedures during construction. Also, a final revised WWOP, including specific procedures based on actual operating experiences of the upgraded WWTP, will be issued after the completion of the construction.

2.0 UNIT PROCESS OPERATIONS

The following section presents equipment summaries and wet weather operating protocols for each major unit process at the Tallman Island WWTP. This evaluation includes descriptions of associated equipment, basis for protocols, and events or observations that trigger the protocol. Operating protocols are divided into tasks to be completed before, during, and after wet weather conditions.

2.1 HEADWORKS

2.1.1 Equipment

Unit Processes	Equipment
Powell's Cove Pumping Station Influent Gates	1- Motorized Influent Sluice Gate
Powell's Cove Influent Screen	1- Manually Cleaned Bar Screen
Plant Influent Gates	4- Automated Influent Sluice Gates
Plant Influent Screens	4- Primary Bar Screens – Infilco-Degremont - Climber Screens, 1 for each channel (4 Channels). 3/8 inch bar thickness, 1 inch opening between bars – 6 foot wide Channel, Channel Depth: 8 feet; Velocity: 1.3 feet / second, current average DWF, daily max of 80 MGD, (2 channel operation); Velocity @design max of 160 MGD: 2 feet / second (3 channel operation) 4- Motorized Effluent Sluice Gates 1- Belt Conveyor 10 Cubic Yard Screenings Containers

2.1.2 Wet Weather Operation Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• Powell's Cove Influent Gate is left fully open. • Powell's Cove screen is in service and manually cleaned as necessary. • The Plant Influent Gates are typically in automatic mode where the gate bottom is submerged approximately two inches below the water surface elevation to keep gas and odor in the interceptor. • Typically, two of the four Plant Influent Gates are in operation during dry weather and prior to wet weather conditions. The shift supervisor decides the specific gates and channels in use. • Evaluate the need for maintenance or repair of the throttling gates and associated equipment. • Bar screen mechanism is set for both time and level differential. Visually inspect screen to confirm proper operation.
SEE	SSTW/STW	• Rotate screen operation to ensure that all available screens and associated components are in working order. • Evaluate the need for maintenance or repair of the bar rakes and associated equipment. Make sure empty screenings containers are available. • Replace 10 cubic yard containers as needed.

During Wet Weather Event		

SEE	SSTW/STW	• Leave gate in automatic position until:
		  o Plant flow approaches 160 MGD; or
		  o Wet-well level exceeds maximum level; or
		  o Bar screens become overloaded with debris; or
		  o Conditions warrant going to manual ex. high wet well levels could cause the gates to close under automatic operation.
		• Maintain acceptable wet-well level during throttling gate operation.
		• Record all throttling adjustments on the Sluice Gate Log.
		• If all channels are in service and channel flow continues to rise, constrict the influent sluice gates as necessary to keep channels from flooding.
		• Visually monitor the screen channel flow. If the channel level is rising put another screen in service.
		• If screen blinding occurs, place another screen in service.
		• If the screening conveyor fails, direct the screen chute to the 3 cubic yard container and as each 3 yard container gets full, empty screenings into 26 cubic yard containers.
		• Switch bar rakes to continuous cleaning mode.
		• Evaluate the need for maintenance or repair of the bar rakes and associated equipment.
		• Replace 10 cubic yard containers as needed.

After Wet Weather Event		
SEE	SSTW/STW	• If the main Influent Sluice Gates are controlling flow, return them to the fully open position to receive all backed up floatables. Return gates to automatic mode once backed up floatables have been cleared. • Evaluate the need for maintenance or repair of the throttling gate and associated equipment. • As channel flow height continues to lower, determine when gates may be fully closed and channels taken off-line to return to normal operation of two gates/channels.
SEE	SSTW/STW	• Switch bar rakes from continuous cleaning to automatic cleaning (differential elevation or timer control mode). • Shovel screenings that may have overflowed back into the container. • Evaluate the need for maintenance and repair the bar rakes and associated screening equipment as necessary. • Replace 10 cubic yard containers as needed.
Why Do We Do This?		
• Bar screens prevent damage to downstream wastewater pumps by removing large debris from the raw wastewater stream. Bar rakes clear debris from the bar screen continuously during wet weather flow to prevent bar screen blinding. Elevated levels of debris are observed during wet weather conditions. • The influent sluice gate is adjusted to maximize flow into the WWTP without flooding bar screens, bar channels, screen room, and wet well. Flooding of these areas will reduce plant performance and decrease plant stability and could result in damage to the main sewage pumps.		
What Triggers the Change?		

- Auxiliary bar screens are put into service to accommodate high flows during wet weather conditions. Bar rakes operate continuously during wet weather conditions to prevent increased debris from blinding bar screens.
- High flow rates, wet well level, and rising level of flow in bar screen channels indicate that throttling with the sluice gate is necessary.

What Can Go Wrong?
• Blinding of bar screens. • Sluice gate failure.

2.2 INFLUENT WASTEWATER PUMPING

2.2.1 Equipment

Unit Processes	Equipment
Powell's Cove Pumping Main Wet-Well Equipment	3- Main Sewage Pumps (3 @ 4,200gpm) 2- Float Level Sensor in Wet Well
Main Sewage Pumping Equipment	1- Wet Well Level Sensor 2- Venturi Flow Meters 5 – Engine Pumps – Rating: 2 @ 55 MGD, 3 @ 60 MGD, Each Engine rated @ 520 hp 8 – Standby - (Pump around) Submersible Flygt Pumps (2 / Channel) Rated @ 15 MGD each 7 – Standby – (Pump around) Godwin Pumps Each rated @ 10 MGD

2.2.2 Wet Weather Operation Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• For Powell's Cove Pump Station during dry weather, 1 pump is generally in service and 2 spare pumps are available. At the Plant during dry weather, 1 or 2 main sewage pumps are in service and at least 3 pumps may be on standby. • All pumps are generally cycled to ensure all pumps are in working order. • Check that all wet well level monitors are functional. • Number and speed of pumps in service are selected and manually adjusted by operator in the pump control room. • Adjustments are made based on maintaining wet well level. • Monitor pumped flow based on wet well level, number of pumps in service and read-outs from Venturi meters. • Repair pumps and associated equipment as necessary.
During Wet Weather Event		
SEE	SSTW/STW	• Monitor wet well elevation. • As wet well level rises, put off-line pumps in service as necessary. • Pump to maximum plant capacity during wet weather event and when possible leave one pump available as standby. • All adjustments are made manually by operators based on maintaining wet well level within desired operating range. • Restrict flow through influent gates if pumping rate is maximized and wet well level continues to rise.

After Wet Weather Event		
SEE	SSTW/STW	• Maintain pumping rate as required to keep wet well level in operating range. • If influent gates have been throttled, maintain maximum pumping rate until all previously constricted influent gates are returned to normal operating position, flow begins to decrease lowering wet well level and flow stored in collection systems is brought to the Plant.
SEE	SSTW/STW	• Reduce number of pumps in service to maintain wet well level and return to dry weather operation. • Investigate pump malfunctions and repair pumps and associated equipment as necessary.
Why Do We Do This?		
• Maximize flow to treatment plant, and minimize need for flow storage in collection system and associated storm overflow from collection system into Long Island Sound. • To allow the plant to pump the maximum flow through the preliminary treatment tanks without flooding the wet well or bar screen channels.		
What Triggers the Change?		
• Rises and falls in wet-well water level control the number of pumps online.		
What Can Go Wrong?		
• Pump fails to start. • Pump fails while running. • Pump engine failure. • Cone check valve failure.		

2.3 PRELIMINARY SETTLING TANKS

2.3.1 Equipment

Unit Processes	Equipment
East and West Battery Preliminary Settling Tanks	3 - Primary Tanks 1, 2 & 3 – East Side Max hydraulic loading = 4,150 gal/d/sf or 25.7 MGD per tank 2 - Primary Tanks 4, 5, – West Side Max hydraulic loading = 4,150 gal/d/sf; 19.9 MGD per unit 2 - Primary Tanks 6, 7 – West Side Max hydraulic loading = 4,150 gal/d/sf; 21. 5 MGD per unit 42 - Influent Sluice Gates (6 per PST) 21 - Longitudinal Collectors (3 per PST) 7 - Sludge Trough Cross-Collector (1 per PST) 21 - Rotating Scum Collectors (3 per PST) 12 - Primary Sludge Transfer Pumps (7 in East Battery, 5 in West Battery) 4 - Scum Pits (2 in each Battery) with clamshell hoisting equipment Equalization Channel is common to both sides for the primary effluent.

2.3.2 Wet Weather Operation Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• All 7 settling tanks are normally in operation during dry weather conditions. • Check the sludge collector operation and inspect tanks for broken flights. • Check surface scum collection system operation and remove scum as necessary. • Check primary sludge pump operation.
SEE	SSTW/STW	• Maintain scum pits by cleaning regulary • Repair primary sludge pumps and associated equipment as necessary.
During Wet Weather Event		
SEE	SSTW/STW	• One primary sludge pump is in service for each tank with adequate standby pumps available. • Watch water surface elevations at the weirs for flow imbalances. • Check the level of both preliminary tank influent channels. • Check the effluent weirs and, if flooding is occurring, notify supervisor. • Check primary sludge pumps for proper operation. Switch pumps in service as necessary. If the sludge pump suction line appears clogged, shut the pump and back flush. • If the tank cross collector fails, remove the tank from service. • In case of longitudinal collector failure, maintain final tank in service. Balance flows to the tanks to keep the blanket levels even.
After Wet Weather Event		
SEE	SSTW/STW	• Repair equipment failures as necessary. • Check tank collectors for normal operation. Notify supervisor of sheared pins, broken chain or chains off the sprocket. • Remove scum from preliminary tanks as necessary. • Maintain scum pits by cleaning regularly
Why Do We Do This?		
• Preliminary settling tanks protect downstream mechanical equipment and pumps from abrasion and accompanying abnormal wear, and prevent accumulation of grit in aeration tanks and downstream processes. • To maximize the amount of flow that receives primary treatment. • To protect downstream processes from solids overload and scum accumulation.		
What Triggers the Change?		
• Excessive flow and consequent increased grit accumulations.		
What Can Go Wrong?		
• Tank collection system failure • Primary sludge pump failure • Grease carryover to the aeration tanks.		

2.4 GRIT REMOVAL

2.4.1 Equipment

Unit Process	Equipment
Grit Removal	4- Cyclone Sludge Degritters 4- Grit Classifiers 6 cubic yard Containers

2.4.2 Wet Weather Operation Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• One grit cyclone feeding one grit classifier is the normal operation. All 4 units are in service. • Verify that empty grit containers are available. If not, contact the supervisor to bring empties and remove full containers. • Repair any equipment failure as necessary.
During Wet Weather Event		
SEE	SSTW/STW	• If Degritters are on timers change setting to more on time or hand for more severe storms.
After Wet Weather Event		
SEE	SSTW/STW	• No changes are made after wet weather event.
Why Do We Do This?		
• To protect the downstream equipment from abnormal wear and to prevent accumulation of grit in the aeration tanks and digesters.		
What Triggers the Change?		
• Rain		
What Can Go Wrong?		
• Grit cyclones can clog. • Grit classifier failure. • Accumulation of grit in aeration tanks.		

2.5 SECONDARY SYSTEM BYPASS

2.5.1 Equipment

Unit Processes	Equipment
Bypass Channel	1- Venturi Flow Meter (not in service) 2- Fine Tune Gates (with actuators not in service) 8- Fixed Weirs (stop planks)

2.5.2 Wet Weather Operation Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• No changes are made before a wet weather event.

During Wet Weather Event		
SEE	SSTW/STW	• Visually monitor the bypass channel.
After Wet Weather Event		
SEE	SSTW/STW	• No changes are made after a wet weather event.
Why Do We Do This?		
• The bypass channel is used to relieve flow to the aeration system, to avoid excessive loss of biological solids, and to relieve primary clarifier flooding. • To prevent secondary system failure due to hydraulic overload.		
What Triggers the Change?		
• No changes are made.		
What Can Go Wrong?		
• N/A		

2.6 AERATION TANKS

2.6.1 Equipment

Unit Processes	Equipment
Aeration Tanks	4 – Aeration tanks, 4 passes / tank 30 MGD Maximum flow per tank. <u>2 – East Aerators:</u> Length: 373 feet Width: 24 feet 3 inches Side Water Depth: 15 feet Volume: 257,800 cubic feet <u>2 – West Aerators:</u> Length: 360 feet Width: 23 feet 1 inch Side Water Depth: 15 feet Volume: 236,850 cubic feet Process Instrumentation not yet available

2.6.2 Wet Weather Operation Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• All aeration tanks are in operation during dry weather conditions. • The plant operates in a step feed mode, which requires even air distribution to each pass.
SEE	SSTW/STW	• Check the dissolved oxygen (DO) levels and control airflow to maintain at least 2 mg/L (with an average of 4 mg/L) DO in the aeration tanks. • Check telescoping valves for clogging with rags and other debris and temporarily lower valve (1 minute or so) to increase flow and flush debris then return to normal level. • Check damage to air piping system and repair as necessary.
During Wet Weather Event		
SEE	SSTW/STW	• No changes are made during a wet weather event.

After Wet Weather Event		
SEE	SSTW/STW	• No changes are made after a wet weather event.
Why Do We Do This?		
• Wasting is adjusted to maintain steady aeration tank inventory. • Aeration tank operations do not change between dry and wet weather flows.		
What Triggers the Change?		
• There are no significant changes to the aeration tank operations during wet weather.		
What Can Go Wrong?		
• Dissolved Oxygen drops below 2 mg/L. • Mixed flow sludge pump failure. • No return sludge.		

2.7 FINAL SETTLING TANKS

2.7.1 Equipment

Unit Processes	Equipment
Final Settling Tanks	6 – Final Settling Tanks (total) 2 – East Side (Tanks 1 & 2): Length: 272 feet Width: 93 feet, 9.5 inches Depth: 12 feet, 1inch Volume: 308,200 cubic feet. No. of Passes = 5 Max hydraulic loading = 1,200 gal / day / square foot or 30 MGD per tank 2 – West Side (Tanks 3 & 4): Length: 189 feet Width: 55 feet Depth: 12 feet, 1inch Volume: 125,600 cubic feet No. of Passes = 3 Max hydraulic loading = 1,200 gal / day / square foot or 13 MGD per tank 2 – West Side (Tanks 5 & 6): Length: 189 feet Width: 74 feet, 8 inches Depth: 12 feet, 1inch Volume: 170,500 cubic feet No. of Passes = 4 Max hydraulic loading = 1,200 gal / day / square foot or 17 MGD per tank 44- Inlet Sluice Gates 44- Longitudinal Collectors 6- Sludge Trough Cross Collectors 26- Rotating Scum Collectors 3- Scum Pits 8- Telescoping weirs (West Battery) 1- Gate (East Battery) 8- RAS Pumps (4 in each Battery) 3- Wasting Pumps

2.7.2 Wet Weather Operation Protocols

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• All final settling tanks are in service during dry weather conditions. • Skim tanks as necessary. • Check the flow balance to all tanks in service. • Observe effluent quality. • Check RAS/WAS pumps in service for proper operation. • Check tank collectors for proper operation. • Check the effluent quality. Notify the supervisor if solids are washing out over the weirs. • Check the RAS/WAS pump flow rate. • If tank cross collector fails, remove tank from service.
During Wet Weather Event		
SEE	SSTW/STW	• In case of longitudinal collector failure, maintain final tank in service. Balance flows to the tanks to keep the blanket levels even.

After Wet Weather Event		
SEE	SSTW/STW	• Modify the sludge wasting based on MLSS levels and recommendation from Process Engineer. • Observe effluent clarity. • Skim the clarifiers if needed. • Repair equipment failures as necessary.
Why Do We Do This?		
• To prevent solids washouts from secondary clarifiers.		
What Triggers the Change?		
• Rising sludge blankets that cannot be controlled • Flooding of weirs		
What Can Go Wrong?		
• RAS/WAS pump failure. • Solids washout at the final effluent weirs. • Broken sludge collection equipment. • Secondary clarifier weirs are flooded.		

2.8 SLUDGE THICKENING, DIGESTION, AND STORAGE

2.8.1 Equipment

Unit Processes	Equipment
Sludge Thickening	**<u>8 - Gravity Thickeners</u>** South Side – 4 thickeners – 50 ft diameter, 21,292 cuft/tank North Side – 4 Thickeners – 60 ft diameter, 32,228 cuft/ tank 5 thickeners used for continuous duty; 3 standby units Thickener effluent discharges to the primary effluent channels on East & West sides Flows vary from 5 – 15 MGD
Anaerobic Digestion	**<u>4 - Digesters</u>** 3 – Primary digesters – each 83 feet in diameter, 176,000 cubic feet / tank 1 - used as Sludge Storage Tank (see below) 4 - Heat Exchangers 2 - Engine Jacket Cooling Water Pumps 8 - Sludge Recirculation Pumps 4 - Sludge to Storage Pumps
Sludge Storage	**<u>Sludge Storage</u>** No. 4 digester - 83 feet in diameter, Volume =176,000 cuft No. 1 Storage – 75 feet in diameter, Volume= 100,000 cuft No. 2 & 3 Storage tanks – 35 feet in diameter & 28,000 cuft 1 - Sludge Mixing/Sludge to Barge Pump 2 - Sludge Dewatering Pumps 1 - Pump Back/Sump Pump

2.8.2 Wet Weather Operation Protocols

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• Five gravity thickeners are in operation during dry weather conditions. • Five thickened sludge pumps are in operation during dry weather conditions. • One sludge to storage pump is in operation during dry weather conditions.
SEE	SSTW/STW	• Thickener Pump timer settings are adjusted if necessary based on solids inventory in the tank.
During Wet Weather Event		
SEE	SSTW/STW	• No changes are currently made during wet weather.
After Wet Weather Event		
SEE	SSTW/STW	• Repair equipment failures as necessary. • The thickened sludge pumping rate may require adjustment due to a reduction in wasting following a wet weather event.
Why Do We Do This?		
• No changes are made during wet weather conditions.		
What Triggers the Change?		
• No changes are made during wet weather conditions.		
What Can Go Wrong?		
• Thickened collector mechanism failure • Thickened sludge pump failure • Sludge recirculation pump failure • Sludge to storage pump failure		

2.9 EFFLUENT CHLORINATION

2.9.1 Equipment

Unit Processes	Equipment
Effluent Chlorination	2– Chlorine Contact Tanks **East / Old – Side** Length = 143 feet; Width = 100 feet Depth = 9.81 feet @ 80 MGD, 10.41 feet @ 160 MGD **West / New – Side** Length = 130 feet, 4 inches; Width = 102 feet, 4 inches Depth = 9.81 feet @ 80 MGD, 10.40 feet @ 160 MGD Contact Times with both tanks in service: Average Daily Flow of 55 MGD = 53 minutes Daily Peak Flow of 80 MGD = 38 minutes Maximum Flow of 160 MGD = 19 minutes 3 - 6,800 gallons each 2 - 6,000 gallons each – (DW building) 3 – Sodium Hypochlorite feed pumps skids: 2 - continuous duty pump skids (one per CCT tank) 1- standby pump skid Each pump skid consists of: 1 – 28.5 GPH pump; 1 – 96.5 GPH pump 2 – Standby hypochlorite feed pumps skids (DW building) 2 – Induction mixers 2 – Standby ring diffusers 4 - Chlorine Residual Analyzers with control system 4 - Effluent Ultrasonic Flow Meters 1 - Influent Gate

2.9.2 Wet Weather Operation Protocol

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	• Make sure chlorine contact tanks are in service. • Make sure there are sufficient chlorine residual test kit supplies. • Check and maintain hypochlorite tank levels. If low, isolate the tank and place a different tank on-line. Request delivery if necessary. • Check operation of sodium hypochlorite feed pumps. • Check operation of induction mixers. • Check and adjust hypochlorite feed rates to maintain adequate residual.
During Wet Weather Event		
SEE	SSTW/STW	• Check and adjust hypochlorite feed rates to maintain adequate residual. • Increase the chlorine residual measurements to hourly.
After Wet Weather Event		
SEE	SSTW/STW	• Check and adjust hypochlorite feed rates to maintain adequate residual. • Check and maintain hypochlorite tank levels. Request delivery if necessary. • Repair equipment failures as necessary.
Why Do We Do This?		
• During wet weather conditions, hypochlorite demand may change (increase or decrease). Need to adjust hypochlorite feed in order to maintain adequate disinfection of effluent.		
What Triggers the Change?		
• High flows and secondary bypasses may increase hypochlorite demand.		
What Can Go Wrong?		
• Failure of a hypochlorite feed pump • Failure of induction mixers • Failure of a check valve on hypochlorite feed pump piping		

3.0 PLANNED PLANT UPGRADE

The Tallman Island WWTP is currently undergoing a construction upgrade program to address the facility's critical needs and upgrade the aeration process for BNR pursuant to the Judgment.

This section summarizes the major improvements anticipated to be implemented as part of the first phase of the Plant Upgrade Program.

3.1 MAIN SEWAGE PUMPING STATION

The existing main sewage pumps, suction, discharge piping and valves will be demolished and replaced with five new centrifugal-type pumps each capable of pumping 60 MGD depending on wet well height conditions. The facility will have the capability of pumping at least 160 MGD to the preliminary settling tanks during wet weather with three pumps in operation. During this work, a temporary pump around system will be installed in the influent channels following the primary screens. The temporary pump around system has the capability to pump a maximum flow of 160 MGD and consists of: eight submersible Flygt pumps (two in each screening channel, channels are commoned out after main screens) for a maximum flow of 120 MGD and seven Godwin pumps, each rated from 8 – 10 MGD. The existing conveyor system for the Main Influent Screens will be demolished and replaced in-kind. This work should have no effect of the Plant's ability to accept and treat wet weather flow.

The Powells Cove Pumping Station, located in the plant's Pump and Blower Building, will also be upgraded. The existing pumps and climber screen will be demolished and replaced with three new pumps each capable of 4 MGD and a new climber screen. Temporary pumping units capable of handling the entire Powells Cove Pumping Station flow will be provided during this phase of the work. As a result, this work will not impact the Plant's ability to accept and/or treat wet weather flow.

3.2 AERATION TANKS

The aeration tanks at the Tallman Island WWTP will be modified to provide basic step-feed BNR. Baffles will be added to allow for anoxic and oxic treatment zones. Mixers will be provided in the anoxic zones to maintain the suspension of biomass. A new aeration system including fine bubble diffusers will be provided along with new centrifugal process air blowers. The existing air header will be rehabilitated to reduce air losses and a new dissolved oxygen (DO) control system will be provided. The existing spray water system will be demolished and replaced with a new system capable of providing full tank coverage. New influent gates will be added to the aeration tanks to allow for uniform flow distribution to each pass. Automation will need to be provided to allow storm flow to be sent to Pass D of each aeration tank so as to prevent biomass washout. Two froth control hoods will be added in Pass A and B to reduce sludge bulking. Surface wasting will also be provided to maintain the SRT and prevent nocardia and foam accumulation. Only one aeration tank will be allowed to be taken out of service by the contractor at any time. As a result, the system should be capable of processing a minimum wet-weather secondary flow of 90 MGD for short durations without a significant effect on overall treatment performance.

3.3 RAS AND WAS SYSTEM

New submersible RAS pumps will be added to the system with the capacity of 50 to 60 percent of design dry weather flow. This is the currently recommended RAS rate from the Comprehensive Nitrogen Management Team (CNMT). RAS chlorination will be provided to prevent sludge bulking. WAS will be conveyed from Pass A and B of the aeration tanks. Additional instrumentation will be provided to measure RAS flow and RAS total suspended solids (TSS) concentrations.

3.4 GRAVITY THICKENERS

Four of the existing eight gravity thickeners will undergo complete rehabilitation. New mechanisms, drive units, over-flow piping and sludge pumps will be provided under this phase of the upgrade. Only five gravity thickeners are required by the plant at any time. As a result, the Contractor will be allowed to upgrade two gravity thickeners at any time, and should have no effect on the plant's ability to process wet weather flows.

3.5 MIXED FLOW PUMPING STATION

The existing pumps in the mixed flow pump station will be demolished and replaced. Due to the current space limitation, the pumps will be replaced in-kind with new pumps of the same capacity. As part of this upgrade, the spray water system will also be replaced. The capacity of the spray water system will be increased, but only to the extent possible within the existing foot print of the mixed flow pumping station. Only one mixed flow pump will be allowed to be taken out of service at any time. As a result, this work will have no effect on the plant's ability to treat wet weather flows.

3.6 SLUDGE DIGESTION AND STORAGE

The existing covers on the four digesters will be demolished and replaced. New gas piping will be provided from the digester tank covers to the gas compressor building. New piping will be provided from the digester sludge transfer pumps to the existing sludge storage tanks located near the dewatering building.

APPENDIX A

ALLEY CREEK CSO RETENTION FACILITY WWOP

Alley Creek CSO Retention Facility
Bayside, New York

Wet Weather Operating Plan
Alley Creek CSO Retention Facility

Prepared for:
New York City Department of Environmental Protection
Bureau of Engineering, Design and Construction

Prepared by:
URS Corporation
Paramus, New Jersey

June 2003
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1. INTRODUCTION

The purpose of a wet weather operating plan (WWOP) is to provide a set of operating guidelines to assist operating personnel in making operational decisions that will best meet the wet weather operating performance goals. The WWOP is also a SPDES requirement for the Alley Creek Combined Sewer Overflow (CSO) Retention Facility (CSO storage facility) as well as for the Tallman Island Wastewater Treatment Plant (WWTP) as the CSO storage facility is tributary to the WWTP.

During wet weather events, numerous operational decisions must be made to effectively manage and optimize treatment of wet weather flows and CSOs. This WWOP is intended to provide a basis for consistent wet weather operating practices, and to maximize the utility of the Alley Creek CSO Retention Facility during wet weather conditions. The WWOP provides for a consistent and documentable method of approach for various situations.

Each rain storm produces a unique combination of flow patterns and facility conditions. Therefore, no plan or manual can provide specific, step-by-step procedures for every possible wet weather scenario. The procedures presented in this WWOP are conceptual in nature, and will be modified as necessary based on experience operating the CSO storage facility.

1.1. Background

The Alley Creek CSO Retention Facility Project was planned and designed by the New York City Department of Environmental Protection (NYCDEP) to: (1) alleviate surcharging of sewers and subsequent street flooding within areas located immediately west and north of Oakland Ravine and Lake and Alley Park along Springfield Boulevard and 46th and 56th Avenues; and (2) reduce CSOs discharged into Alley Creek through existing Outfall TI-008 (SPDES No. NY0026239), a 10'-0" W x 7'-6" H (inner dimensions) conduit. The Alley Creek CSO Retention Facility is designed as a flow-through retention facility to store and capture up to 5 million gallons (MG) of combined sewage during a wet weather event, and return the captured combined sewage to the existing combined sewer system to be conveyed to the Tallman Island WWTP for treatment during dry weather.

The Alley Creek CSO Retention Facility was constructed in an area within Alley Park in the Bayside section of Queens, New York, north of Northern Boulevard and across from the Alley Pond Environmental Center. Figure 1-1 shows the site location of the Alley Creek CSO Retention Facility, and the principal elements associated with the facility.

1.2. Drainage Area

Outfall TI-008 discharges to Alley Creek at a location south of Northern Boulevard on the west bank of the Creek. This outfall, which was found to be a significant component of water quality degradation in Alley Creek, consists of a 10'-0" W x 7'-6" H (inner dimensions) outfall sewer that is undersized for serving an overall wet-weather drainage area of approximately 1,975 acres within the Tallman Island WWTP service area. The drainage area of Outfall TI-008 is shown on Figure 1-1. This same drainage area is served by the new outfall TI-025 and CSO storage conduit.

1.3. Wet Weather Flow Control

The Alley Creek CSO Retention Facility is designed to store and capture approximately 5 MG of combined sewage overflows resulting in a CSO capture of about 261 MG/year during a typical year. The new outfall sewer and CSO storage conduit were designed to operate completely passively during wet weather events. During a typical year 100% of combined sewage volumes in excess of the CSO storage facility capacity of 5 MG will overflow the crest of the fixed weir at the terminus of the new outfall sewer, and discharge to Alley Creek through new Outfall TI-025.

During storms which exceed a five-year return period as defined by the NYCDEP, the portion of CSO flow that exceeds the hydraulic capacity of the new outfall sewer will overflow a fixed side weir at Chamber No. 6 located near the intersection of 223rd Street and Cloverdale Boulevard, and be conveyed through the existing 10'-0" W x 7'-6" H outfall sewer to discharge into Alley Creek through existing Outfall TI-008.

Captured CSO is drained by gravity to the wet well of the Old Douglaston Pumping Station (ODPS) following wet weather events, provided that there is adequate hydraulic capacity in the Tallman Island WWTP combined sewer system and at the plant. From the ODPS, the captured CSO is pumped through a new 20-inch diameter force main to the existing combined sewer system for conveyance to the Tallman Island WWTP.

1.4. Alley Creek CSO Retention Facility Description

The Alley Creek CSO Retention Facility provides approximately 5 MG of in-line storage volume to decrease the frequency and severity of CSO discharges to Alley Creek. The hydraulic capacity of the existing Outfall TI-008 outfall sewer, which extends from the intersection of 223rd Street and 46th Avenue through Alley Park south of Northern Boulevard, is utilized during extreme storm events that exceed the capacity of the CSO facility. During dry and wet weather, the overflow from Oakland Lake continues to discharge to the existing outfall sewer into Alley Creek through Outfall TI-008, as under existing conditions. CSO entering the CSO storage facility is captured and stored behind the fixed overflow weir that was constructed at the terminus of the new outfall sewer. Upstream of the end weir of the conduit is a conrete baffle that decends from the roof slab. The baffle is designed so that when the water reaches the level required to overflow the end weir, the bottom of the baffle is submerged. The submerged baffle restrains floating material, preventing the material from flowing over the weir. Once the storm ends, the water level drops, along with the floatable material. The CSO and floatables drain to the Old Douglaston Pump Station and is pumped to the Tallman Island WWTP.

During dry weather after a wet weather event, the collected CSO within the Alley Creek CSO Retention Facility will be drained by gravity to the wet well of the ODPS through a 24-inch diameter sewer that extends from the CSO storage facility, crosses under Northern Boulevard, and terminates at a new junction chamber that routes the flow into an existing sewer that discharges to the pumping station wet well. The ODPS pumps sanitary sewage and captured CSO into the new 20-inch diameter force main that terminates in the general vicinity of 46th Avenue and 223rd Street, discharging into the existing Tallman Island WWTP combined sewer system.

Flow and level monitoring equipment is installed to allow the determination of the volume of combined sewage that is captured and pumped back to the Tallman Island WWTP and the volume of combined sewage that flows through the CSO storage facility during storms. The flow and level monitoring equipment provided are able to operate over the range of tidal conditions typical for Alley Creek. Figure 1-2 shows a schematic plan of the Alley CSO Retention Facility with monitoring locations, and Figure 1-3 provides a flow diagram of the facility also with monitoring locations. Monitoring locations are as follows:

- Facility Overflow (Flow-Through) Monitoring - The Facility overflow volume is measured by using a flow meter in conjunction with data collected from two level transmitters as follows: the "Overflow" level transmitter is located upstream of the end weir; and the "Spillway" level transmitter is located downstream of the end weir. A more detailed description on how the overflow volume is computed can be found in Section 2.2.
- Facility Capture (Retained Volume) Monitoring – Four level transmitters will be used to automatically compute the retained volume for each vertical foot of depth of retained CSO. Two of the transmitters will be used to measure the level in the CSO storage conduit; and the other two transmitters will be used to measure the level in the CSO outfall sewer.
- Old Douglaston Pumping Station - The total flow pumped back from the wet well (sanitary & CSO) through the new 20-inch diameter force main from the ODPS is monitored and recorded by a magnetic flow meter.

A listing of systems/equipment included in the Alley Creek CSO Retention Facility is as follows:

- CSO storage facility sluice gate drainage system;
- CSO storage facility drainage control structure housing the pinch valve;
- CSO storage conduit flushing system;
- CSO storage facility and ODPS air treatment system;
- Two open-channel sewage grinders at influent to ODPS; and
- Four main sewage pumps with pump control discharge cone valves at ODPS.

The operation of the Alley Creek CSO Retention Facility is coordinated with the operation of the Flushing Bay CSO Retention Facility to ensure that dry-weather overflows are not induced, and that treatment capabilities of the Tallman Island WWTP are not exceeded during periods of pumping operations. Control of the pumping from the ODPS is based on level monitoring at key locations within the combined sewer system upstream of the Tallman Island WWTP as well as at the influent to the plant as discussed in Section 2.2.

1.5. Performance Goals for Wet Weather Events

The primary goals of the Alley Creek CSO Retention Facility are to reduce the volume of combined sewer overflows into Alley Creek, thereby improving the water quality of the Creek. The goal of the facility is to maximize storage of rain events and minimize overflows by pumping back early and often so the CSO storage facility is emptied prior to the next storm event.

The CSO storage facility is designed to provide 100 percent capture of combined sewage generated by all storms up to about 0.46 inch total precipitation, or approximately 70 percent of the storms that occur on an annual basis in the Outfall TI-025 drainage area. Receiving water computer modeling projections indicate that the overall volume of CSOs discharged to Alley Creek will be reduced by about 54 percent; total suspended solids (TSS) loading will be reduced by about 70 percent; and the biochemical oxygen demand (BOD) loading will be reduced by about 66 percent. In addition, the amount of floatables and settleable solids discharged into Alley Creek will decrease.

1.6. Purpose of this Plan

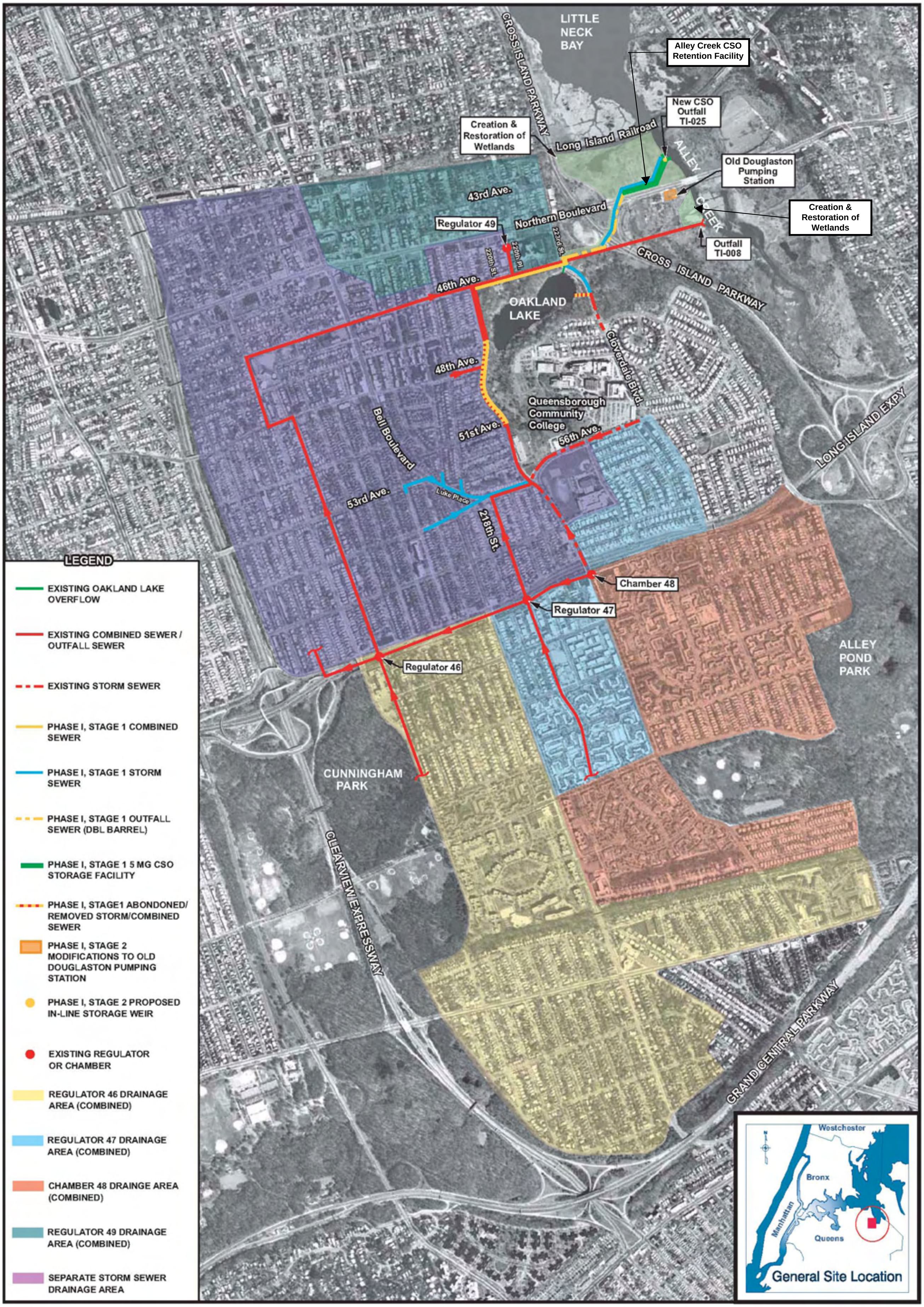
The purpose of this plan is to provide a set of general operating guidelines to assist the DEP operations staff in making operational decisions for the Alley Creek CSO Retention Facility, which will best meet the performance goals stated in Section 1.5 and the requirements of the SPDES discharge permit.

1.7. Using the Plan

This plan is designed for use as a general reference during wet weather events, and is meant to supplement the Alley Creek CSO Retention Facility operation and maintenance manual. It is broken down into sections that cover operation of the Alley Creek CSO Retention Facility. The following information is included:

- Steps to take before, during and after a wet weather event;
- Discussion of why the recommended control steps are performed;
- Identification of specific circumstances that trigger the recommended changes; and
- Identification of things that can go wrong with the equipment.

This plan is a living document. Users of the plan are encouraged to identify new steps, procedures, and recommendations to further the objectives of the plan. Modifications, which improve upon the plan’s procedures, are encouraged. With continued input from the plant’s experienced operations staff, this plan is a useful and effective tool.

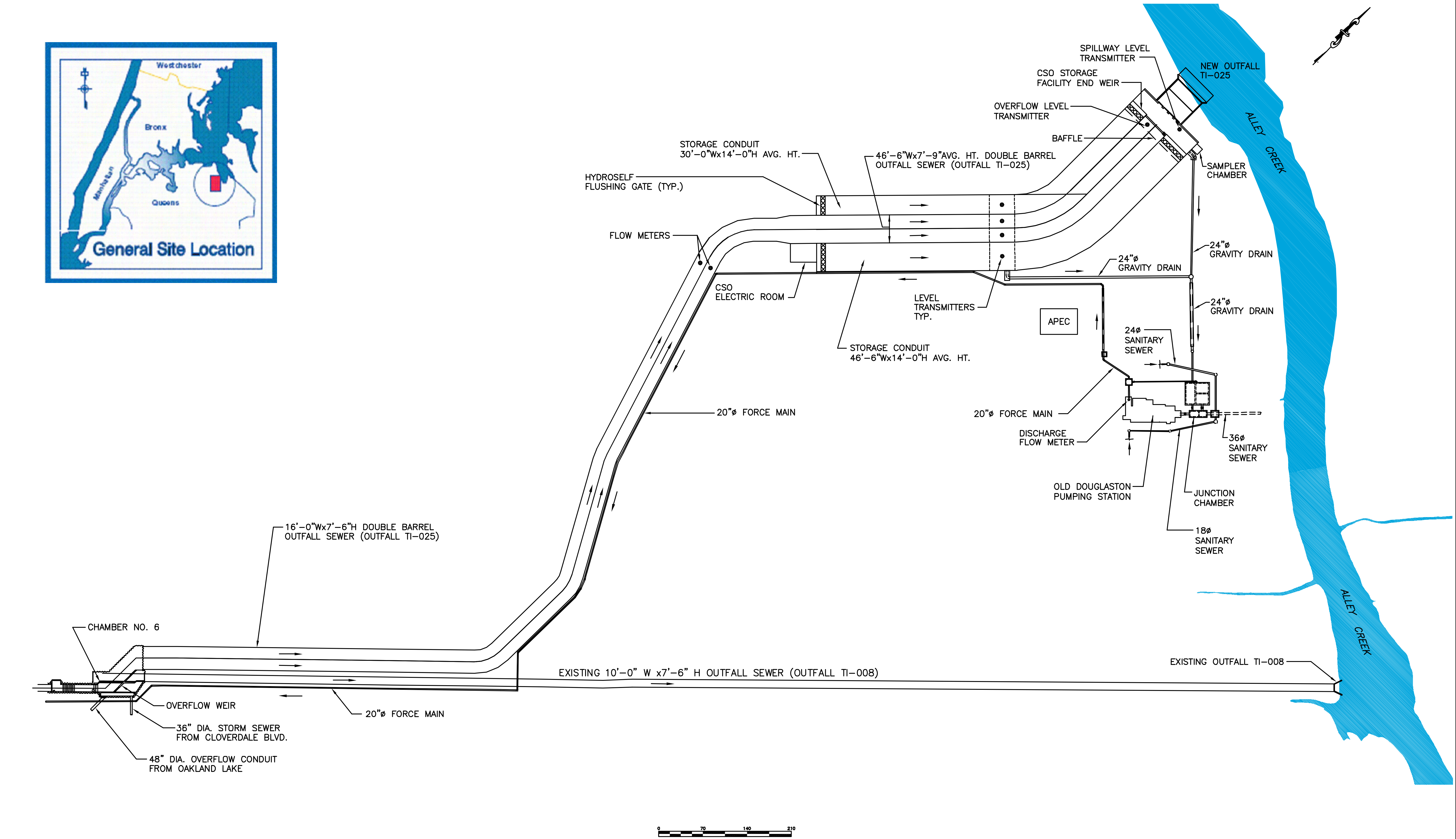


WET WEATHER OPERATING PLAN - ALLEY CREEK

FACILITY SITE LOCATION & DELINEATION OF DRAINAGE AREA

FIGURE 1-1

Storage\lorenzo\TI_Schematic plan_8.5x11_6.02.03.ai

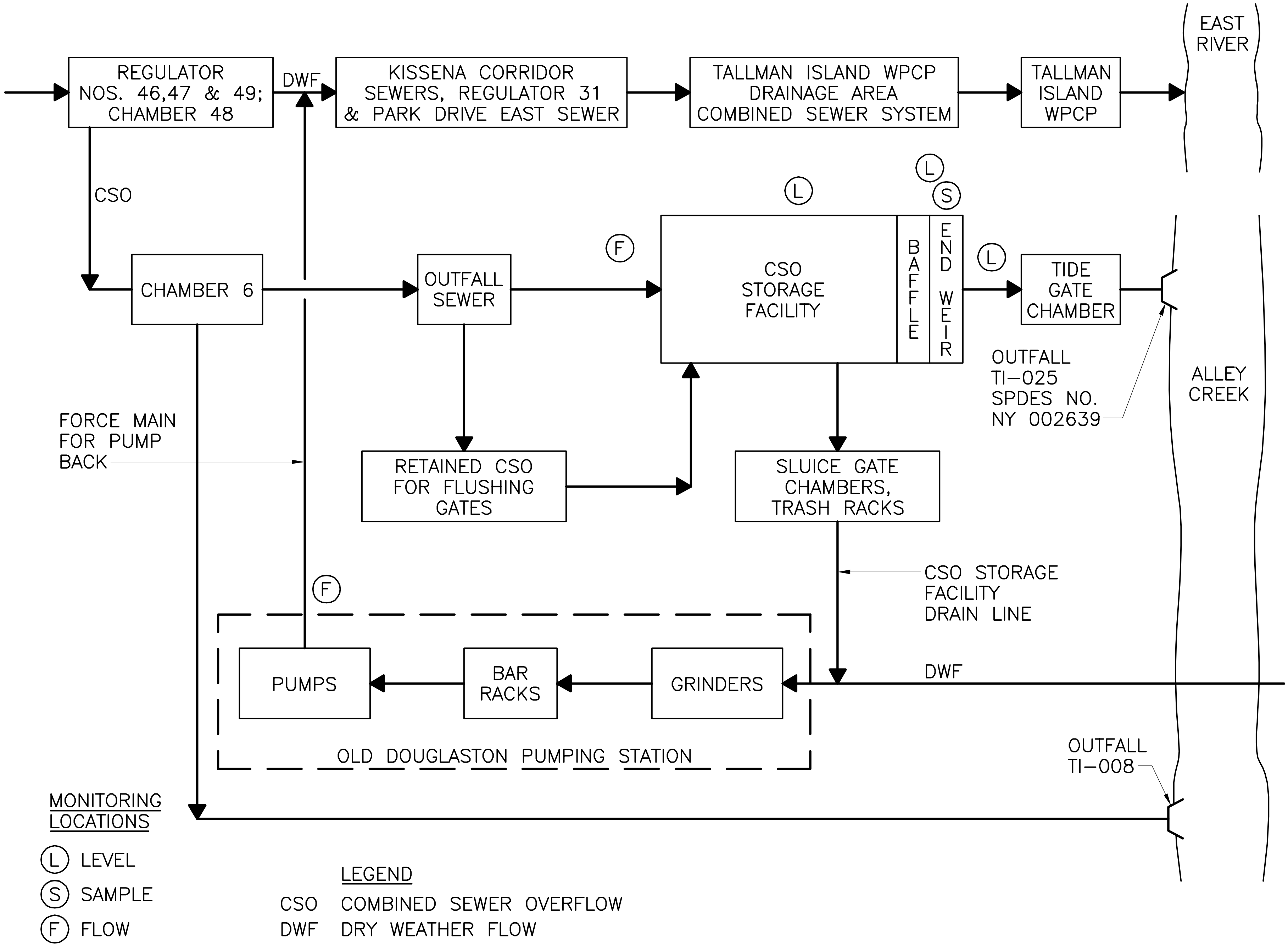


WET WEATHER OPERATING PLAN - ALLEY CREEK

RETENTION FACILITY SCHEMATIC AND MONITORING LOCATIONS

FIGURE 1-2

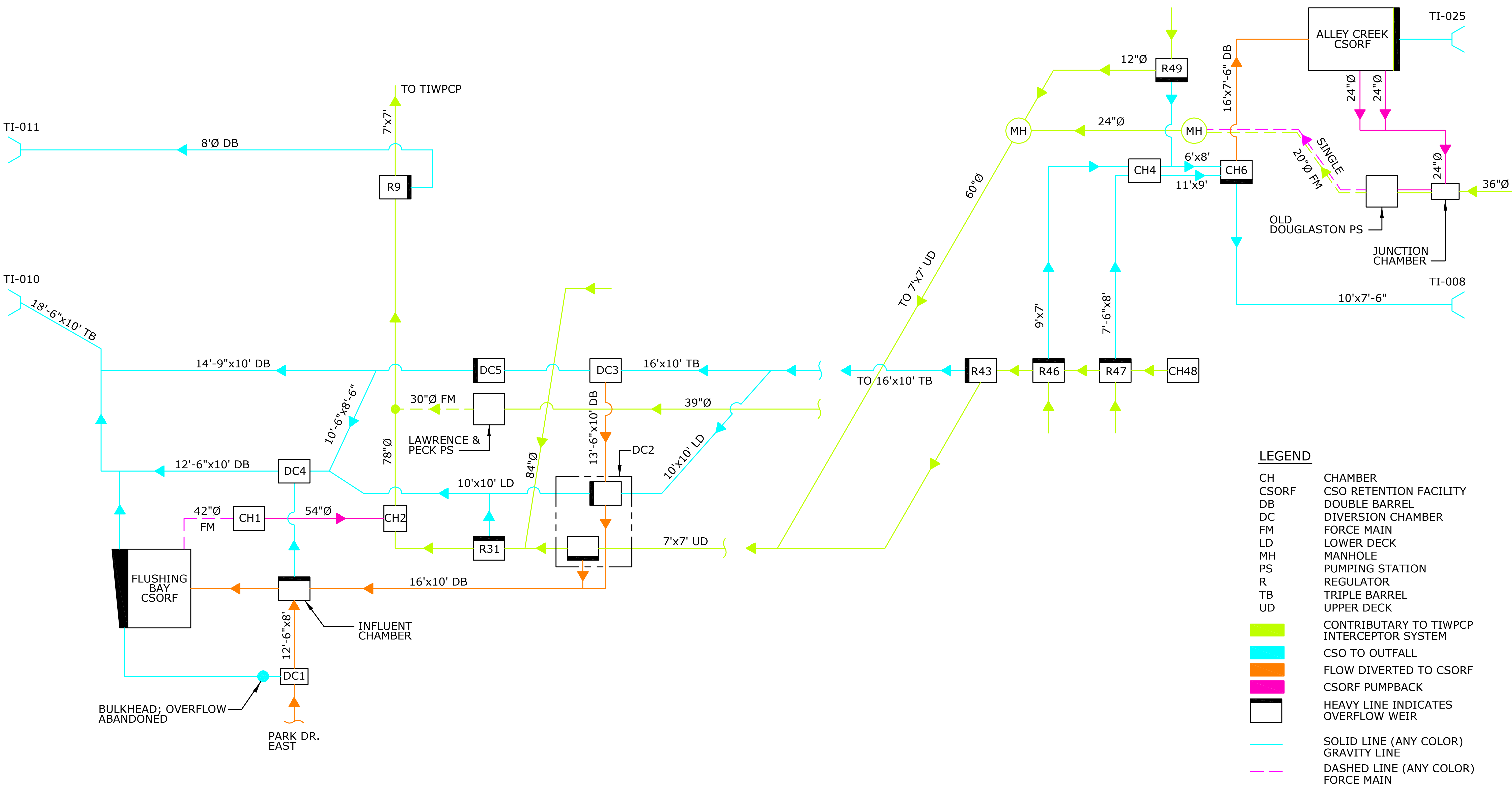
Time: 2:52 P.M. Date: 12/19/2008 Joe_Pizappi Drawing File: H:\10980290\FIG1-3.dwg



NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION

WET WEATHER OPERATING PLAN– ALLEY CREEK
CSO RETENTION FACILITY SCHEMATIC FLOW DIAGRAM

FIGURE 1–3



NYC Environmental Protection

WET WEATHER OPERATING PLAN - ALLEY CREEK

ALLEY CREEK AND FLUSHING BAY CSORF PUMPBACK SCHEMATIC

FIGURE 1-4

2. CSO STORAGE FACILITY OPERATION

This section presents equipment summaries and wet weather operating protocols for the major unit operations of the Alley Creek CSO Retention Facility. The protocols are divided into steps to be followed before, during and after a wet weather event. The protocols also address the basis for the protocol (Why do we do this?), events or observations that trigger the protocol (What triggers the change?), and discussions of what can go wrong.

2.1. CSO Storage Conduit and Outfall Sewer (CSO Storage Facility)

Before Wet Weather Event

- Under normal conditions the CSO storage conduit and new outfall sewer will be in service.
- Check to ensure flow and level monitoring equipment are operational.
- Make sure that the sluice gates for the drain lines to the ODPS are completely closed.

During Wet Weather Event

- Via telemetry, monitor the water levels upstream and downstream of the end weir for the collection of CSO within the Facility and for the overflow condition into Alley Creek for large wet weather events that can be impacted by a high tide condition.

After Wet Weather Event

- Clean the overflow weirs if needed.
- Repair any malfunctioning operations or equipment out of service.
- Trash racks located in Sluice Gate Chamber Nos. 1 and 2 are to be inspected after every storm, and cleaned if necessary.

The CSO storage facility pumpback sequence is initiated remotely, as appropriate, by an operator at the Tallman Island WWTP. Once initiated, the pumpback sequence will continue automatically until the CSO storage facility is completely empty. Should conditions arise that require the automatic pumpback be stopped, the operator at the Tallman Island WWTP will do so remotely from the plant. The CSO storage conduit cleaning sequence is part of the overall automatic pumpback sequence. Following is a generalized description of the pumpback/cleaning sequence:

- An operator at the Tallman Island WWTP remotely initiates the CSO storage facility pumpback sequence following a wet weather event.
- The water levels within the CSO storage conduit flushing water storage areas are automatically checked.
  - o If the flushing water storage areas are confirmed to have been filled by the rain event, drainage of the CSO storage conduit cells to the ODPS commences.
  - o If the flushing water storage areas are found to be not completely filled by the rain event, supplemental flushing water will be automatically delivered to the respective flushing water storage area through the flushing water feed system; which draws stored combined sewage from the elevated double barrel outfall

sewer that is located above the CSO storage conduits. Once confirmed to be filled, cleaning of the individual CSO storage conduit cells commences and drains to the ODPS.

  - The operator that initiates pumpback has an option to run a second flushing sequence via selector switch through the control workstation. The second flushing sequence will automatically run, as long as: the selector switch is set to (2) flushes; and there is adequate volume of stored CSO remaining in the elevated double barrel outfall sewer.

- Upon completion of the CSO storage conduit flushing system sequence, drainage of the elevated double barrel CSO outfall sewer to the ODPS commences.
- When the pumpback sequence is complete, all equipment is automatically returned to their respective pre-operation positions.

During the draining of the CSO storage facility and the pumpback sequence, there are two means of floatables control for the facility as follows:

- Two trash racks are provided, each with 6-inch clear spacing between the bars. The first rack is located in Sluice Gate Chamber No. 1 upstream of the sluice gate that drains the CSO storage facility, and the second rack is located in Sluice Gate Chamber No. 2 upstream of the sluice gate that drains the CSO outfall sewer. The trash racks are provided to protect the downstream sluice gates and downstream pinch valve from damage by any large objects that may be collected within the CSO Storage Facility. Debris collected behind the trash racks is removed manually.
- A new underground structure has been added upstream of the wet well for the ODPS, which houses two open-channel sewage grinders. All flow (sanitary and combined) pass through these grinders prior to entering the wet well and being pumped out to the combined sewer system for conveyance to the Tallman Island WWTP.

Why Do We Do This?
Combined sewage flows and levels need to be monitored in the CSO storage conduit and outfall sewer for the following reasons:

- Prevent premature overflow weir flooding and discharge into Alley Creek.
- Prevent short circuiting.
- Prevent excessive sludge and grit accumulation.
- Prevent dry-weather discharges during facility pumpback and cleaning sequences.

What Triggers The Change?
Wet weather events exceeding the design storm will cause CSO discharges from the regulators serving the Outfall TI-025 drainage area, Regulators TI-R46, TI-R47, and TI-R49. The Alley Creek CSO Retention Facility is designed to reduce the frequency and severity of CSO discharges into Alley Creek during rain events. During dry weather, the CSO storage facility drains to the ODPS wet well for conveyance to the Tallman Island WWTP for treatment.

What Can Go Wrong?
Despite potential failures in flow, level, and sediment control equipment, the Alley Creek CSO Retention Facility is designed to allow the passive storage and capture of combined sewage during wet weather events. During intense storms, the water surface in the new outfall sewer and CSO storage conduit can rise above the crest of the fixed overflow weir at the downstream end of the new outfall sewer and discharge into Alley Creek. In addition, combined sewage can also be relieved via Chamber No. 6 to discharge to Alley Creek though Outfall TI-008 during extreme wet weather events.

2.2 CSO Pumping – Old Douglaston Pumping Station

The ODPS has been modified to accept flow drained from the CSO storage facility. After storms, during dry-weather conditions, when there is available hydraulic capacity in the existing combined sewer system and at the Tallman Island WWTP, the outfall sewer and CSO storage conduit is drained to the wet well of the pumping station.

Flow and level monitoring equipment have been installed to allow for automated computing of the volume of combined sewage that is captured and pumped back to the Tallman Island WWTP, and of the volume of combined sewage that overflows the end weir in the CSO storage facility during large storms. The flow and level monitoring equipment provided are able to operate over the range of tidal conditions typical for Alley Creek. Figure 1-2 shows a schematic plan of the Alley CSO Retention Facility with monitoring locations as follows:

- The Facility overflow volume is measured by using a flow meter in conjunction with data collected from two level transmitters as follows: the “Overflow” level transmitter is located upstream of the end weir; and the “Spillway” level transmitter is located downstream of the end weir. The condition of CSO overflow occurs when the water surface elevation within the CSO Retention Facility is above elevation 2.0, as determined by the Overflow level transmitter, and is greater than the water surface elevation between the end weir and the tide gate as determined by the Spillway level transmitter. The volume of overflow is computed based upon the specific average flow rate for the time that the storm produces a water surface elevation that satisfies these conditions.
- Facility Capture (Retained Volume) Monitoring – Four level transmitters will be used to automatically compute the retained volume for each vertical foot of depth of retained CSO. Two of the transmitters will be used to measure the level in the CSO storage conduit; and the other two transmitters will be used to measure the level in the CSO outfall sewer.
- Old Douglaston Pumping Station - The total flow pumped back from the wet well (sanitary & CSO) through the new 20-inch diameter force main from the ODPS is monitored and recorded by a magnetic flow meter.

The ODPS has a new capacity of approximately 8.5 mgd. Given the average dry-weather flow for the pumping station drainage area, the pumping station has available capacity, approximately 3.3 mgd, to pump out the Alley Creek CSO Retention Facility in approximately 36 hours.

The operation of the Alley Creek CSO Retention Facility is coordinated with the operation of the Flushing Bay CSO Retention Facility to ensure that dry-weather overflows are not induced, and that the treatment capabilities of the Tallman Island WWTP are not exceeded during periods of pumping operations. The actual rate of pumping from the ODPS at any time depends on the available hydraulic and treatment capacity of the Tallman Island WWTP and the available capacity in the Flushing Interceptor Sewer. The following interceptor system level information is available via telemetry. All measuring and monitoring functions are performed by Tallman Island WWTP staff:

- Regulator No. 9 located at the intersection of Linden Place and 32nd Avenue, Flushing, NY.

The combined pumping rates from the Alley Creek CSO Retention Facility and the Flushing Bay CSO Retention Facility, during the pumpback sequence are controlled so that the flow at the influent to the Tallman Island WWTP does not exceed its full secondary treatment capacity. Refer to Figure 1-4 for an overall schematic that includes both the Alley Creek and Flushing Bay Retention Facilities and the surrounding sewers.

An operator at the Tallman Island WWTP is responsible for monitoring flow at the influent to the WWTP and water levels in Regulator No. 9. As discussed in Section 2.1, an operator at the WWTP manually initiates the pumpback sequence for the Alley Creek CSO Retention Facility, and also has manual override capability of terminating the pumpback sequence if it becomes necessary due to flows/levels exceeding preset limits at any of the key monitoring locations. Once the pumpback sequence for the Alley Creek CSO Retention Facility is initiated, the CSO storage facility will begin draining, and the ODPS will begin pumping at a constant rate of approximately 8.5 mgd. The flow/level monitoring system at the influent to the Tallman Island WWTP and within the Flushing Interceptor detects this additional flow from the Alley Creek CSO Retention Facility, and sends a signal to the pumpback system for the Flushing Bay CSO Retention Facility. This signal is processed by the pumpback system’s variable frequency drives, and the pumpback rate for the Flushing Bay CSO Retention Facility is automatically adjusted to ensure that the preset flows/levels are not exceeded at the influent to the Tallman Island WWTP or at Regulator No. 9.

Before Wet Weather Event

- Check the status of all pumps and sewage grinders at the ODPS via telemetry.
- Check that wet well monitors at the ODPS are functional.
- Check that sluice gates for the drain lines to the ODPS from the outfall sewer and CSO storage conduit are closed.

During Wet Weather Event

- Check that wet well monitors at the ODPS are functional.
- Monitor water levels in the CSO Retention Facility.
- Compute overflow volume (automatically) based upon flow meter data and the time element for duration of overflow over the end weir in the CSO Facility.

After Wet Weather Event

- Open sluice gates for the drain lines to the ODPS to allow combined sewage from the CSO storage conduit and the outfall sewer to drain into the ODPS wet well for conveyance to the Tallman Island WWTP for treatment.
- Adjust number of pumps in operation at the ODPS so as to maintain safe water levels in the ODPS wet well and the Flushing Interceptor.

Why Do We Do This?

The pump operating strategy after wet weather events is to maintain a safe water level in the ODPS wet well and to prevent dry-weather overflows. This is accomplished by using a pinch valve to control the combined sewage flow draining from the CSO storage facility, and monitoring the level within the Flushing Interceptor located upstream of the Tallman Island WWTP and at the Tallman Island WWTP.

What Triggers The Change?

The number of pumps online at the ODPS, and the operation of the pinch valve used to control the draining of the CSO storage facility are controlled by the ODPS wet well water level, the available capacity within the Flushing Interceptor located upstream of the Tallman Island WWTP, and the available capacity of the Tallman Island WWTP. If any one of the following events occurs, the sluice gates located at the Alley Creek CSO Retention Facility will be shut down and will not allow additional CSO to drain to the ODPS:

- A high water level within Regulator No. 9.
- The Tallman Island WWTP has reached its hydraulic design capacity.
- The ODPS is unable to handle the existing flow; the high water alarm in the wet well is activated.

What Can Go Wrong?

If the sluice gates, pinch valve and pumps are not operating properly, water levels in the wet well at the ODPS will vary significantly and flooding could occur. System monitoring instrumentation may fail or give false, misleading readings. Uncontrolled or excessive pumping could induce dry-weather overflows at downstream regulators and sewer surcharging.

2.3 Hydroself Flushing Gates

Hydroself Flushing Gates are provided to flush and clean settled solids and debris from the invert of the CSO storage conduit. The Hydroself Flushing Gates use the combined sewage captured during rainstorms. Each gate is equipped with its own hydraulic operator; and the gates are activated one at a time as part of the automatic pumpback process.

Before Wet Weather Event

- Make sure flushing gates are locked in the closed position.
- Make sure all instruments are operational.

During Wet Weather Event

- Make sure flushing gates remain in the closed position.
- Make sure all instruments are operational.

After Wet Weather Event

- Initiate CSO storage facility draining, cleaning and pumping operations sequence.
- Make sure that flushing gates are properly reseated and locked in the closed position.

Why Do We Do This?
Proper functioning and operation of the Hydroself Flushing Gates is necessary for the proper cleaning of the CSO storage conduit. Proper cleaning of the CSO storage conduit is necessary to prevent the build-up of solids that could cause undesirable odors, and diminish the volumetric capacity of the CSO storage facility.

What Triggers The Change?
The onset of a wet weather event of sufficient magnitude causes the overflow of the regulators in the Outfall TI-025 drainage area, and the CSO storage facility collects and stores combined sewage. This also causes the reservoirs behind the Hydroself Flushing Gates to fill. After the wet weather event is over, the stored combined sewage is used to flush the CSO storage conduit.

What Can Go Wrong?
The Hydroself Flushing Gates can become inoperative, or get stuck in either the open or closed positions. These conditions will not allow for the collection of water for flushing purposes during a wet weather event, or allow for proper cleaning of the CSO storage conduit following a wet weather event.

2.4 Permit Monitoring

2.4.1 Monitoring Requirements

The following effluent overflow parameters, listed in Table 2.1, shall be monitored and the sampling results shall be reported on the monthly operating report.

Table 2 - 1. SPDES Monitoring Requirements for CSO Regional Facilities

OVERFLOW PARAMETER	REPORT	UNITS	SAMPLE FREQUENCY	SAMPLE TYPE	FN
Overflow Volume	total, per event (7)	MG	See Footnote 5	Calculated	(1) (4)
Retained Volume	total, per month	MG	See Footnote 5	Recorded, Totalized	(8)
BOD, 5-day	average, per event	mg/l	1 / Each day of event	Composite	(2)
Total Suspended Solids	average, per event	mg/l	1 / Each day of event	Composite	(2)
Settleable Solids	average, per event	ml/l	1 / Each day of event	Grab	(3)
Oil & Grease	average, per event	mg/l	1 / Each day of event	Grab	(6)
Screenings	total, per month	cu. yds.	---	Calculated	
Fecal Coliform	geometric mean, per event	No./100 ml	1 / Each day of event	Grab	(3)
Precipitation	total, per event	Inches	Hourly / Each day of event	Auto, Recording Gauge within drainage area	

FOOTNOTES:

(1) Flows refers to effluent overflows associated with the design storm for the CSO retention facility.
(2) Composite sample shall be a composite of grab samples, one taken every four hours during each overflow event.
(3) When the facility is manned, grab samples are to be taken every four hours during each overflow event.
(4) Effluent overflow shall be calculated using the recorded flow data and level measurements within the CSO Facility during a wet weather event.
(5) In addition to the data supplied on the monthly operating report, the permittee shall provide a summary of the required monitoring to be submitted annually as part of the CSO BMP report required in CSO BMP #14 of this permit. The report shall tabulate sampling results, summarize the number of overflow events, the volume during each event, volume retained and pumped to the WWTP, and the peak flow rate (a calculated number) during each event, and provide an evaluation of the performance of the facility.
(6) Only when the CSO retention facility is manned.
(7) An event starts once overflow out of the CSO retention facility begins, and ends once the overflow stops and the pumpback to the associated wastewater treatment plant has finished.
(8) The permittee shall measure and record the total volume of flow retained and returned to the WWTP each month.

SPECIAL CONDITIONS FOR OPERATION OF THE CSO RETENTION FACILITY

1. The facilities shall be operated in conjunction with the tributary system, pump stations and the WWTP to maximize CSO capture.
2. Upon completion of construction of the retention facility and associated pumping station and conveyances, the permittee shall divert rain induced combined sewage flow to the facility in accordance with the design criteria and the WWOP. The permittee shall notify the Department in writing in accordance with 6 NYCRR Part 750-2 of any changes in the operation due to construction.

3. The permittee shall not discharge from the CSO retention facility unless the tank volume is full to the estimated 5 MG of facility storage and/or the facility cannot accept additional wastewater.
4. The contents of the CSO retention facility, (i.e. captured wastewater) shall not be delivered to the WWTP at a rate which would exceed the peak flow or loading as determined by the CSO BMP#4. The WWOP will detail operating conditions of the CSO retention facility.
5. Flow shall not be delivered to the WWTP at a rate that will cause an upset as defined 6 NYCRR Part 750-1.2(a)(94).
6. If a new CSO retention facility is constructed in the drainage basin of the WWTP, a NY-2A application, as well as the NY-2A Supplement for the Control Facilities, must be submitted to the Department, and the permit modified to include the facility, before construction can commence. In addition, DEP shall modify the WWOP in CSO BMP#4 to reflect the changes required for the new facility.

2.4.2 Monitoring Performed

All samples must be taken in conformance with the SPDES permit, and are to be taken and preserved according to all regulatory guidelines. A blank copy of the monthly operating report is attached in Figure 2.1.

1. Tank Overflow Volume. The tank total effluent overflow volume (MG) per event shall be monitored and reported. The data collected from the flow metering data and the effluent weir level transmitters are used to calculate the overflow volume.
2. Retained Volume. The SPDES permit states that the total Retained Volume shall be measured, recorded and totalized for each month. Additionally, NYSDEC has requested that the reporting of the total Retained Volume for each event be included in the monthly operating report. Tank Overflow Volume and Retained Volume shall also be submitted annually as part of the CSO BMP report. Measurement of Stored Volume within the CSO retention facility:
   - CSO Outfall Sewer - Two level transmitters; one located within the northern barrel, and one located within the southern barrel of the outfall sewer will be used to automatically compute the retained volume for each vertical foot of depth of CSO.
   - CSO Storage Conduit - Two level transmitters; one located within the northern section of the storage conduit, and one located within the southern section of the storage conduit will be used to automatically compute the retained volume for each vertical foot of depth of CSO.
3. BOD, 5-Day, Total Suspended Solids. An automatic sampler has been provided and is used to collect overflow effluent samples during an overflow event. The sample is taken from the overflow at the end weir in the CSO Retention Facility. BOD, 5-day and Total Suspended Solids (TSS) composite samples shall be taken every 4 hours during each overflow event and shall be reported as average per event.
4. Settleable Solids. This facility is typically unmanned, grab samples shall be taken when the facility is mannedduring an overflow event and shall be reported as average per event.
5. Oil & Grease. This facility is typically unmanned, oil & grease grab samples shall be taken when the facility is manned during an overflow event and shall be reported as average per event.
6. Screenings. Screenings are removed manually from trash racks in Sluice Gate Chambers 1 & 2. Screenings shall be recorded, calculated and reported as total per month. .

7. Fecal Coliform. This facility is typically unmanned, grab samples shall be taken when the facility is manned during an overflow event and shall be reported as the geometric mean per event.
8. Precipitation. SPDES permit states that precipitation data (in inches of rain) shall be acquired hourly for each day of event and shall be reported as total per event. Precipitation data are obtained from the local weather station in LaGuardia airport.

FIGURE 2-1

CSO RETENTION FACILITY OPERATION REPORT FOR THE MONTH OF:		DESIGN STORM (IN/DAY): approx 0.46 inches	DESIGN STORAGE VOLUME: 5 MG	**Page 1 of 1**
SPDES PERMIT No. NY-0026239	FACILITY NAME Alley Creek CSO Retention Facility	FACILITY OWNER New York City Department of Environmental Protection	FACILITY LOCATION North of Northern Blvd & across from Alley Pond Environmental Center	

Event Type	Event Start		Event End		Overflow Volume Total per Event	Volume in Storage at 7am	Retained Volume Total per Event	Pumped Back Volume	Precipitation Total per Event	BOD5 Average per Overflow Event	TSS Average per Overflow Event	Settleable Solids Average per Overflow Event	Oil & Grease Average per Overflow Event	Fecal Coliform Geo. Mean per Overflow Event	Screenings Total per Month	Facility Manned
	Date	Time	Date	Time	MG	MG	MG	MG	inches	mg/l	mg/l	ml/l	mg/l	No./100 ml	26 cu. yds.	Y/N
				Monthly Total		Monthly Total	Monthly Total	Monthly Total						Monthly Total	

REMARKS:

1. Note: Pumpback volume also contains sanitary flow.
2. Note: The facility is unmanned. Samples for settleable solids, oil & grease and fecal coliform will not be collected.
3.
4.
5.
6.
7.
8

I hearby affirm under penalty of perjury that information provided on this form is true to the best of my knowledge and belief. False statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

Signature of Chief Operator or Designated Facility Representative. Date

APPENDIX B

FLUSHING BAY CSO RETENTION FACILITY WWOP

Flushing Bay CSO Retention Facility

Queens, New York

Wet Weather Operating Plan

Prepared for:

New York City Department of Environmental Protection

Bureau of Engineering, Design and Construction (BEDC)

Prepared By:

URS Corporation

Paramus, New Jersey

June 2003

(Revised August 2009)

(Revised April 2010)

(Revised July 2010)

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1. INTRODUCTION

The purpose of a wet weather operating plan (WWOP) is to provide a set of operating guidelines to assist personnel in making operational decisions that will best meet the wet weather operating performance goals. The WWOP is also a SPDES requirement for the Flushing Bay CSO Retention Facility as well as for the Tallman Island Wastewater Treatment Plant (TI WWTP).

During wet weather events, numerous operational decisions must be made to effectively manage and optimize treatment of wet weather flows and CSOs. This WWOP is intended to provide a basis for consistent wet weather operating practices, and to maximize the utility of the Flushing Bay CSO Retention Facility during wet weather conditions.

Each rain storm produces a unique combination of flow patterns and facility conditions. Therefore, no plan or manual can provide specific, step-by-step procedures for every possible wet weather scenario. The procedures presented in this WWOP are preliminary in nature, and will be refined as necessary based upon operating experience. However, the WWOP can provide a consistent method of approach for various situations.

1.1 Background

The Flushing Bay CSO Retention Facility is a 43.4 million gallon (MG) storage Facility with flow-through capacity. The Facility is comprised of a 28.4 MG CSO storage tank, and a 15 MG in-line storage component. The Flushing Bay CSO Retention Facility is designed to capture and store the combined sewage that normally overflows to Outfall No. TI-010, an 18'-6" W x 10'-0" H (inner dimensions) triple barrel (TB) conduit. The Kissena Corridor combined sewage line contribute flow to the outfall. A portion of CSO from the Kissena Corridor CSO line shall be diverted and the remaining CSO shall overflow into the outfall, whereas the entire flow from the Park Drive CSO line shall be diverted into the facility. New diversion structures and influent conduits constructed as part of the overall facilities convey CSOs into the storage tank.

The CSO storage tank is located below-grade at the Avery Avenue Ballfields in Flushing Meadow - Corona Park in the Borough of Queens, New York City in a triangular area bounded by Fowler Avenue on the north, College Point Boulevard on the East, and the Van Wyck Expressway on the West. Figure 1-1 shows the project site location for the Flushing Bay CSO Retention Facility.

The Flushing Bay CSO Retention Facility Tank is comprised of two (2) “trains” of storage cells in a parallel arrangement; there are a total of fifteen (15) storage cells. Storage cells Nos. 1 through 7 comprise the north train; cells Nos. 8 through 15 comprise the south train. The overall storage tank dimensions are approximately 555′ x 464′; the dimensions of storage cells vary with the largest cell having dimensions of 260′ x 58′ and the smallest cell being 110′ x 58′.

During rain events, the Diversion Chambers divert the CSO to the five (5) facility influent channels. Each influent channel is provided with mechanically cleaned bar screens. The screened flow is routed to the two trains (provided with sluice gates) which supply CSO to the North and South side storage cells. If the incoming flow exceeds the capacity of the storage tank, the additional flow overflows the effluent weirs at Storage Cells Nos. 7 and 15 and discharge into the effluent channel. The additional flow shall also overflow the weirs (constructed across the CSO lines) in the CSO lines that discharge into the outfall. The effluent channel is equipped with tide gates to protect the storage tank against high tides. The effluent channel is connected to the existing Fowler Avenue TB (12′-6″ W x 10′-0″ H) CSO line. The Fowler Avenue and the Avery Avenue CSO lines combine at a mixing chamber to form a TB CSO (18′-6″ W x 10′-0″ H) which in turn discharges to Flushing Bay through Outfall TI-010. This TB CSO outfall is also equipped with tide gates.

After storms, the CSO stored in the storage tank and the combined sewer system (in-line storage) drain by gravity to the Primary wet well. The drained CSO into the Primary wet well is then pumped to the Flushing Interceptor for conveyance to the TI WWTP for treatment. The Facility is also designed to collect dry weather infiltration into Storage Cells No. 1 and No. 8 and subsequently pumped to the Flushing Interceptor on a continuous basis during dry weather, with the use of primary/secondary pumps (a*t present, the secondary pumps are not utilized as part of the pumping control sequence and are scheduled for replacement. This WWOP will be updated when their status changes back to operational)*.

The Facility is projected to capture approximately 1,114 Mg/Yr of CSO in a typical year and reduce CSO discharges into Flushing Creek by about 57%. At peak flow, with the storage tank initially empty, a storm with a return period of up to one month can be fully captured in the Flushing Bay CSO Retention Facility. During storms that generate CSOs in excess of the volumetric capacity of the retention Facility, combined sewage flows through the CSO storage tank and discharge to Flushing Bay through Outfall TI-010. During infrequent, intense storms, portions of the CSOs will overflow the diversion/bypass weirs and bypass the storage tank.

1.2 Drainage Area

The outfall TI-010 drainage area consists of 7,400 acres in north central Queens within the TI WWTP service area, and discharges to the upstream end of Flushing Bay. Sewers originating at different sections of the drainage area as storm sewers, collect and carry storm water from catch basins and inlets. However, in this system, these storm sewers also carry combined sewage from upstream regulators during wet weather. Outfall TI-010 contributes approximately 60 percent of the total CSO discharge and pollutant loading to Flushing Bay. The drainage area tributary to outfall TI-010 is shown on Figure 1-2. The locations of outfalls discharging into Flushing Bay are shown in Figure 1-3.

1.3 Performance Goals for Wet Weather Events

The primary goal of the Flushing Bay CSO Retention Facilities is to reduce the frequency and volume of CSOs through Outfall TI-010 into Flushing Bay. With this, the quality of the receiving waters will ultimately be improved by increasing dissolved oxygen (DO) levels, decreasing coliform levels, and decreasing discharges of floatables and settleable solids. The goal of the facility is to maximize storage of rain events and minimize overflows by pumping back early and often so the tanks are emptied prior to the next storm event.

The new influent channels, in-line storage and the CSO storage tank that comprise the Flushing Bay CSO Retention Facility provide the following pollution control functions:

- CSO Retention Tank with 28.4 MG of storage capacity.
- In-line CSO storage of up to 15 MG in the combined sewers and influent channels upstream of the retention tank.
- Full capture of storm events up to 43.4 MG with subsequent pumping (pumpback) of the retained CSOs to the Flushing Interceptor after storms for conveyance to the TI WWTP where it is treated.
- Screening of debris and floatables from all CSO passing through the Facility.
- Cleaning of the tank after each storm upon the completion of pumpback operations. Stored combined sewage is used for this purpose.
- Multiple overflow paths consisting of retention tank overflow weirs, and an influent channel side overflow relief weir to convey peak storm flows to bypass the retention tank and discharge directly to outfall TI-010.

1.4 Purpose of this Manual

The purpose of this manual is to provide a set of operations the Flushing Bay CSO Retention Facility will undergo in order to best meet the performance goals stated in Section 1.3 and the requirements of the New York SPDES discharge permit. Each storm event produces a unique combination of flow patterns and conditions. No manual can describe every action the Facility will have during every possible wet weather scenario. This manual can, however, serve as a useful reference which both new and experienced operators can utilize during wet weather events, and in preparing for wet weather events.

1.5 Using this Manual

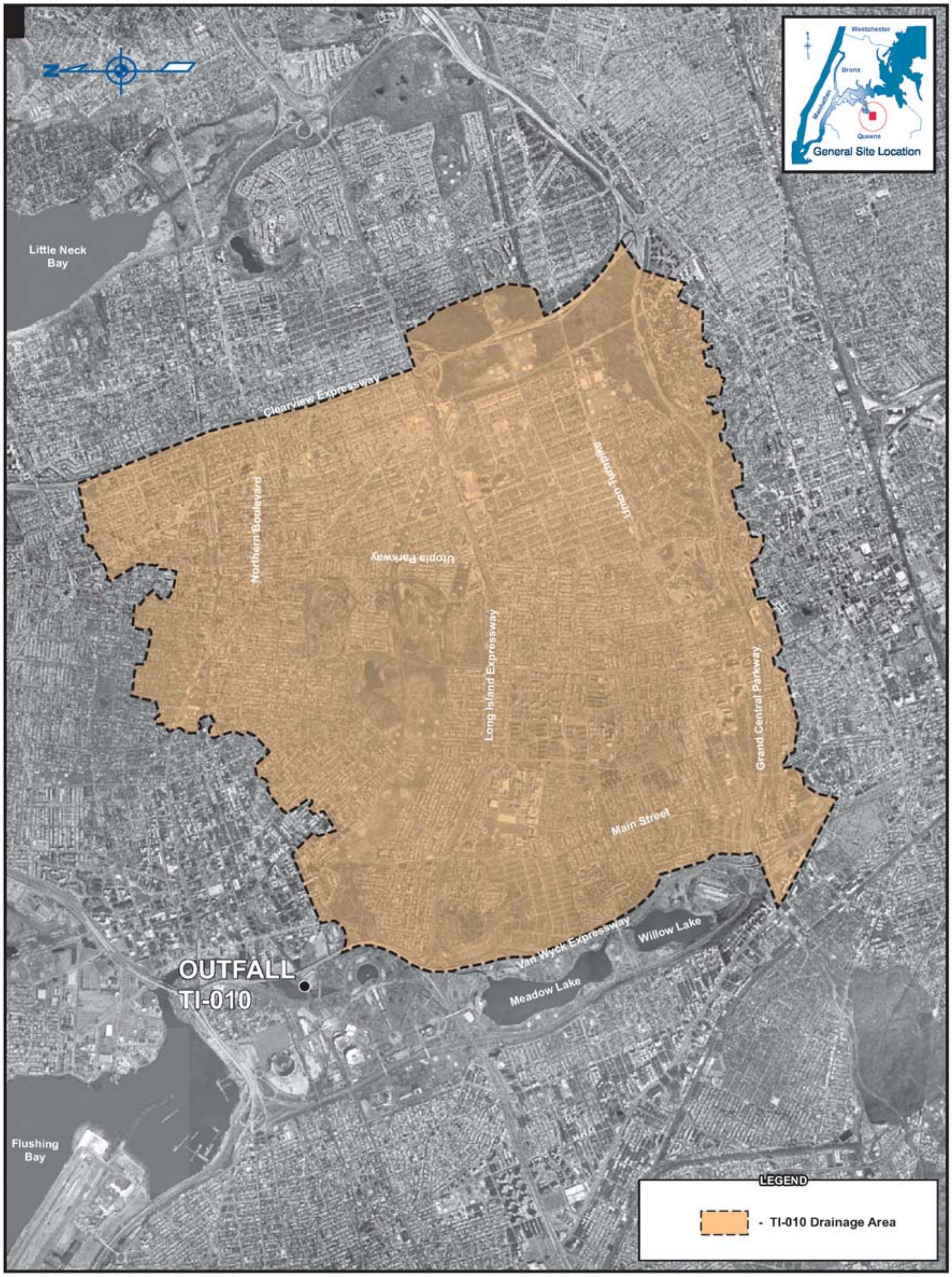
This manual is designed for use as a reference during wet weather events. This manual is broken down into sections that cover operation of the Flushing Bay CSO Retention Facility. The following information is included:

- Facility operations that occur before, during and after a wet weather event;
- Discussion of why these operations occur;
- Identification of specific circumstances that trigger the recommended changes; and
- Identification of things that can go wrong with the equipment.

This manual is a living document. Users of the manual are encouraged to identify new steps, procedures, and recommendations to further the objectives of the manual. Modifications that improve upon the manual's procedures are encouraged. With continued input from the Facility's operations staff, this manual will become a more useful and effective tool.

WET WEATHER OPERATING PLAN - FLUSHING BAY
SITE LOCATION

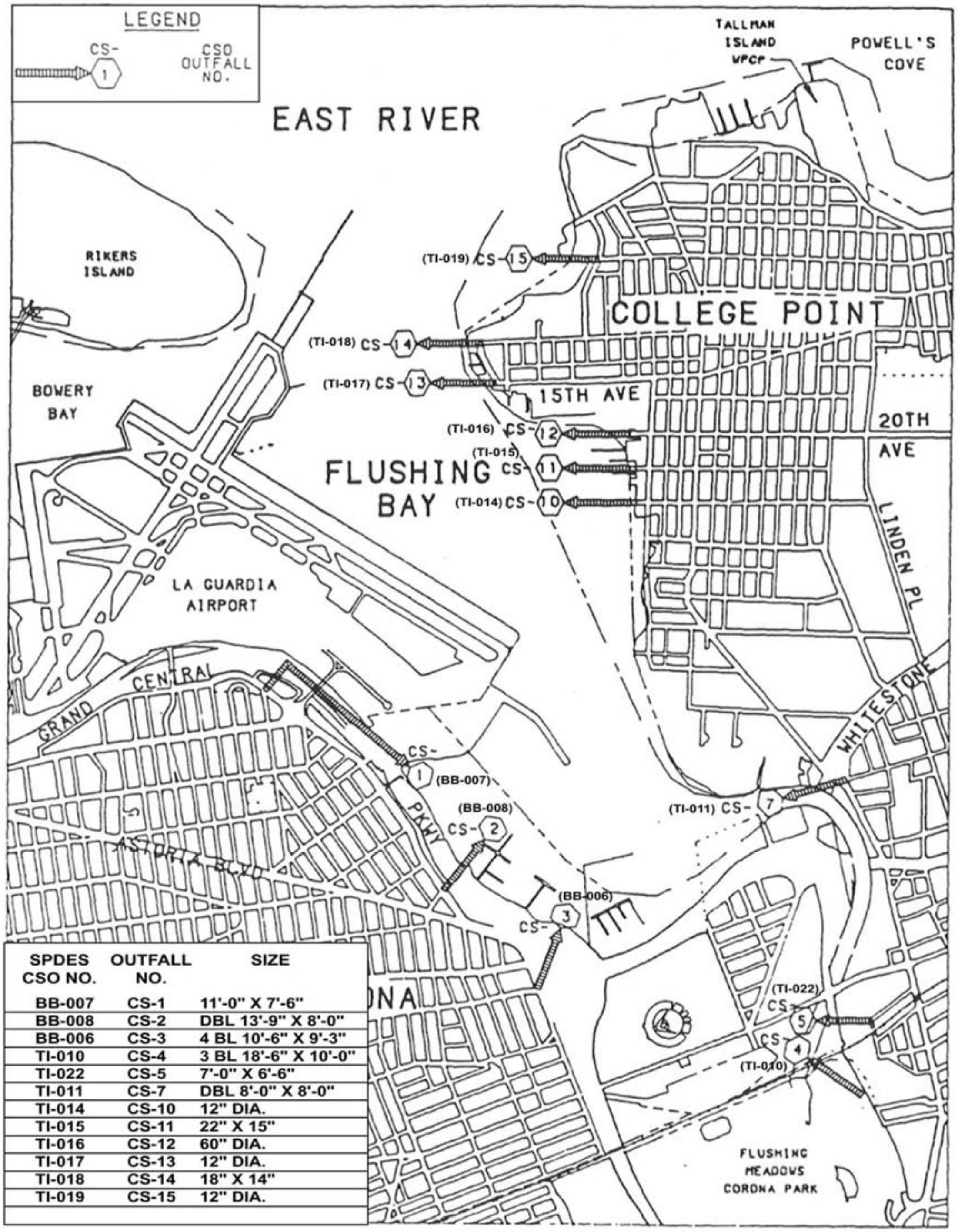
FIGURE 1-1



WET WEATHER OPERATING PLAN - FLUSHING BAY

OUTFALL TI-010 DRAINAGE AREA

FIGURE 1-2



SPDES CSO NO.	OUTFALL NO.	SIZE
BB-007	CS-1	11'-0" X 7'-6"
BB-008	CS-2	DBL 13'-9" X 8'-0"
BB-006	CS-3	4 BL 10'-6" X 9'-3"
TI-010	CS-4	3 BL 18'-6" X 10'-0"
TI-022	CS-5	7'-0" X 6'-6"
TI-011	CS-7	DBL 8'-0" X 8'-0"
TI-014	CS-10	12" DIA.
TI-015	CS-11	22" X 15"
TI-016	CS-12	60" DIA.
TI-017	CS-13	12" DIA.
TI-018	CS-14	18" X 14"
TI-019	CS-15	12" DIA.

WET WEATHER OPERATING PLAN - FLUSHING BAY

OUFALL LOCATIONS

FIGURE 1-3

2. DESCRIPTION OF FACILITY AND WET WEATHER FLOW CONTROL

2.1 Overview

The Flushing Bay Combined Sewer Overflow (CSO) Retention Facility has the capacity to store 28.4 million gallons (MG) of CSO. The CSO flows entering the Facility are screened and the screenings are collected for disposal after each rainfall. When the maximum storage volume of 43.4 MG (28.4 offline plus 15 in line storage) is exceeded or the water level reaches EL. 2.00, combined sewage flows through the storage cells of the tank and discharge to the effluent channel. Subsequently, flow travels through the Triple-Barrel effluent sewer line and eventually discharges to the TI-010 outfall in Flushing Creek. After storm events, stored CSO is pumped to the Flushing Interceptor, which conveys flow to the Tallman Island Wastewater Treatment Plant (WWTP). The storage cells are then washed down with stored CSO after each storm.

The following is a description of the Facility and the controls for the process elements:

2.2 Diversion Facilities

- Diversion Chamber No. 1: This chamber is located on the Park Drive East storm sewer (14'-3" x 8'-0") and is equipped with stop logs that allow the flow to be diverted into the facility or to the effluent channel that collects overflow from the facility and discharges into the outfall. The entire flow is diverted in Flushing Bay facility and there are no operating procedures as all operations are passive.
- Diversion Chamber No. 2: The diversion weir constructed across the Kissena Corridor 10′ x 10′ storm sewer is 7′ high providing 3′ clearance to the crown of the CSO line. The weir diverts flow and also allows relief of flows in excess of facility hydraulic capacity to discharge to the existing CSO line. There are no operating procedures, as all operations are passive.
- Diversion Chamber No. 3: This chamber is constructed on the TB 16′ x 10′ storm sewer and has windows, or openings, between the barrels. The weirs at Diversion Chamber No. 5/Bulkhead Chamber divert the flow through Chamber No. 3 leading to the Facility influent structure. There are no operating procedures, as all operations are passive.
- Diversion Chamber No. 4: The north side of the influent channel wall has a weir at EL. 4.00. Excess flow above EL. 4.00 overflow to Diversion Chamber No. 4. This diverted flow through Chamber No. 4 discharges into Fowler Avenue and continues to the outfall. There are no operating procedures, as all operations are passive for this chamber.
- Diversion Chamber No. 5/Bulkhead Chamber: There are three bulkhead gates in the chamber, one in each barrel. Each bulkhead gate is 16′ x 7′, providing 3′ clearance to the crown of the CSO line. Each gate is equipped with motor-operated actuator to open/close these gates. Normally, the gates are in closed position and these gates act as a weir. This weir at EL. 2.0 shall divert the flow through Diversion Chamber No. 3 and into the facility.

For the locations of the above diversion structures see Figure 2-1 and Figure 2-2.

The other process objective of bulkhead chamber is to release upstream CSO when the water surface EL. 7.0 during the wet weather event. The following is the control strategy:

- On rising water level, the Lead Gate opens when upstream level reaches 10.85 feet (EL. 6.00). The first Lag Gate opens when level reaches 11.35 feet (EL. 6.50) and the second Lag Gate opens when level reaches 11.85 feet (EL. 7.00). Gate openings will delay based on the actuation delay time setpoint.
- On falling water level, the second Lag Gate closes when level falls to 9.85 ft (EL. 5.00). The first Lag Gate closes when level falls below 9.35 feet (EL. 4.50) and the Lead Gate closes when level falls below 8.85 feet (EL. 4.00). Gate closings will delay based on the actuation delay time setpoint.

2.3 Flushing Bay CSO Retention Facility Influent Flow and Screening Area

During the wet weather event(s), combined sewage from the Kissena Corridor and Park Drive East and overflow from Diversion Chamber No. 2 is diverted into influent channel/screening area of the facility.

The influent flow first passes through five (5) motor-operated sluice gates; then it flows through five (5) mechanically cleaned, climber type, single front raked bar screens. At peak flow, a minimum of four (4) screens are needed/operational (n + 1). In case a bar screen is not operational, the corresponding sluice gate shall be closed. Each influent channel's design flow is 63.2 MGD (316 MGD total) with a peak flow of 280 MGD (1400 MGD total). The excess flow is diverted to the TI-010 outfall.

After passing through the sluice gates, the combined sewage flows through five (5) mechanically cleaned, climber-type, single front raked bar screens. The mechanical bar screens have clear spaces between the bars of 1.25" and provide additional protection for other downstream equipment. The bar screens are designed to operate in automatic/continuous mode, automatic/timer mode and manual mode. In automatic mode, the screens start when influent channel water level reaches 4 ft and screens shut back off when the level drops or recedes to 3 ft.

Solids collected on the mechanical bar screens are raked off and discharged onto a longitudinal belt conveyor. The longitudinal belt conveyor discharges the screenings onto a bi-directional cross belt conveyor, which can discharge the collected solids to either of two 30 cubic yard dumpsters. In the event that either belt conveyor is inoperable, bypass chutes have been provided to allow each mechanical bar screen to discharge solids into an individual 1 cubic yard wheeled container.

Influent flow is monitored and recorded by measuring transient time and level in the storage cells as follows. Each cell is provided with a level transmitter. The cell level transmitter's sensor is an open diaphragm type, which protrudes through the wall of the cell at El. (-) 21.00. The implemented method to compute flow rate through the facility is the "Timed Volume" method (Flow Rate =Volume/Time). The computer system is logically dividing each cell into multiple sub-volumes in increments of one (1) foot high starting from El (-) 20.00. As each sub-volume fills up, the computer registers the average flow rate, which is a function of the fill time. As a cell's water level rises and fills each sub-volume, the previously filled sub-volume is added into the computer's totalizer. As the first cells (No. 1 and No.8) are filled to the water surface elevation (-)5.0 the CSO will overflow into the next cells. The same principle of flow estimation is applied for each cell. When the water surface elevation reaches El. 2.0, the CSO will overflow into the effluent channel. At this point the influent flow is no longer a function of the cell(s) level rise and therefore the overflow measurement procedure described in Section 4.2 is used to register the influent flow.

After passing through the mechanical bar screens, the combined sewage flows to the storage tank through Influent Channel Nos. 1 and 2. Influent Channel No. 1 routes flow to storage cell Nos. 1 through 7; Influent Channel No. 2 routes flow to storage cell Nos. 8 through 15. Flow to the two influent channels is regulated by four motor operated sluice gates. Each influent channel is served by two gates.

Facility operators have the ability to start and stop bar screens, belt conveyors, open and close sluice gates and select set points, auto/timer, auto/continuous and also bar screen run time interval and run time from SCADA Supervisory Control and Data Acquisition System at Facility and from SCADA at TI WWTP. Local Control Stations (LCS) at the equipment are provided for maintenance purposes only, and are not intended to be used during normal operation.

The "Normal" operation is an automatic/timer mode and automatic/continuous mode. In automatic/timer mode, the operator selects repeat time, run time and the operation start/stop. In automatic/continuous mode the bar screens operate continuously. In either case the screens shall start when water level rises and reaches 4 ft and shut down when the water level drops to 3 ft. During dry weather, the bar screens shall operate from the elapsed off timer (this is the exercise routine).

The manual operation shall be performed from the local control station (LCS), located adjacent to each bar screen. This mode should be used for testing and maintenance or when automatic mode is inoperable.

Plan and section views of the screening area are illustrated in Figure 2-3 and Figure 2-4.

2.4 Storage Cells

The Facility is provided with fifteen (15) storage cells with a total capacity of 28.4 MG. The cells range in size from a minimum of 987,000 gallons to a maximum of 2,497,000 gallons.

The storage cells are arrayed in two banks on either side of the 48 inch diameter drain line pipe tunnel. Storage cells 1 - 7 comprise the north bank of cells and provide a storage capacity of approximately 11 MG. Storage cells 8 - 15 comprise the south bank of cells and provide a storage capacity of approximately 17 MG. The north bank of cells is fed by Influent Channel No. 1; the south bank of cells is fed by Influent Channel No. 2.

Once the cell water surface rises to the level of the overflow weir to the adjacent tank (set at EL. (–)5.00), the screened CSO overflows to the next cell. The above repeats as long as CSO is entering the Facility until the storage cells are filled to elevation (-5.00).

Now the additional CSO raises the water surface level in all connected cells. When the CSO rises to the level of the Overflow Weir (set at EL. 2.00) it exits the Facility via the Effluent Channel and flow to the TI-010 Outfall.

The storage cell No. 7 and No. 15 are provided with a cross baffles that runs along the overflow weir. The baffle is hung from the ceiling and the bottom elevation of the baffle, along with the effluent weir elevation are the same (EL. 2.00). As the CSO flows over the weir, all the floatables shall be captured behind the baffle and eventually carried out with the CSO (to the wet well) when the cell is drained.

A schematic of the Storage Cells is shown in Figure 2-5.

2.5 Tank Effluent Channel and Tide Gates

The tank Effluent Channel runs along the storage cells and is located on the West Side of the storage tank. When the last cells of the storage tank, namely No 7 and No 15, overflow, they discharge into the tank Effluent Channel, which subsequently flows in to the Fowler Avenue Triple Barrel 12'-6" x 10'-0" CSO line and eventually to the Flushing Creek TI-010 outfall.

The effluent channel tide gate chamber is located at the end of the tank effluent channel. In a 40' wide effluent channel, there are three (3) pontoon tide gates with 132" W x 120" H opening frames. A schematic of the effluent channel and tide gates is shown in Figure 2-5.

2.6 Outfall Tide Gates

The tide gates have been installed in the Triple-Barrel Storm Sewer (18’-6”x10’-0”) near the TI-010 outfall at Flushing Creek. The tide gates are flap gates designed to prevent the backflow of the tidal waters of Flushing Bay into the CSO line and the Facility and allow the water from the sewer system to return to the bay with a minimum of head loss. A schematic of the effluent channel and tide gates is shown in Figure 2-5.

Each barrel of the outfall sewer is equipped with flow measurement devices, which utilize pulse-Doppler velocity profiling technology to measure the velocity distribution within the flow. Four (4) piezoelectric ceramics in the sensor emit short pulses along narrow acoustic beams pointing in different directions to measure velocity. A fifth ceramic mounted in the center of the sensor assembly, and aimed vertically, is used to measure the depth. Each acoustic beam measures velocity at multiple points, known as bins, in the water column. The instruments provide flow accuracy of 2% of reading. The flow data is transmitted via wireless radio network to the Facility SCADA system.

2.7 Tank Draining System

Each storage cell has been constructed to slope toward a trough which collects and transports the stored CSO via two 24" diameter exit pipes. These exit pipes are equipped with two 24" diameter motor-operated plug valves and are connected to the 48" diameter cell drain pipe. The drain pipe carries CSO and discharges into wet well. All drain piping and motor-operated valves are located in an accessible pipe tunnel. By opening the valves, the CSO stored in each storage cell drains to the wet well. A schematic of the tank drain system is shown in Figure 2-6.

2.8 Flushing Bay CSO Retention Facility Pump Station

The Flushing Bay CSO Retention Facility ("Facility") is provided with a pumping station to pump out captured combined sewage to the 78″ Flushing Interceptor, where it is conveyed to the TI WWTP after rainstorms. The pumping station is also designed to pump dry weather infiltration and inflow to the tank from the Kissena Corridor to the Flushing Interceptor.

The primary and secondary wet wells are filled by opening the cell drain valves that allow the tank storage cells to empty. Captured combined sewage is drained from the cells and conveyed to the wet well through a 48″ diameter drain line. This drain line terminates at the southeastern corner of the wet well. Pumpback is the process by which the stored combined sewage is drained from the storage cells to the pumping station wet well. The captured combined sewage is then pumped to the Flushing Interceptor. The actual rate of pumping at any time will depend on the available hydraulic capacity of the TI WWTP. By coordinating pumping rates with the available capacities at TI WWTP, dry-weather overflows will not be induced, and the TI WWTP will meet its SPDES permit limits.

During dry weather, the facility accepts dry weather flow. This dry weather flow consists of infiltration and inflow conveyed by the Kissena Corridor sewers. Dry weather flow is conveyed directly into Cells No. 1 and No. 8 and then drain into the well for pumping to the Flushing interceptor.

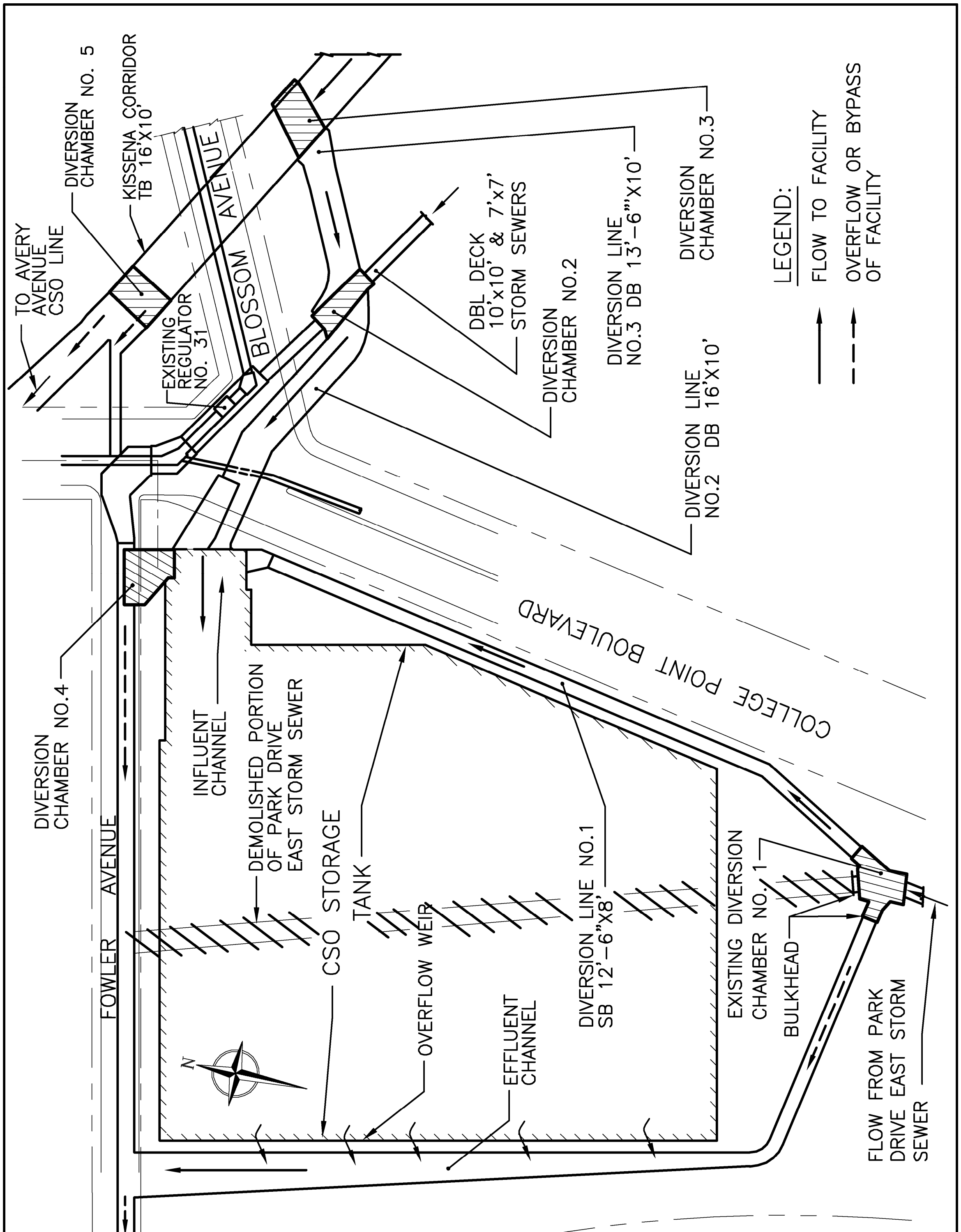
The flow and level monitoring stations in the TI WWTP collection system are used to control the rate of pumpback (see Figure 2-7). The schematic flow diagram of the Facility is shown in Figure 2-8. The overflow weir at Regulator No. 9 has been modified from adjustable sluice gates to a fixed concrete weir so that the carrying capacity of the Interceptor does not exceed 90 MGD at that point; flow in excess of 90 MGD shall overflow to the outfall. The level at Regulator No. 9 is measured to assure that dry weather flow does not occur.

- The average dry weather hydraulic capacity of the Tallman Island WWTP is 80 MGD. In order to minimize the time it takes to empty the Facility, and as agreed with NYSDEC, the Tallman Island plant will receive flows up to 90 MGD during the pump back of the Flushing Bay Facility or as much flow as the Facility and/or Regulator #9 will allow. As further agreed with NYSDEC, if the pumpback should cause the daily average flow to exceed the design dry weather flow of 80 MGD, then the TSS and CBOD removals will be removed from the monthly percent removal calculation.
- The current influent flow at the Tallman Island Plant is provided to the retention Facility. Available capacity (setpoint) at the Tallman Island WWTP is computed as follows:
    - Setpoint = 90 (+) Pumping Rate (–)Measured WWTP Influent Flow. For example, if the rate of pumping is zero, and measured flow is 50 mgd, then the setpoint would be 40 MGD. In other words, setpoint varies with change in the Measured WWTP Influent Flow *.
    - In the equation above, 90 MGD is a constant that was agreed upon with NYSDEC to minimize the time it takes to empty the facility. This value is Operator adjustable dependent upon conditions at the WWTP, and equipment availability. In the event plant capacity is curtailed due to emergencies or

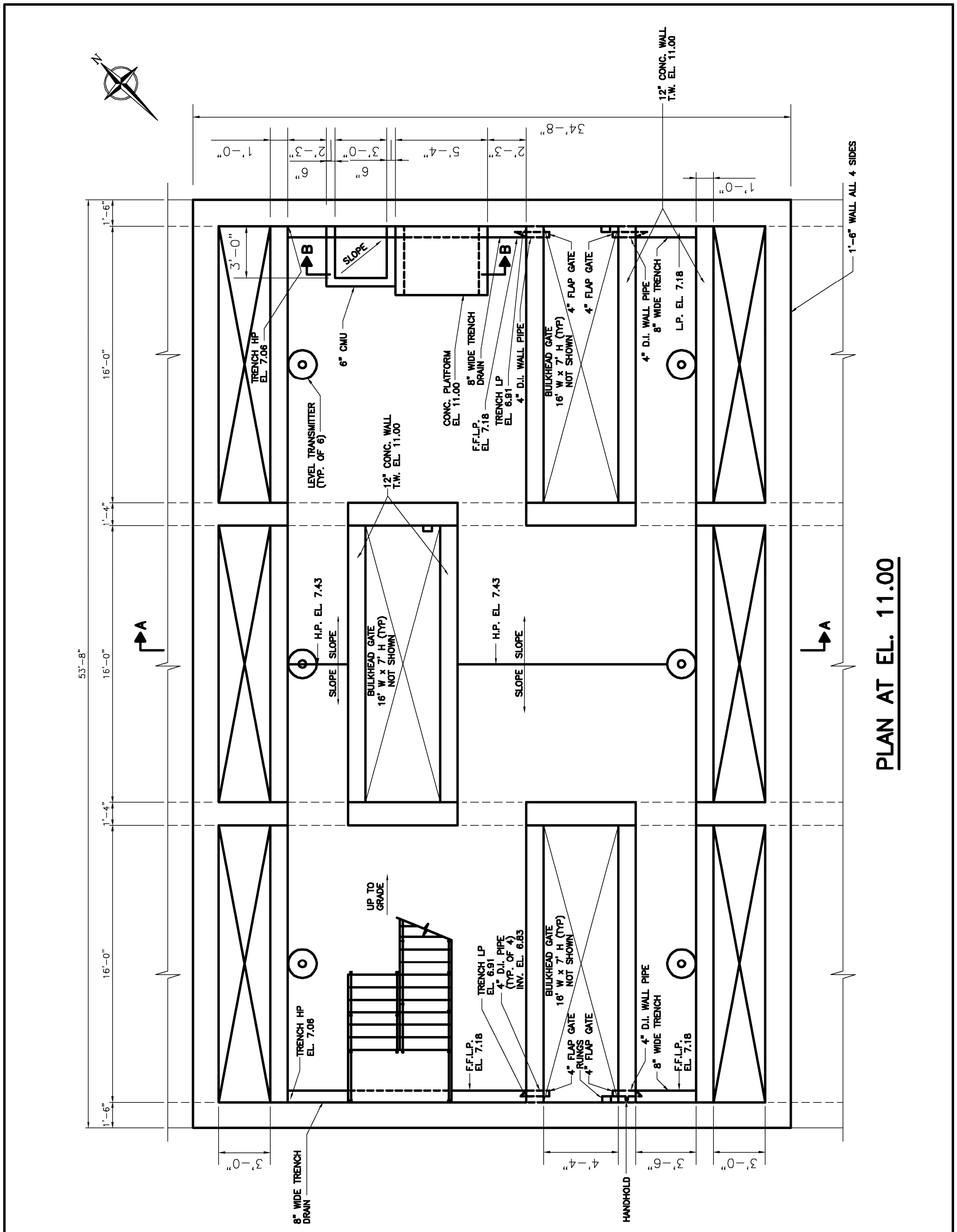
required maintenance, the Operator may, at his discretion, lower the allowable floor (80 MGD) for the setpoint calculation.
    - The maximum pump back capacity is approximately 40 MGD ± 1 MGD.
- The water level in Regulator No. 9, as determined by the level device installed in Regulator No. 9. Since the capacity of Regulator No. 9 is 90 MGD, the chances of overflow are minimized; therefore, operator will observe the level.
- The pumping rate of the Primary Pumps is measured by a 30-inch flow magmeter installed in a common discharge header. The flow meter provides feedback information to the Control Room where the flow data is recorded and totalized in million gallons.
- The pumping rate of the secondary pumps is measured by an 8-inch flow meter installed in a common discharge header. The flow meter provides feedback to the Control Room where the flow data is recorded and totalized in million gallons. *At present, the secondary pumps are not utilized as part of the pumping control sequence and are scheduled for replacement. This WWOP will be updated when their status changes back to operational.*
- The Pumpback is not limited to nighttime or to dry weather periods following rainfall and CSO capture. The intent is to pump back the stored CSO whenever there is available capacity at the TI WWTP. The Pumpback can be faster if the capacity at the TI-WWTP is increased beyond the present capacity of 80 MGD to 90 MGD.
- Note that the pumpback rate is limited to 40 MGD due to the capacity of the pumpback pumps and restrictions caused by the Chamber No. 2 weir."

The pump station area is shown in Figure 2-9.

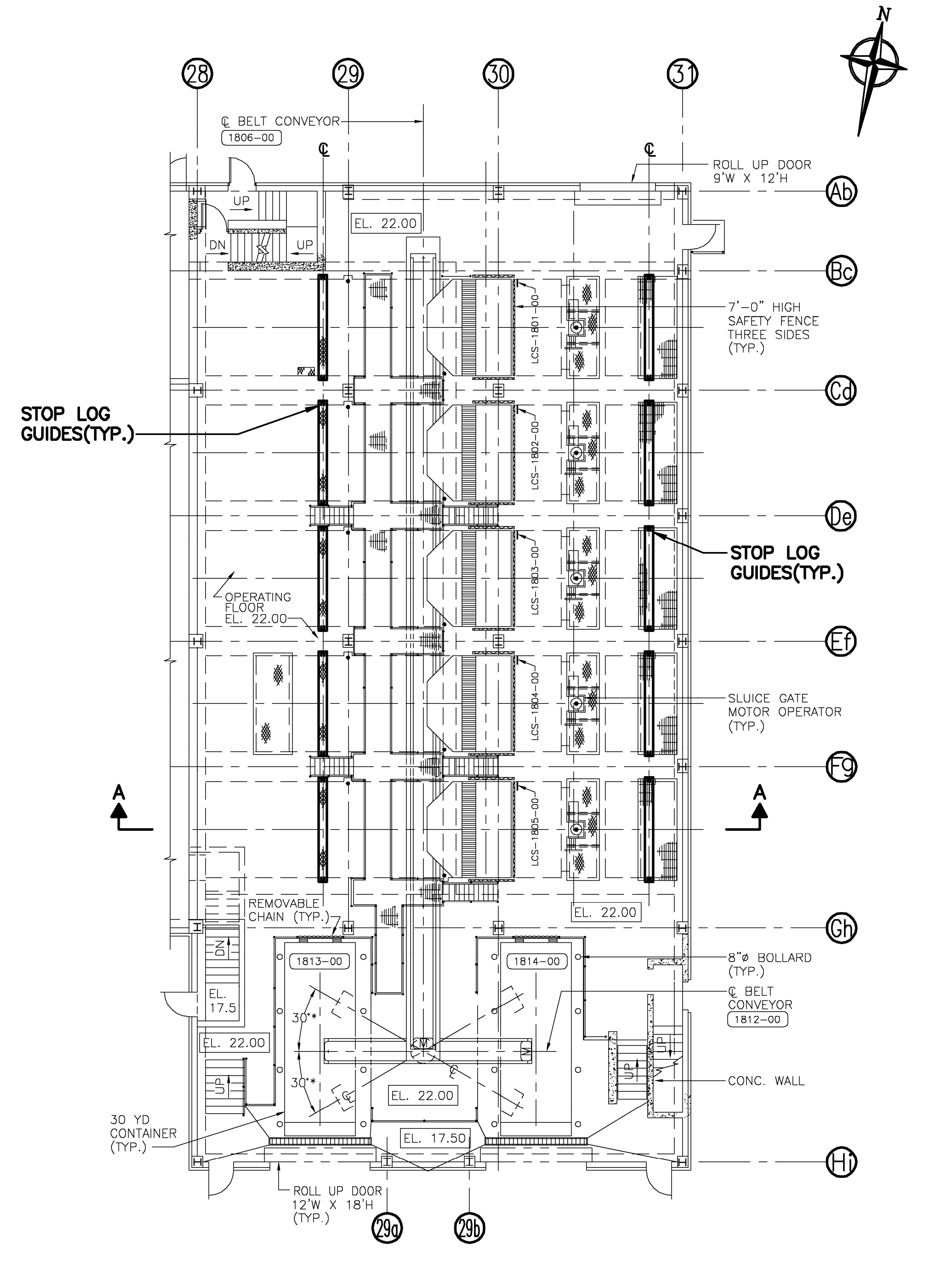
* The pumpback rate for the Flushing Bay facility will also account for the additional flow in the interceptor system that results from the pumpback of the Alley Creek CSO retention facility. This is further detailed in the Alley Creek WWOP. A schematic of the sewer systems in and around each facility is provided as Figure 2-10.



NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION DEP	WET WEATHER OPERATING PLAN – FLUSHING BAY **DIVERSION STRUCTURES LOCATION PLAN**	FIGURE 2–1



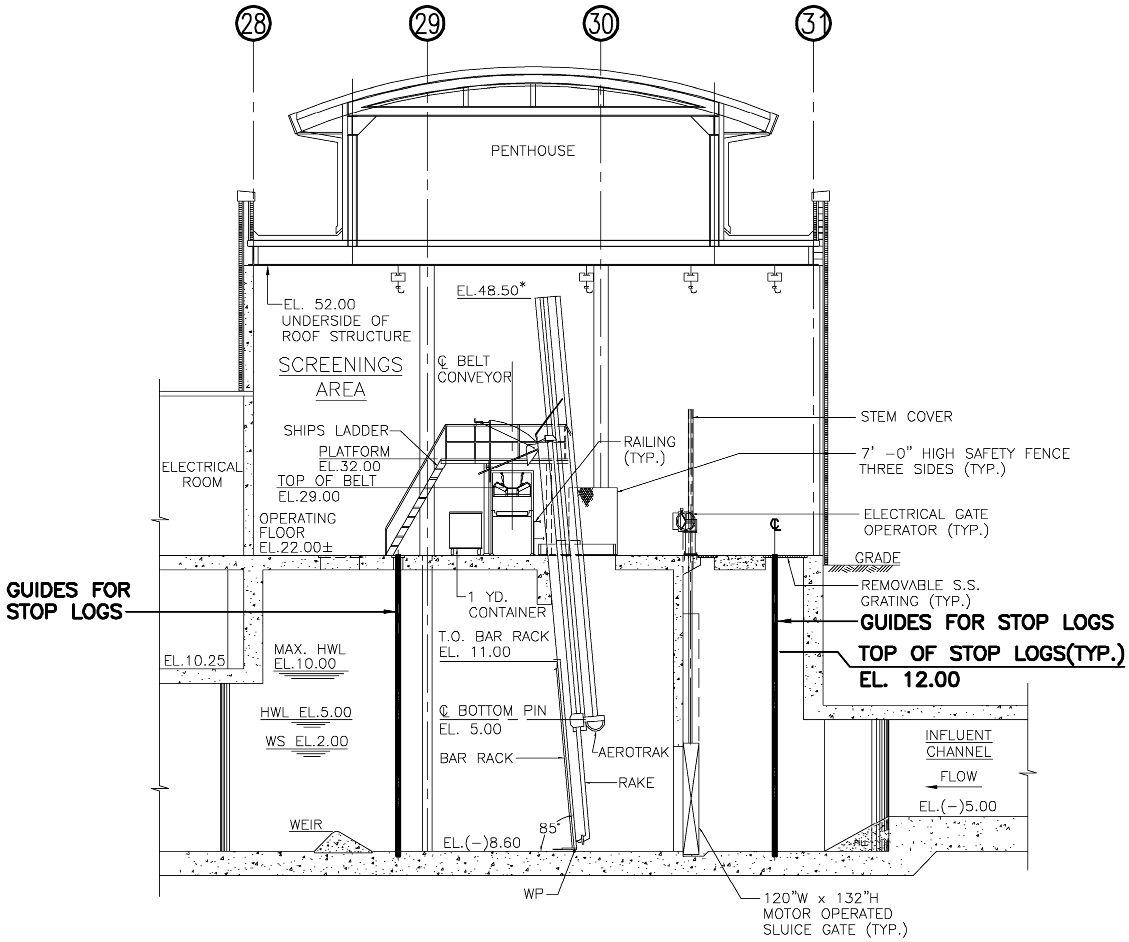
NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION — DEP	WET WEATHER OPERATING PLAN – FLUSHING BAY **DIVERSION/BULKHEAD CHAMBER NO. 5** **PLAN**	FIGURE 2–2



WET WEATHER OPERATING PLAN – FLUSHING BAY

SCREENING AREA – PLAN

FIGURE
2–3

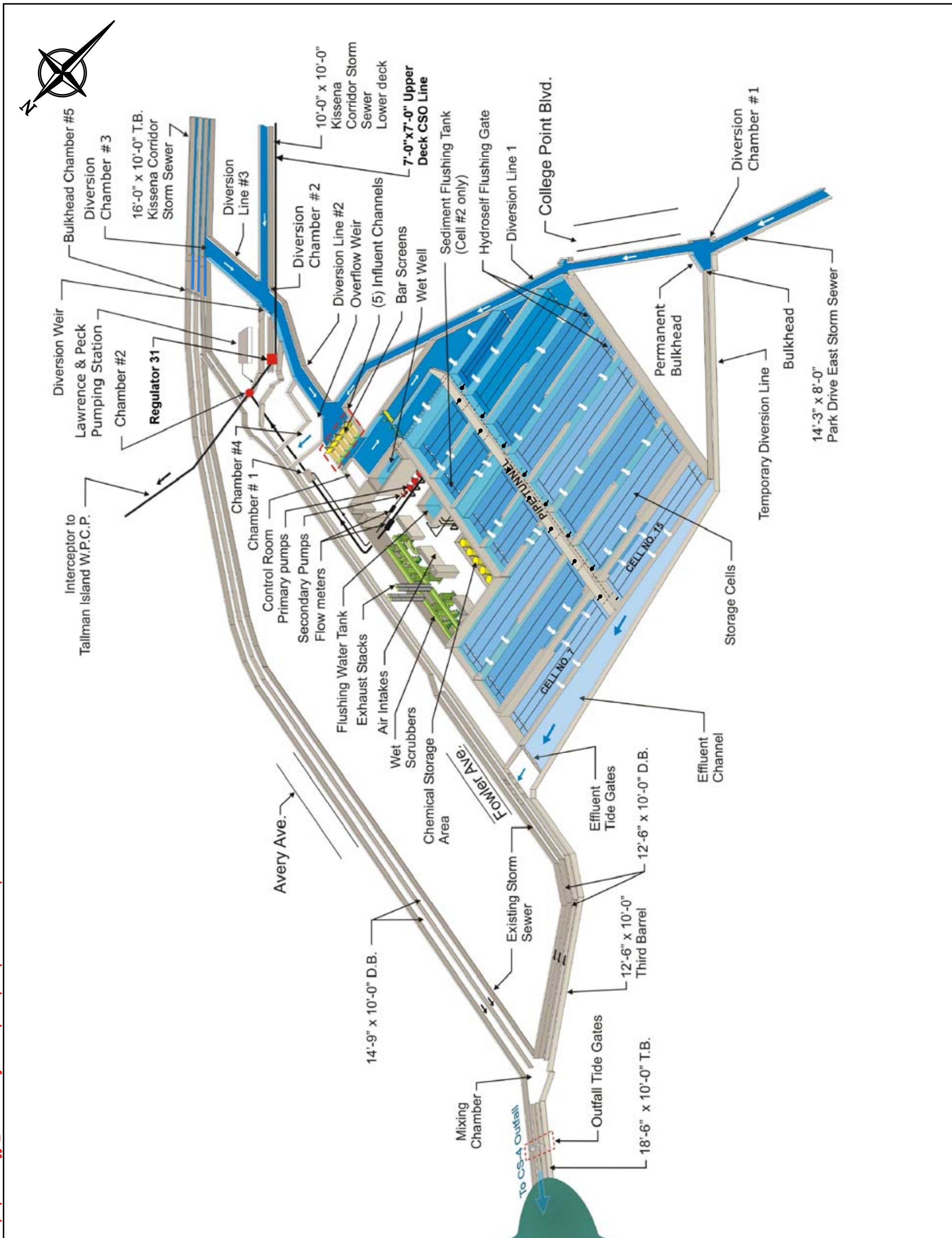


SECTION A–A

WET WEATHER OPERATING PLAN – FLUSHING BAY

SCREENING AREA
SECTION A–A

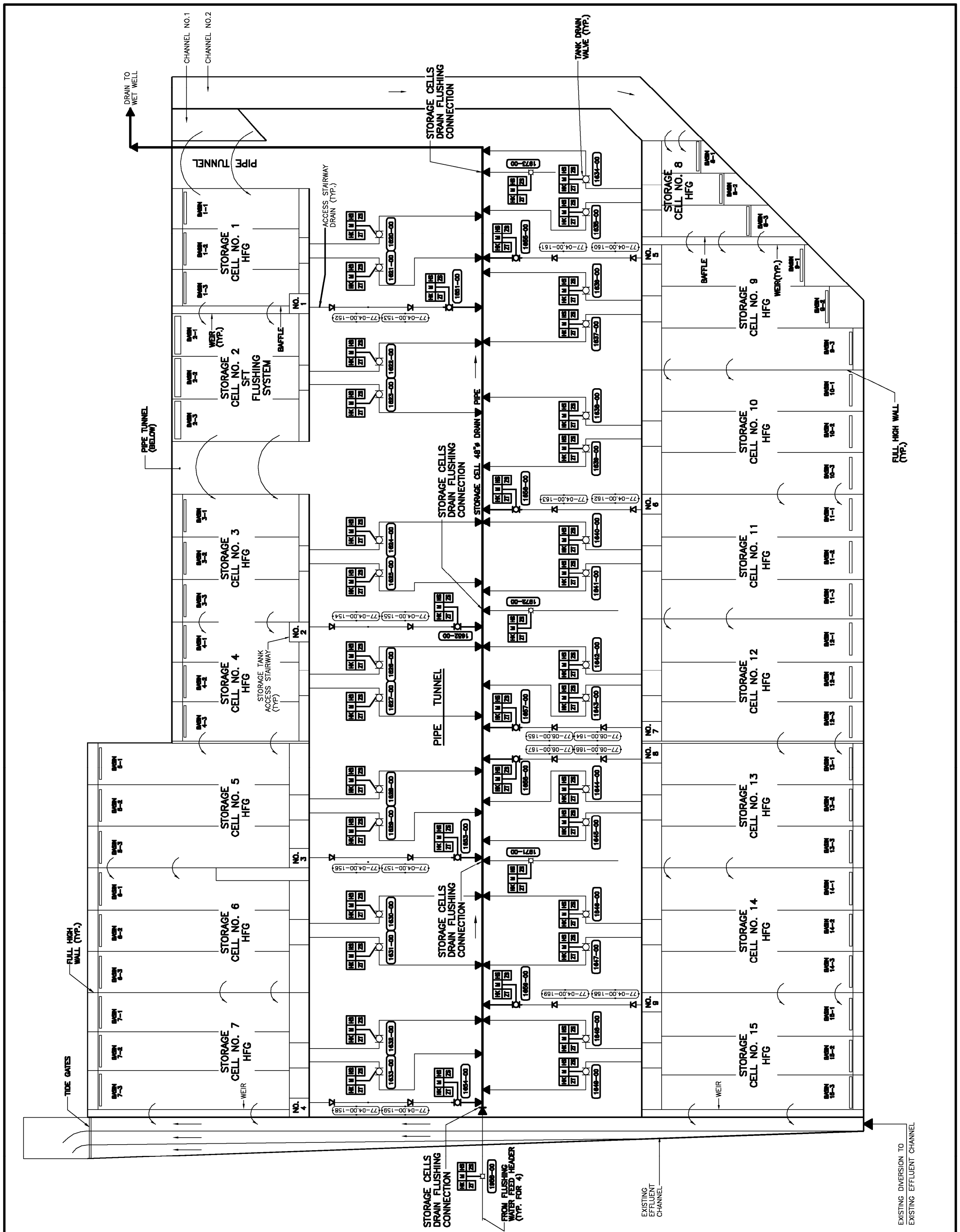
FIGURE
2–4



WET WEATHER OPERATING PLAN – FLUSHING BAY

FACILITY LAYOUT

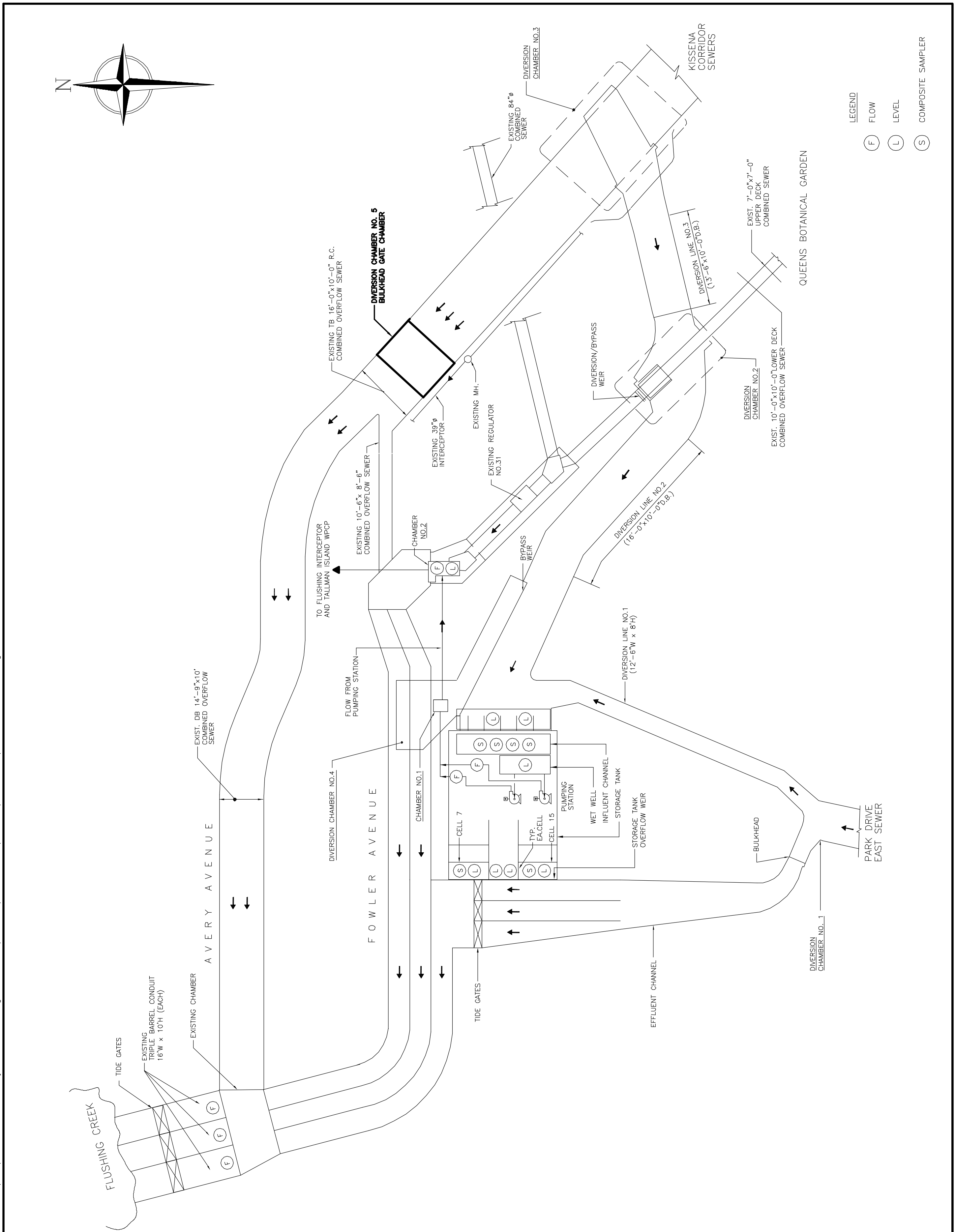
FIGURE 2–5



WET WEATHER OPERATING PLAN – FLUSHING BAY

STORAGE CELLS – DRAIN PIPING SYSTEM

FIGURE 2–6



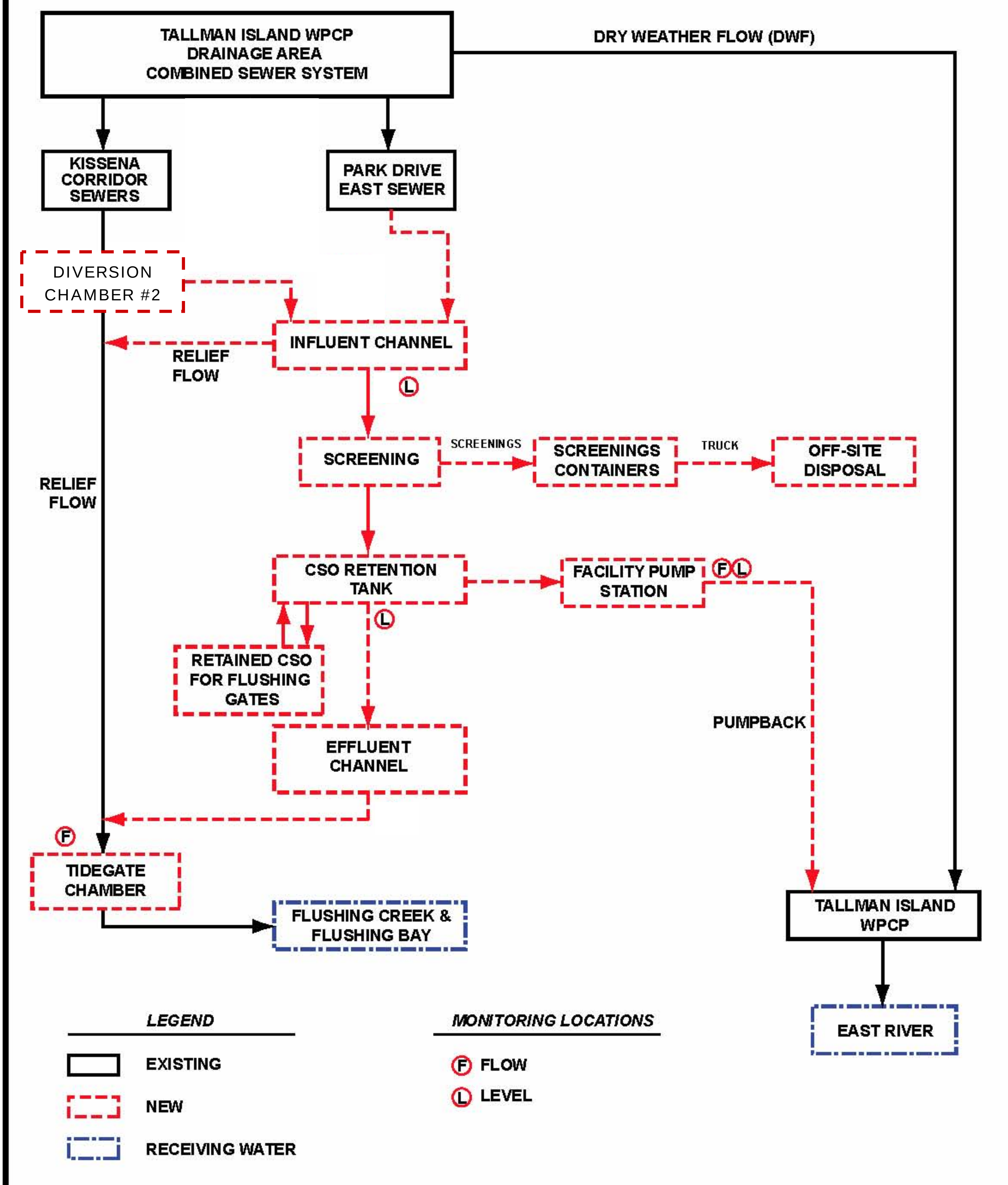
Time: 3:21 P.M. Date: 6/30/2010 Ron_Hayden Drawing File: H:\32174\CD100108\WWOP\FIGURES\2-7REV63010.dwg

NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION — DEP

WET WEATHER OPERATING PLAN – FLUSHING BAY

RETENTION FACILITY MONITORING STATIONS

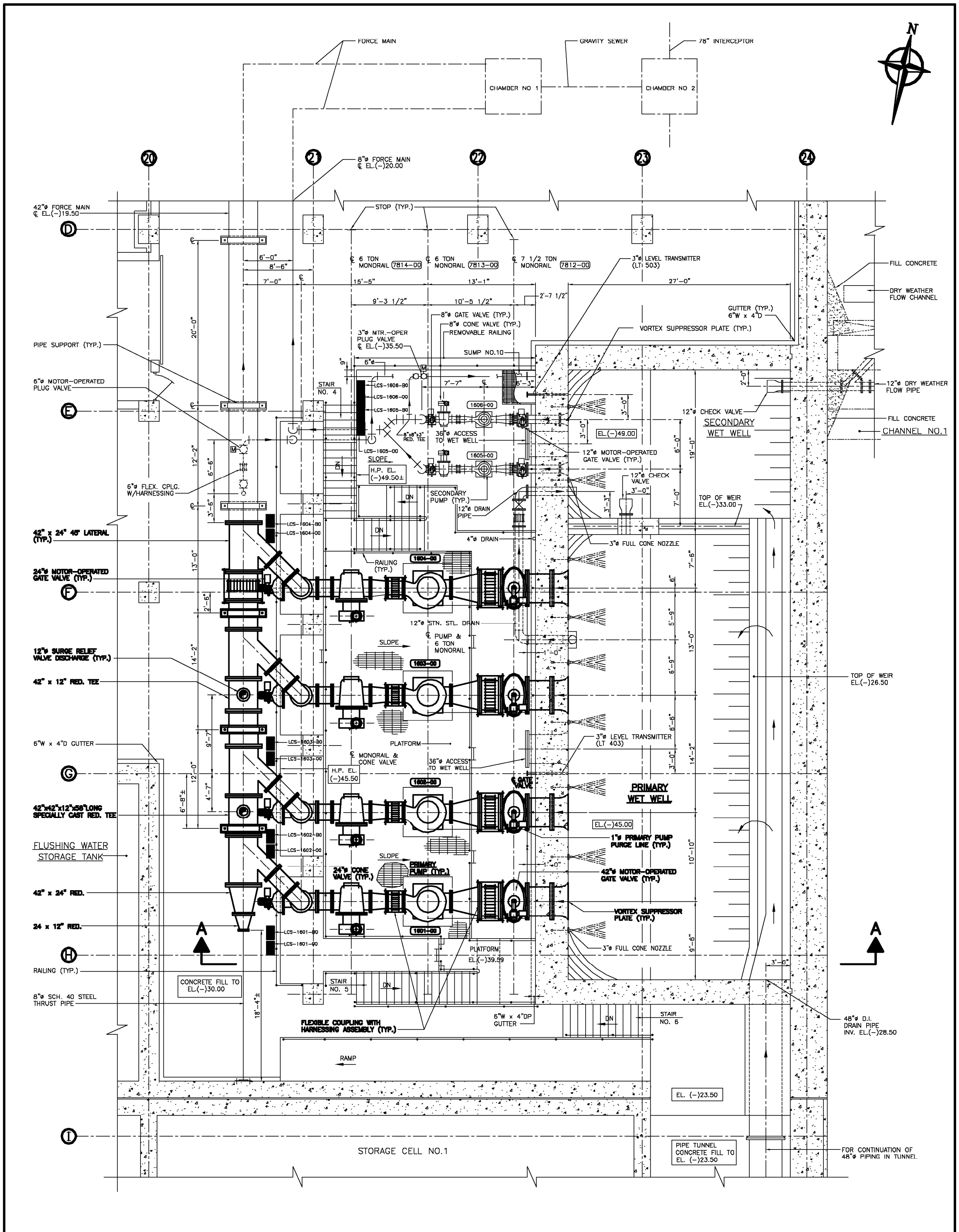
FIGURE 2–7



WET WEATHER OPERATING PLAN - FLUSHING BAY

CSO RETENTION FACILITY SCHEMATIC FLOW DIAGRAM

FIGURE 2-8



WET WEATHER OPERATING PLAN – FLUSHING BAY

PRIMARY AND SECONDARY PUMPS

FIGURE 2–9

3. UNIT PROCESS OPERATIONS

This section presents equipment summaries and wet weather operating protocols for each major unit operation of the Flushing Bay CSO Retention Facility. The protocols are divided into steps to be followed before, during and after a wet weather event. The protocols also address the basis for the protocol (see "Why do we do this?"), events or observations that trigger the protocol (see "What triggers the change?"), and a discussion of what can go wrong. The following information and protocols apply to proposed unit processes.

3.1 Bulkhead Chamber and Diversion Chambers

Before Wet Weather Event

- Dry weather flow is diverted to the Facility by means of weirs and slide gates constructed across the CSO lines.

During Wet Weather Event

- Diversion Chamber No. 1 (Park Drive East CSO lines). The entire CSO flow is diverted to the Facility.
- Diversion Chamber No. 2 (Kissena Corridor: Lower Deck and Double Deck storm sewers). A 7′ high weir constructed across the CSO line of the Lower Deck diverts the flow to the Facility. If the water surface level exceeds the 7′ height of the weir the CSO overflows to the outfall TI-010.
- Diversion Chamber Nos. 3 & 5 (Bulkhead Chamber). Within Diversion Chamber No. 5, there are three (3) individual barrels, each equipped with a 7-foot high slide gate. During a storm event, the CSO passes through Diversion Chamber No. 3 moving downstream towards Diversion Chamber No. 5. The CSO builds up against the slide gates, ultimately diverting through Diversion Chamber No. 3 to the Flushing Bay facility. If CSO exceeds the 7-foot height of the slide gates, it will overflow to the CSO line that discharges through Outfall TI-010.

After Wet Weather Event

- Enter Diversion Chamber No. 5 and check for any debris that would affect the operation of the slide gates
- Report any failures of the gates

Why do we do this?

- Divert the CSO flow into the Facility
- The slide gates in the CSO lines open to eliminate the potential for flooding in the upstream sewer lines along the Kissena Corridor.

What can go wrong?

- If, during a storm event, the water level rises in the Bulkhead Chamber and exceeds the crown (EL. 5.80) of CSO line, the first gate will open at WS EL. 6.00, second gate will open at WS EL. 6.50, and the third gate will open at WS EL. 7.00. The gates shall close on falling water level. See also Section 2.2. In case the water level rises above EL. 5.80, and the gate does not open, an alarm shall be initiated in the facility and also in TI WWTP.

3.2 Sluice Gates and Mechanical Bar Screens

Before Wet Weather Event

- Normally, the screens do not operate during the dry weather flow, and removal of solids and debris that may build up on the screens may be necessary. Therefore, during dry weather, all screens should be exercised.
- The "elapsed off–timer" starts the bar screens at a set interval and run them for a set duration. The time interval shall be soft-programmed and therefore be operator selectable. The time interval and run duration shall include that all screens should run for 30 min every 6 hrs. The EXERCISE feature operates in either the "TIMER" or "CONTINUOUS" sequence of the automatic operation setting. The exercise program automatically starts the belt conveyors which in turn starts the bar screen.
- For any bar screen not in operation, close the corresponding influent sluice gate.
- Under normal operations, a minimum of four (4) mechanical bar screens should be in service.
- Rotate screen operation to ensure that all screens are in working order.
- Make sure empty screenings containers are available.
- During normal operating conditions and provided that there is power to the operator and explosive gases are not present in concentrations above the lower explosive limit (LEL), the control strategy automatically maintains all the sluice gates for available screens in a fully open position at all times to accept incoming flow.
- Influent Channels No. 1 & No. 2 Sluice Gates are capable of manual positioning from 0-100% of full open position. Manual gate positioning is required to enhance the flow distribution to the selected cells. Manual positioning is available from local control station or from the control room SCADA.

During Wet Weather Event

- When the water surface elevation in the channel rises to EL. -4.60 (4.0 ft. channel depth), the belt conveyors and bar screens start. The equipment continue to run until the water surface elevation falls to EL. -5.60. At EL. -5.60, the bar screens stop and the belt conveyors continue to operate for a set time duration (0–30 min.) and then stop.
- If the water surface elevation in the channel rises to EL. 6.00, an emergency high level shutdown will occur. At EL. 6.00, the bar screens stop, the influent sluice gates close and the conveyors continue to operate for a set time duration (0–30 min.) and then stop.
- When the level falls to EL. 4.00, the influent sluice gates open and the conveyors and bar screens are restarted by the PLC–BS logic control in the CP–BS. If the level rises back up to EL. 6.00, this shutdown cycle will be repeated. When the level falls to EL. -5.60, the bar screens stop and the belt conveyors continue to operate for a set time duration (0–30 min.) and then stop. The influent sluice gates remain in the open position.
- The belt conveyors are interlocked with the bar screens when operated in the "Automatic" mode. In the "Automatic" mode, the conveyors start at a set water surface elevation in any screening channel. A level sensor automatically starts the belt conveyors which in turn starts the bar screens.

After Wet Weather Event

- Remove screenings for disposal.
- Repair any failures.

Why Do We Do This?

- Preventative maintenance on the bar screens will increase the efficiency of the mechanical bar screens by minimizing the floatables discharging into Flushing Creek through Outfall TI-010.

What Can Go Wrong?

In the event of extreme high-flow events, or the failure of equipment that would lead to high water surface levels, such as the blinding of the mechanically cleaned bar screens, the Flushing Bay CSO Retention Facility is designed to passively bypass excess flows over fixed diversion/bypass weirs, and discharge into Flushing Creek. Specific failure possibilities are outlined below:

- In the event that either belt conveyor shuts down, all bar screens operating in the automatic position will also shut down and an alarm shall be initiated in the facility and also in TI WWTP. The bar screens shall be ready to operate/function only after the belt conveyors are repaired. In auto mode, the bar screens can only start when water depth in the influent channel exceeds 4 feet.
- When it is planned to start the screens during the failure or stoppage of either of the belt conveyors, the Facility Operators should first position the bypass plates on the bar screens so that collected screenings are deposited into the one cubic yard containers, and then start the bar screens manually in the "HAND" position remotely or locally.
- If the belt conveyors are not operational, then the bar screens can be operated in the automatic position in whichever sequence, "CONTINUOUS" or "TIMER" has been selected provided that the "Belt Conveyors"/"Bypass Chute" selector switch is in the "Bypass Chute" position. The "Belt Conveyors"/"Bypass Chute" selector switch is located in the CP–BS panel
- The alarm status of the following conditions are displayed on the CP–BS and OICS. A common malfunction alarm light is also provided on the LCS. The bar screen shuts down and alarm if any of the following conditions exist:
    - Torque overflow (torque retreat)
    - Thermal overload
    - High brake temperature
    - High Influent level condition (EL. 6.00)
    - Either of the two belt conveyors failed and "Belt Conveyors"/"Bypass Chute" selector switch is not in the "Bypass Chute" position
- When the safety pull cord is pulled, the belt conveyors and all bar screens immediately shut down. In order to be restarted, the reset at the LCS must be manually initiated.
- Each belt conveyor is provided with a zero speed switch. Should the zero speed switch indicate the loss of motion to either of the belt conveyors beyond the starting time delay setting, the belt conveyors and bar screens immediately shut down. In order to be restarted, the reset at the LCS must be manually initiated.
- Each conveyor is provided with motor overload protection. Should a motor overload condition occur, the belt conveyors and bar screens immediately shut down. In order to be

restarted, the reset at Motor Control Center (MCC) and at the LCS must be manually initiated. Alarm status of the following conditions are displayed on CP–BS and OICS. A common malfunction alarm light is also provided on the LCS. The belt conveyor shuts down and alarm if any of the following conditions exist:

    - Safety pull cord activation
    - Belt Zero speed switch activation
    - Motor overload
    - High Influent level condition (EL. 6.00)

- If explosive gases are detected in concentrations above the lower explosive limit (LEL), the control strategy will automatically close all influent sluice gates, regardless of the selected mode(s). The louvers in the screenings building will be automatically opened.
- If a sluice gate local/remote selector switch is left in Local Mode (maintenance position) and is not fully open, the control strategy will initiate an alarm "INFLUENT SLUICE GATE NO. # is not in auto mode" after a time interval (initially set to 60 minutes).
- If two or more gates are partially or fully closed and the control strategy is unable to automatically raise the gates after the selected time interval, then an alarm condition will be indicated, "More than one gate disabled" on the CP–BS and OICS.

3.3 CSO Pumping

The facility is equipped with four (4) primary pumps; each pump has a capacity of 6,500-15,500 gpm with four (4) variable frequency drives. The facility also has two (2) secondary pumps; each pump has a capacity of 875 gpm.

Before Wet Weather Event

- Pumps are generally cycled to ensure all available pumps are in working order.
- Check that the wet well monitors are functional.

During Wet Weather Event

- Continue to cycle pumps to ensure that all available pumps are in working order.
- Check that the wet well monitors are functional.
- Monitor water level in the CSO lines.

After Wet Weather Event

- Storage Cells No. 1 and No. 8 drain motor-operated valves are opened. This drains Cells No. 1 and No. 8 and the in-line storage to wet well.
- After Cells No. 1 and No. 8 are drained, close these valves and open all the remaining drain valves in sequential fashion, the stored CSO shall drain into the wet well.
- The Facility Control System monitors the available treatment capacity at the TI WWTP. The actual pumping rate set point is the available flow capacity at TI WWTP.
- The primary wet well level is monitored by an "open diaphragm type" level indicating transmitter LIT–403. Signals from this level transmitter are used by the PLC–PS to perform the following tasks and logic:
    - Indicate and record the wet well water surface elevation through the Facility Distributed Control System.

    - STOP the primary pumping operation when the wet well water surface elevation falls below EL. -35.50.
    - Enable the primary pumping operation and activate the permissive when the wet well water surface elevation rises to EL.-34.50.
- The secondary wet well water surface elevation is monitored by an "open diaphragm type" level indicating transmitter LIT–503. The signal from this level transmitter is used by PLC–PS to perform the following tasks and logic:
    - Indicate and record the wet well water surface elevation throughout the Facility control system.
    - STOP the secondary pumping operation when the wet well level falls below EL. -45.50.
    - START the secondary pumps when the wet well water surface elevation rises to EL. -44.00.
    - STOP the secondary pumps when the wet well water surface elevation rises above EL. -33.00.
- The sensing element of the transmitter was installed on the west wall of the primary pumps dry well at EL. -48.00. The sensing element (diaphragm) is equipped with a flushing connection which is activated automatically once every 24 hours for the duration of 3 minutes. This flushing sequence prevents clogging of the area surrounding the diaphragm.

Why do we do this?

- The pumping operation after wet weather events maintains a safe water level in the pumping station wet wells and prevents dry-weather overflows. This flushing sequence prevents the Facility from flooding.

What triggers the change?

- The pumping rates and set point trigger the pumpback operation. Pumping rate set points are driven by the measured TI WWTP influent flow, available capacity at the Chamber No. 2, and the available capacity at the Tallman Island Regulator No. 9.

What can go wrong?

- An alarm will activate if “NO FLOW THROUGH” conditions exist when the transmitter flushing sequence is activated.
- The maximum water surface elevation in the Facility is EL. 10.00. If the output of the transmitter falls below 4 mA DC (milliampere), then an alarm "Loss of Signal" will be activated.

3.3.1 Primary Pumps

The Primary Pumps are each operated from dedicated Local Control Stations (LCS) adjacent to the pumps. The pumps are controlled and monitored by PLC–PS. The operating control logic and interlocks strategy is part of PLC–PS program. The Facility SCADA system provides supervisory control, data monitoring, alarming and reporting. The primary pumps each have a capacity of 6,500 to 15,500 gpm, are 215 hp, and have variable frequency drive.

Before Wet Weather Event

To operate the primary pumps from SCADA and control panel in Control Room:

- Set the Local/Remote selector switch on LCS to the "REMOTE" position.
- Set the HAND/OFF/AUTO (HOA) selector switches for all available pumps to the "AUTO" position.
- Set the HAND/OFF/AUTO (HOA) selector switches for all available cone valves to "AUTO" position.
- Select desired "LEAD/LAG/2ND–LAG/STANDBY" configuration by rotating the 6–position "SEQUENCE" selector switch on the front of the panel.
- Check that pumps and cone check valves are in working order.
- Check that influent gate valves are open.
- Check that wet wells are empty.
- Check that wet well monitors are functional.
- Check that storage cell drain valves are closed.
- To operate the pumps in auto-pumpback sequence:

During Wet Weather Event

- Make sure primary pumps are being operated in automatic mode.
- Continue to monitor that the pumps are in working condition.
- Check that wet well monitors are functional.
- Check the water surface level in the influent channel and in the storage cells.

After Wet Weather Event

- The selected LEAD pump starts provided that all of the following conditions are met:
    - Wet well level at, or above EL. -34.50
    - Intake isolation valve is fully open
    - Discharge isolation valve is fully open
    - Discharge cone valve is in "AUTO" position and is fully closed
    - Local/Remote selector switch at LCS in "R" position
    - Resulting flow set point is at least FIVE (5) MGD
    - No Alarm conditions exist
    - Neither secondary pump is in use
- When the LEAD pump has started, its speed is automatically controlled by PLCs Proportional Integral (PI) flow controller.
- If the LEAD pump is at the maximum allowed speed, and flow demand (set point) cannot be met, then the first LAG pump will start. The PI (Proportional Integral) controller will vary the LAG pump speed while the LEAD pump is at its maximum allowed speed. The LAG pump will run at least 50%.
- If LEAD and LAG pumps are at the maximum allowed speed, and flow demand (set point) cannot be met, then a second LAG pump will start. The PI controller will vary the second LAG pump speed, while maintaining the LEAD and the first LAG pumps at the maximum allowed speed. The second LAG pump will run at least 50% speed.
- Decrease in the flow demand causes the output of the PI controller to adjust (lower) the speed of the last pump started. When the LEAD, first LAG and second LAG pumps are running,

and the second LAG pump speed drops to 50% (minimum), if the pumped flow is greater than the set point, then the second LAG pump will stop.

- When the LEAD and first LAG pumps are running, and the speed of both pumps drops to 50% (minimum), if the pumped flow is greater then the set point, then the first LAG pump will stop.
- When the LEAD pump is running and the pump speed is 50% (minimum), and the pumped flow is greater then the set point, then the LEAD pump will stop.
- The PLC program allows for adjustable time delays prior to executing the above conditions. The time delay is operator selectable and was determined during start up (initial setting is 120 seconds).

Why do we do this?

- The storing of CSO during the wet weather and pumping to TI WWTP, prevents dry weather flows and CSO overflows to Flushing Creek
- The pumping operating strategy after wet weather events is to empty the storage cells and wet wells so that the Facility is ready to accept CSO from the next wet weather event.

What triggers the change?

- The pumping rates and the setpoints trigger the pumpback operation.
- The pump speeds and the number of pumps on-line at the facility are controlled by the wet well water level, available capacity at the TI WWTP and at Regulator No. 9.

What can go wrong?

- If the cell drain valves, pumps and associated equipment are not functioning properly, and the stored CSO cannot be pumped out, the facility will not be ready for the next storm. During the next storm flow will bypass the facility and can surcharge the screens.
- System monitoring instrumentation may fail or give false readings and uncontrolled or excessive pumping can surcharge the Flushing Interceptor.

3.3.2 Secondary Pumps

The Secondary Pumps are operated from dedicated Local Control Stations (LCS) adjacent to the pumps. The pumps are controlled and monitored by PLC–PS. The operating control logic and interlocks strategy is part of PLC–PS program. The Facility SCADA system provides supervisory control, data monitoring, alarming and reporting. The secondary pumps each have a capacity of 875 gpm at their rating point, and are 30 hp

Before Wet Weather Event

To operate secondary pumps from SCADA and control panel in Control Room:

- Set the Local/Remote selector switch on the LCS to the "REMOTE" position.
- Set the HAND/OFF/AUTO (HOA) selector switches for both cone valves to the "AUTO" position.
- Set the Local/Remote selector switch for both intake and discharge valves to the "REMOTE" position (these valves are normally open).

    - Set the HAND/OFF/AUTO (HOA) selector switches for both pumps to the "AUTO" position.

During Wet Weather Event

- Check that secondary pumps are set to automatic.

After Wet Weather Event

- When in "AUTO", the control logic automatically alternates the Lead/Standby pump assignment. The Lead function is assigned to the pump which has less runtime. Logic compares the runtime values only when both pump "HOA" selector switches are set to the "AUTO" position; or one pump "HOA" switch is set to the "AUTO" position for time longer then 30 seconds (operator selectable).
- The Lead pump starts provided that the following conditions are met:
    - Secondary wet well level at, or above EL. -44.00
    - Secondary wet well level not above EL. -32.50
    - Secondary wet well level not below EL. -45.70
    - No Primary pump in service
    - Intake isolation valve is fully open
    - Discharge isolation valve is fully open
    - Discharge cone valve is in "AUTO" position and is fully closed
    - Local/Remote selector switch at LCS in "R" position
    - No Alarm conditions exist
- The Lead or Standby pump stops automatically if any of the following conditions exist:
    - Secondary wet well level falls below EL. -45.70
    - Secondary wet well level rises above EL.-33.00
    - Any Primary pump starts (in any mode)
    - Cone Valve malfunction
    - Isolation valves are not open
    - Pump malfunction
- The PLC program allows for adjustable time delays prior to executing the above conditions. The time delay, operator selectable, is determined during start up (initial setting is 30 seconds).

Why do we do this?

- The pumping operation after wet weather events maintains a safe water level in the pumping station wet wells.

What triggers the change?

- The pumping rates and set point trigger the pumpback operation. Pumping rate set points are driven by the measured TI WWTP influent flow and the available capacity at the TI WWTP.

What can go wrong?

- If during normal operation any pump fails, then the STANDBY pump will automatically start in place of the failed pump. The standby pump will start immediately upon failure of the Lead pump.

3.4 Flushing Water System

The Flushing Water System consists of Water Storage Tank, Flushing Water Feed Pumps, Valves, Flow measurement, Local control panel, SCADA and Control Panel in the Control Room.

How does it work?

- Stored combined sewage from one of the last cells filled or any selected cell(s) is drained (by gravity) into the Flushing Water Storage Tank. This stored CSO shall be used as wash down water to clean the cell(s).
- Each Storage Cell equipped with Hydroself Flushing Gates shall be washed with the stored CSO in the corresponding Flushing Water Storage Reservoir. If additional flushing is required, the Flushing Water Feed pumps provide the stored CSO from the Flushing Water Storage Tank into Hydroself Flushing System (HFG) storage reservoir. Note that Storage Cells No. 1 and No. 8 require additional flushing Cell No. 2 is washed using the Sediment Flushing Bucket (SFT) system. After cell No. 2 is drained, the flushing buckets shall be filled with CSO and subsequently tip to spill its contents and wash down the cell floor. The SFT flushing Water Pumps pump the stored CSO from the Flushing Water Storage Tank to the flushing buckets.

Why do we do this?

- Following each rainfall event, combined sewage stored in the storage cells is drained into the wet well and pumped to the Flushing Interceptor. This is done in order to keep the tank storage cells clean and free from solids deposition, and to minimize the potential for odors.

What triggers the change?

- Storage Cell Level, Flushing Water Storage Tank Level, Flushing Water Feed Header Pressure and Flow are the main parameters that activate the system to operate.

Before Wet Weather Event

- Verify that the storage cells are empty.
- Verify that all Flushing Water SFT pumps are operational.

During Wet Weather Event

- During a wet weather event, the cells should be filling and the flushing water system must be set to start operation after the wet weather event.
- Make sure all instruments are operational.

After Wet Weather Event

Storage Cell Level Measurement:

Each cell is monitored by an "open diaphragm type" Level Indicating Transmitter (LIT). The signal from the level transmitter is used by PLC–FS, which is located in the Flushing System Control Panel. The PLC–FS is programmed to perform the following tasks and logic:

- Indicate and record cell levels throughout the Facility distributed control system.

- Enable the flushing water supply pumping operation and activate the permissive in the last cell identified to have a water surface elevation of at least EL.-5.00.
- STOP the flushing water supply pumping operation when the water surface level of the selected cell falls below EL.-10.50.

Flushing Water Storage Tank Level Measurement:

The Flushing Water Storage Tank (FWST) stores combined sewage that has been gravity fed from a selected cell. Stored water is used to automatically clean cells in the sequence described below. The FWST level is monitored by an "open diaphragm type" Level Indicating Transmitter (LIT). The signal from the level transmitter is used by PLC–FS, which is located in the Flushing System Control Panel. The PLC–FS performs the following tasks and logic:

- Indicates and records the FWST level throughout the Facility distributed control system.
- Alarm when the water surface level is below EL. -23.00, or rises above EL. -13.00.
- Controls the operation of the alternate (City Water) supply in case of emergencies. A motor operated valve on the City water supply line responds (Open or Close) to tank level demand. The valve enables its manual operation when the tank water surface level falls below EL. -18.00, and close (if was opened) when the level rises above EL. -14.00.

What Can Go Wrong?

- The water level transmitter is in the storage cell at EL. -20.00. Programmable Logic Controller (PLC) will alarm the loss of signal when the output of the transmitter falls below 4 mA DC.
- The sensing water level transmitter is installed in the flushing water storage tank at EL. -27.50. The tank overflows into the Wet Well, when the water surface level reaches EL. 7.00. The PLC will alarm the loss of signal, when the output of the transmitter falls below 4 mA DC.

3.4.1 Flushing Water Feed System

How Does it Work?

- The Flushing Water Feed Pumps are operated from dedicated Local Control Stations (LCS) adjacent to the pumps. The pumps are controlled and monitored by PLC–FS. The operating control logic and interlocks strategy is part of PLC–FS program. The Facility SCADA system provides supervisory control, data monitoring, alarming and reporting.

Before Wet Weather Event

- Make sure that flow meter (FIT) is working properly
- Make sure Flushing Water Feed Pumps are operational.

During Wet Weather Event

- Make sure that flow meter (FIT-301) is working properly
- Make sure Flushing Water Feed Pumps are operational.

After Wet Weather Event

- Flushing water feed flow is measured by a flow meter (FIT–301), installed on the discharge of the flushing water feed pumps.
- To operate the Flushing Water Feed Pumps automatically:
    - Set the Local/Remote selector switch on LCS to the "REMOTE" position.
    - Set the Local/Remote selector switch for both intake valves to the "REMOTE" position.
    - Set the HAND/OFF/AUTO (HOA) selector switches for cell selection to the "AUTO" position.
    - Set the HAND/OFF/AUTO (HOA) selector switches for every available pump to the "AUTO" position
- There are three pumps Lead, Lag and Standby. When in "AUTO", the control logic automatically alternates the initial Lead/Lag/Standby pump assignment. The Lead function is assigned to the pump which has less runtime. Logic compares the runtime values only when all pumps are OFF. The standby pump starts immediately upon failure of either Lead or Lag pump.
- The Lead pump starts provided that all of the following conditions are met:
    - Cell has completely drained as measured by Cell level transmitter.
    - Flushing storage tank level above EL. -14.00
    - Cell selector HOA switch is in "AUTO" position
    - Selected Cell valve is fully open
    - Pump intake isolation valve is fully open
    - HFG is closed and level behind the gate is low.
    - No Alarm conditions exist
- The lead pump stops automatically when:
    - Cell flushing sequence is competed (Operator selectable time duration)
    - Flushing storage tank level below EL. -18.00
    - Selected Cell valve is not fully open
    - Pump intake isolation valve is not fully open
    - Any alarm conditions exist.

What Can Go Wrong?

- An alarm initiates if flow during the pumping rises above 90% of flowmeter capacity and the header pressure falls below 10%. This situation may indicate major leakage and therefore flushing water feed pumps will be stopped. Provide time delay (initial setting 60 sec.) for flow and pressure to stabilize.

3.4.2 Hydroself Flushing Gate System

After all of the storage cells are drained, the drain valves are closed and pumpback operations have been completed, the tank flushing operations will begin. In order to maximize velocity in the 30-inch diameter flushing water drain line and to also ensure that the drain line is empty and ready to accept the next flush, the logic dictates that only one cell shall be washed/flushed at a time.

The sequence of cell washing is operator selective. Normally, the storage cells No. 1 and No. 8 shall be washed first with the CSO where the storage reservoirs were filled during the storm event. Storage cells No. 1 and No. 8 shall be washed one more time. The storage reservoirs shall be filled with flushing water pumps and flushed again. Now wash cell No. 2, the sediment bucket shall be filled with SFT flushing pumps. After completion of flushing cell No. 2, wash/flush the remaining cells No. 3 through No. 15 with the stored CSO in the storage reservoir. The gates are flushed one at a time.

Sediment flushing gates (HFG [Hydroself Flushing Gate] system) are used to flush and clean settled solids and debris from the floor of storage cells. The system uses the volume of water captured during rainstorms to effectively flush each storage cell. The gates are designed, constructed and installed to completely clean cell floor with one flush when filled with five (5) feet of water above the bottom of the gate opening. The cell flushing gate storage reservoirs shall be filled with CSO stored in the flushing water storage tank using the flushing water pumps.

The HFG Control Panel controls the operation of the three (3) flushing gates (typical for all cells except No.2). Each gate is equipped with its own hydraulic operator (integral part of the flushing gate). Each gate is furnished with a solenoid control valve. The solenoid valves are attached to the manifold located on the top of the oil reservoir. The pump is also attached to the top of the oil reservoir. The reservoir, manifold, solenoids, pump and motor are housed in their own enclosure, and a Control Panel. The operation of the Control Panel has been duplicated in CP-FS and SCADA located in the Control Room.

Before Wet Weather Event

- Make sure flushing gates are locked in the closed position
- Make sure all instruments are operational.

During Wet Weather Event

- During rainstorm the three flushing water storage areas (FWSAs) fill, and the flushing gates remain in the locked and closed position until all the water is drained from the Storage Cell.

After Wet Weather Event

The operation of the system is regulated based on signals received from three (3) Level switches, which are provided by HFG vendor.

- The PLC logic monitors, controls and executes a round–robin wash cycle of the selected cells. When cell is called to be washed, the PLC performs the following sequence:
    - Verify that there are no other cells are being washed, and if not then
    - Open both drain valves and verify that the cell is drained, as measured by the cell level transmitter.
    - Verify that the three flushing storage reservoirs are filled as measured by level transmitters. If the levels in the storage area(s) are not sufficient, then logic will open motor operated fill valve and fill the storage areas as necessary. The valve will close when the level reaches the desired value as registered by float switch
    - Activate hydraulic cylinder for the Gate, causing it to open and stay open for predetermined time and until the cell is completely drained.

- Activate hydraulic cylinder for the second gate, causing it to open and stay open for predetermined time and until the cell is completely drained.
- Activate hydraulic cylinder for the third Gate, causing it to open and stay open for predetermined time and until the cell is completely drained.
- Close drain valves and proceed with washing of the next scheduled cell.

What Can Go Wrong?

- PLC and SCADA monitors the performance of the gates system, gate status, and alarms and display these parameters on SCADA screens. When alarm conditions cause the cell wash cycle to halt, the logic aborts the wash of the current cell, re–schedule the wash, and proceed with washing of the next cell.

3.4.3 Sediment Flushing Bucket

How Does it Work?

- Storage cell No. 2 is the only cell equipped with Sediment flushing buckets. The buckets have been provided to test this type of tank cleaning technology, and are operated on the principal of counterweight off-balance. When filled with water to a certain level bucket will flip and release the stored water into the cell bay. Buckets operate one at a time.

After Wet Weather Event

- During the rainstorm, the storage cell and buckets are filled with water. When the storage cell is emptied, and the water surface falls below the buckets, the buckets flip and release their water content. In order to refill the bucket, water is supplied to the buckets by the SFT flushing water pumps at a rate of 100 gpm. The capacity of each flushing bucket is 1,000 gallons and there are three (3) buckets in storage cell No. 2.
- The SFT flushing water pumps discharge to a common header which subsequently divides into three (3) discharge lines that supply water to the flushing buckets. Each discharge line is provided with a motor-operated valve. Water is supplied to one bucket at a time. A flowmeter installed at the common header measures the flow rate and signals the motor-operated valve to close once the bucket receives 1,000 gallons. The bucket then tips, releasing its water and the flushing cycle is repeated for the second bucket by opening the corresponding valve and finally for the third bucket after the flushing cycle of the second bucket is completed.

What Can Go Wrong?

- If the SFT flushing water pump does not work the stand-by pump starts. If the automatic mode is not functioning, the system is operated in manual or “Alternate” mode. The SFT feed pumps operation is available from the local control station and from the valve local control stations.

4. SAMPLING AND ANALYSIS

4.1 Monitoring Requirements

The following effluent overflow parameters, listed in Table 4.1, shall be monitored and the sampling results shall be reported on the monthly operating report.

Table 4 - 1. SPDES Monitoring Requirements for CSO Regional Facilities

OVERFLOW PARAMETER	REPORT	UNITS	SAMPLE FREQUENCY	SAMPLE TYPE	FN
Overflow Volume	total, per event (7)	MG	See Footnote 5	Calculated	(1) (4)
Retained Volume	total, per month	MG	See Footnote 5	Recorded, Totalized	(8)
BOD, 5-day	average, per event	mg/l	1 / Each day of event	Composite	(2)
Total Suspended Solids	average, per event	mg/l	1 / Each day of event	Composite	(2)
Settleable Solids	average, per event	ml/l	1 / Each day of event	Grab	(3)
Oil & Grease	average, per event	mg/l	1 / Each day of event	Grab	(6)
Screenings	total, per month	cu. yds.	---	Calculated	
Fecal Coliform	geometric mean, per event	No./100 ml	1 / Each day of event	Grab	(3)
Precipitation	total, per event	Inches	Hourly / Each day of event	Auto, Recording Gauge within drainage area	

FOOTNOTES:

(1) Flows refers to effluent overflows associated with the design storm for the CSO retention facility.
(2) Composite sample shall be a composite of grab samples, one taken every four hours during each overflow event.

(3) When the facility is manned, grab samples are to be taken every four hours during each overflow event.
(4) As described in Section 4.2, the system uses the standard weir equation to calculate the overflow based on the depth of flow (head) over the weirs as determined by the level transmitters in cell 7 and 15.
(5) In addition to the data supplied on the monthly operating report, the permittee shall provide a summary of the required monitoring to be submitted annually as part of the CSO BMP report required in CSO BMP #14 of this permit. The report shall tabulate sampling results, summarize the number of overflow events, the volume during each event, volume retained and pumped to the WWTP, and the peak flow rate (a calculated number) during each event, and provide an evaluation of the performance of the facility.
(6) Only when the CSO retention facility is manned.
(7) An event starts once overflow out of the CSO retention facility begins, and ends once the overflow stops and the pumpback to the associated wastewater treatment plant has finished.
(8) The permittee shall measure and record the total volume of flow retained and returned to the WWTP each month.

SPECIAL CONDITIONS FOR OPERATION OF THE CSO RETENTION FACILITY

1. The facilities shall be operated in conjunction with the tributary system, pump stations and the WWTP to maximize CSO capture.
2. Upon completion of construction of the retention facility and associated pumping station and conveyances, the permittee shall divert rain induced combined sewage flow to the facility in accordance with the design criteria and the WWOP. The permittee shall notify the Department in writing in accordance with 6 NYCRR Part 750-2 of any changes in the operation due to construction.
3. The permittee shall not discharge from the CSO retention facility unless the tank volume is full to the estimated 28 MG of facility storage and 15 MG of inline storage and/or the facility cannot accept additional wastewater.
4. The contents of the CSO retention facility, (i.e. captured wastewater) shall not be delivered to the WWTP at a rate which would exceed the peak flow or loading as determined by the CSO BMP#4. The WWOP will detail operating conditions of the CSO retention facility.
5. Flow shall not be delivered to the WWTP at a rate that will cause an upset as defined 6 NYCRR Part 750-1.2(a)(94).
6. If a new CSO retention facility is constructed in the drainage basin of the WWTP, a NY-2A application, as well as the NY-2A Supplement for the Control Facilities, must be submitted to the Department, and the permit modified to include the facility, before construction can commence. In addition, DEP shall modify the WWOP in CSO BMP#4 to reflect the changes required for the new facility.

4.2 Monitoring Performed

All samples must be taken in conformance with the SPDES permit, and are to be taken and preserved according to all regulatory guidelines. A blank copy of the monthly operating report is attached in Figure 4.1.

1. Tank Overflow Volume. The proposed methodology uses hydraulic equations and the readings form the pressure transducers/level sensors to determine the overflow rate from the cells. During a wet weather event, influent flow is directed to cells 1 and 8. Once the water elevation reaches the height of the dividing wall between cells, water overflows from cells 1 and 8 into cells 2 and 9, respectively. Depending on the intensity and duration of the storm, the cells continue to fill in order until all 15 cells are full. Once all cells are full, the water elevation is above all the inter-cell dividing walls, and the 15 cells become one large basin with the same water surface elevation.

   For the largest storms, the water level rises above the elevation of the overflow weirs in cells 7 and 15 (+1.81 Queens Sewer Datum for cell 7 and 1.63 Queens Sewer Datum for cell 15). When the water level rises above these elevations, combined sewage overflows the effluent weir at the last two cells (7 and 15) and enters the effluent channel.

   The system uses the standard weir equation to calculate the overflow based on the depth of flow (head) over the weirs as determined by the level transmitters in cell 7 and 15. Since the weir heights differ between cells 7 and 15 the overflows are calculated separately and then combined for a total overflow number. This is computed to volume by a built-in computer totalization routine.

2. Retained Volume. Stored CSO is pumped to Tallman Island WWTP after a storm event is over and there is adequate capacity in the Flushing Interceptor and the Tallman Island WWTP. The Retained Volume is defined as the total CSO volume that is stored in the Retention Facility and in line storage during a storm event and is equal to the total volume pumped to the treatment facility during the pumpback operation. The SPDES permit states that the total Retained Volume shall be measured, recorded and totalized for each month. Additionally, NYSDEC has requested that the reporting of the total Retained Volume for each event be included in the monthly operating report. Tank Overflow Volume and Retained Volume shall also be submitted annually as part of the CSO BMP report.

   The Pumpback flow is measured, recorded and totalized directly by using magnetic flowmeters on the discharge lines of the Primary and Secondary pumps.

3. BOD, 5-Day, Total Suspended Solids. BOD, 5-day and Total Suspended Solids (TSS) composite samples shall be taken from the facility's effluent channel and shall be reported as average per event. The composite samples shall be a composite of samples taken by an automatic sampler from the effluent channel taken every 4 hours during each overflow event. BOD, 5-day and TSS samples are collected every 4 hours from a point in cell No. 7 and cell No. 15 near the effluent weir.

4. Settleable Solids. Settleable Solids grab samples shall be taken from the facility's effluent channel and shall be reported as average per event. When the facility is manned grab samples, shall be taken every 4 hours during each overflow event.

5. Oil & Grease. When the facility is manned, Oil & Grease grab samples shall be taken from the facility's effluent channel and shall be reported as average per event.

6. Screenings. Screenings shall be calculated and reported as total per month. Screenings are collected in the screenings containers and reported as total per month.

7. Fecal Coliform. Fecal coliform grab samples shall be taken from the facility's effluent channel and shall be reported as the geometric mean per event. When the facility is manned, grab samples shall be taken every 4 hours during each overflow event.

8. Precipitation. SPDES permit states that precipitation data (in inches of rain) shall be acquired hourly for each day of event and shall be reported as total per event. Precipitation data are obtained from the local weather station in LaGuardia airport.

FIGURE 4.1

CSO RETENTION FACILITY OPERATION REPORT FOR THE MONTH OF:	DESIGN STORM (IN/DAY): approx. 1 inch	DESIGN STORAGE VOLUME: Total 44.1 MG , Tank 28.7 MG, Sewer 15.3 MG	Page 1 of 1
SPDES PERMIT No. NY-0026239 / FACILITY NAME Flushing Bay CSO Retention Facility	FACILITY OWNER New York City Department of Environmental Protection	FACILITY LOCATION Fowler Ave & College Point Blvd, Queens, 11356	

Event Type	Event Start		Event End		Overflow Volume Total per Event	Volume in Storage at 7am	Retained Volume Total per Event	Wash Water Volume	Pumped Back Volume	Estimated I & I Volume	Precipitation Total per Event	BOD5 Average per Overflow Event	TSS Average per Overflow Event	Settleable Solids Average per Overflow Event	Oil & Grease Average per Overflow Event	Fecal Coliform Geo. Mean per Overflow Event	Screenings Total per Month	Facility Manned
	Date	Time	Date	Time	MG	MG	MG	MG	MG	MG	inches	mg/l	mg/l	ml/l	mg/l	No./100 ml	cu. yds.	
					Monthly Total		Monthly Total	Monthly Total	Monthly Total	Monthly Total	Monthly Total						Monthly Total	

REMARKS:

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I hearby affirm under penalty of perjury that information provided on this form is true to the best of my knowledge and belief. False statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

Signature of Chief Operator or Designated Facility Representative. Date

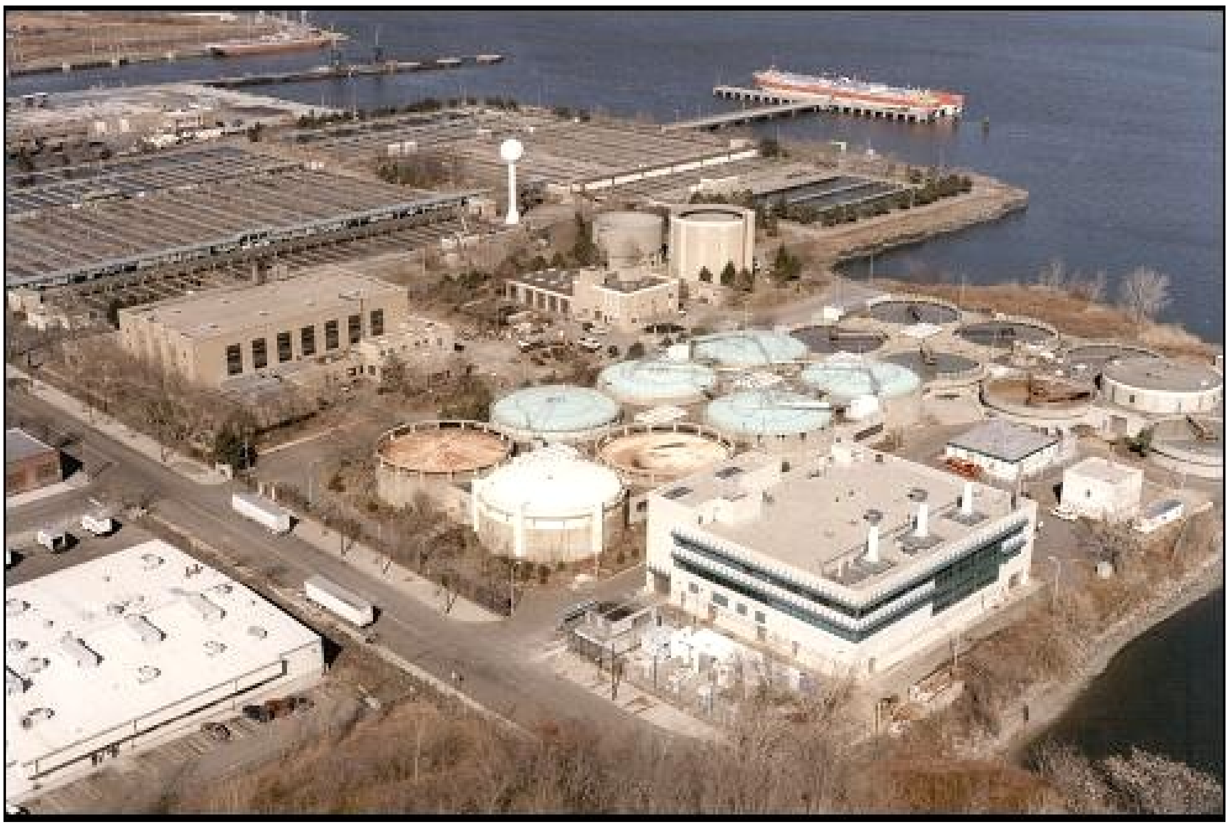
APPENDIX B

BOWERY BAY WATER POLLUTION CONTROL PLANT WET WEATHER OPERATING PLAN

NO TEXT ON THIS PAGE

City of New York
Department of Environmental Protection
Bureau of Wastewater Treatment

Bowery Bay
Water Pollution Control Plant
Wet Weather Operating Plan



Prepared by:

The New York City Department of Environmental Protection
Bureau of Wastewater Treatment

March 2009

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1.0 Introduction

The Nitrogen Administrative Order on Consent, DEC Case # CO2-20010131-7 (the "Order" entered into by the City of New York ("City") and the New York State Department of Environmental Conservation ("DEC") was effective as of April 22, 2002. Pursuant to Appendix A: Upper East River WPCPs Upgrade Schedule and Compliance Deadlines, the City must submit a Wet Weather Operating Plan (WWOP) for the Bowery Bay Water Pollution Control Plant (WPCP) by July 20, 2003. The WWOP shall describe procedures to maximize treatment during wet weather events while the Bowery Bay WPCP is under construction. This shall be accomplished by having the WWOP specify procedures for the operation of unit processes to treat maximum flows, without materially diminishing effluent quality or destabilizing treatment upon return to dry weather operation. The WWOP will establish process control procedures and set points to maintain stability and efficiency of Biological Nutrient Removal (BNR) Processes. The WWOP will specify the treatment facilities that will be available at each WPCP during the construction period, as identified in the Bowery Bay plan. The WWOP shall be based on operations of process units that are available during the construction period operated at the peak hydraulic loading rate. The actual process control set points will be established by the WWOP. Upon completion of construction, the WWOP shall be revised to reflect the operation of the fully upgraded Facility. The revised WWOP for Bowery Bay shall be submitted to DEC within 18 months of the completion of the construction of the Facility.

This document contains the WWOP for the Bowery Bay WPCP operation during construction.

1.1 BACKGROUND

The existing Bowery Bay WPCP, located on a 34.6-acre site adjacent to Berrian Boulevard in Astoria, Queens (Figure 1-1) treats wastewater from a 16,105-acre service area in the Borough of Queens of mostly combined sewers that is divided into high level and low level service areas. The high level service area consists of 11,557 acres in the eastern two thirds of the drainage area. The low level service area includes 4,548 acres in the western third of the service area. The flow from the high level and low level service area enters the plant separately.

There are 27 regulators located in the high level service area. Two of these are designed as hydraulic sluice gates. The remaining 25 regulators are weir chambers that will bypass wastewater to a storm sewer whenever the water in the sewer reaches the weir level. The elevations of the weirs were set during the original design to allow a known volume of combined sewage to remain in the interceptors leading to the plant. No control of these regulators is necessary. Three of the weir chambers use tide gates to prevent backflow from the receiving water into the intercepting sewer.

The Corona Avenue Vortex Facility (CAVF) is located in the high level service area near the junction of Corona Avenue and Saultell Avenue, and services a drainage area of approximately 3,730 acres. The facility is located entirely within Corona Avenue and is completely underground and consists of three, 43-ft diameter vortex concentrators that operate in parallel. As a prototype demonstration facility the units were designed to permit one, two or all three units to be operated during wet weather events. The three vortex units represent the following vortex design configurations: the EPA Swirl Concentrator; the Storm King hydrodynamic separator of British design; and the FluidSep vortex separator, of German design. The hydraulic capacity of each vortex unit is approximately 130 million gallons per day (mgd). The peak hydraulic capacity of the overall facility is approximately 400 mgd. The CAVF was not designed to provide end-of-pipe CSO treatment. However, the facility does remove a portion of the floatables and settleable solids that would otherwise be discharged into Flushing Bay through Outfall BB-006. The units remove settleable solids and floatables and discharges these materials through an underflow stream to the 108^{th} Street Pump Station which discharges into the high level interceptor. The overflow from the units is discharged to the BB-006 lower deck sewer which transports it to Flushing Bay through Outfall BB-006. A WWOP for the CAVF facility is attached to this WWOP as Appendix A.

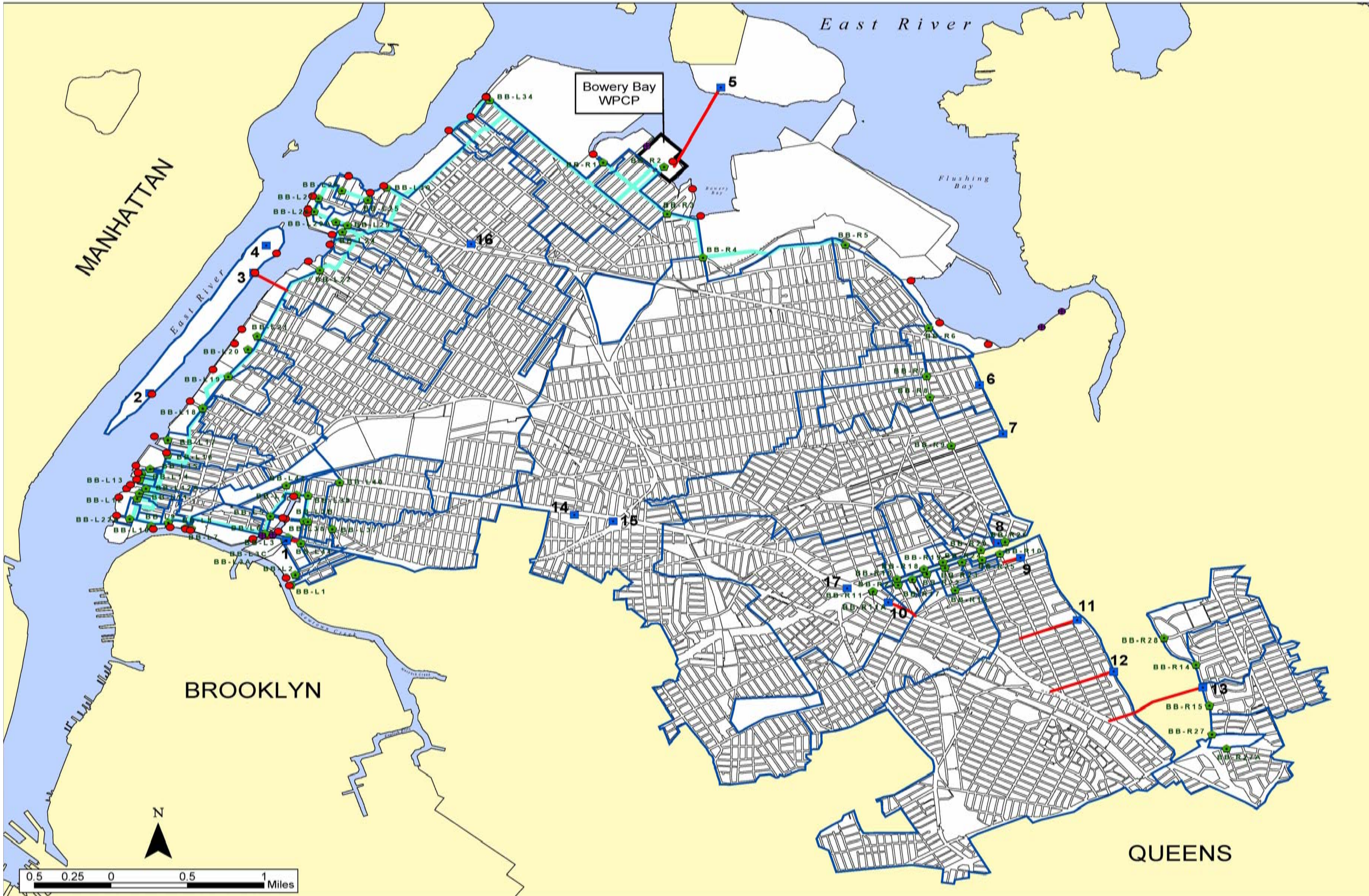


Figure 1-1

Bowery Bay WPCP Drainage Area

New York City
Department of
Environmental Protection

Legend

- Storm Outfall
- Regulator
- CSO Outfall
- Pump Station
- Forcemain
- Interceptor
- Drainage Area

NOTES:

Pump Stations:
1. Borden Avenue
2. Roosevelt Island South
3. Roosevelt
4. Roosevelt Island North
5. Rikers Island South
6. Pell Avenue
7. Corona Avenue
8. 108th Street
9. Lost Batal
10. 62nd Road
11. 67th Road
12. 70th Road
13. Park Drive
14. Bush Street
15. BQE
16. Triboro
17. Woodhaven

Base Map Source:
New York City Department of City Planning
"Bytes of the Big Apple"

HAZEN AND SAWYER
Environmental Engineers & Scientists

In the low level service area, 44 regulators are used to divert storm water to the East River. These regulators are designed to accept all dry weather flow to the plant, but to limit the flow entering the interceptors and thus reaching the plant during storm conditions. Excess flow from the regulators during storms discharge directly to the East River. The low level regulators consist of three chambers: a diversion chamber, a regulator chamber and a tide gate chamber. A manually or hydraulically operated sluice gate is installed to control the flow between the diversion chamber and the regulator chamber. A tide or flap gate is installed between the division chamber and the tide gate chamber. Under normal dry weather conditions, flow entering the diversion chamber will be diverted to the regulator section and then to the intercepting sewer. During high flows, a surcharge will develop in the diversion chamber, opening the tide gate and allowing the combined waste to be discharged to the East River or its tributaries. The sluice gate controls the volume of flow diverted to the interceptors. The manual sluice gates are set based on determination of the maximum allowable flow. A float located in the regulator section of the sanitary sewer controls the hydraulic sluice gates. The float activates valves on a hydraulic cylinder that raises or lowers the gate. A rising float closes the gate while a falling float opens the gate. City water is used as the hydraulic system fluid. Six diversion and tide gate chambers are provided in the low level service area to bypass flow to the East River should a surcharge develop upon the tide gate. Additionally, five overflow chambers are installed that bypass flow to storm sewers over weirs during high flow conditions. The few sanitary sewers in the collection system do not contain regulators. All pumping stations, regulators, tide gates and overflow chambers for the service area are shown in Table 1-1.

Sewage from the high level service area enters the plant through a 9’-0” x 9’-0” intercepting sewer at invert elevation –6.66. This sewer is provided with an overflow chamber and tide gate opposite the high level screening chamber so that the entire flow from the high level service area can be bypassed into Bowery Bay during an emergency. Sewage from the low level service area, via the Long Island City interceptor, enters the low level screening chamber through a 96-inch intercepting sewer at invert elevation – 36.0. This elevation is below tide water level at the treatment plant. Regulators on the connecting sewers limit the flow to the interceptor to approximately twice design dry weather flow. Excess capacity in the intercepting sewer permits some storage capabilities in the event of power failure.

The CAVF treats CSO through one to three vortex separators. Each unit has a hydraulic capacity of 130 MGD.

Table 1-1. Pumping Stations Regulators, Tide Gates, and Overflow Chambers

No.	Name of Structures	Location
-	Lost Battalion Pumping Station	62nd Avenue & Queens Boulevard
-	108th Street Pumping Station	Long Island Expressway & 108th Street
-	37th Avenue Pumping Station	37th Avenue & 114th Street
-	44th Avenue Pumping Station	44th Avenue & 114th Street
-	70th Road Pumping Station	Grand Central Parkway (West Service Road) & 70th Road
-	Park Drive East Pumping Station	Park Drive East of 75th Avenue
-	67th Road Pumping Station	67th Road & Grand Central Parkway (W. Service Road)
-	Bush Street Storm Water Pumping Station	Queens Boulevard & 63rd Street

-	Cypress Hills Storm Water Pumping Station	Interborough Parkway 800 feet West of Cypress Hill Road
-	Central Avenue Storm Water Pumping Station	Central Avenue & 76th Street
-	Woodhaven Boulevard Storm Water Pumping Station	Queens Boulevard & Woodhaven Boulevard
-	Brooklyn-Queens Expressway Storm Water Pumping Station	Brooklyn-Queens Expressway & 65th Street
1	Tide Gate Chamber	37th Street & 19th Avenue
2	Tide Gate Chamber	45th Street at Plant
3	Regulator Weir	Hazen Street & 19th Avenue
MH Chamber “A”	Regulator Manhole	Ditmars Boulevard – 21st Avenue & 81st Street
MH Chamber “B”	Regulator Manhole	19th Avenue & 80th Street
MH Chamber “C”	Regulator Manhole	19th Avenue & Hazen Street
MH Chamber “D”	Regulator Manhole	19th Avenue & 45th Street
4	Regulator Weir	LaGuardia Airport (82nd Street & Ditmars Boulevard)
Chamber “A”	Regulator Manhole	Ditmars Boulevard & 82nd Street
Chamber “B”	Regulator Manhole	Ditmars Boulevard & 88th Street
Chamber “C”	Regulator Manhole	Ditmars Boulevard & 91st Street
Culvert Chamber “D”	Culvert Regulator Manhole	Ditmars Boulevard & 92nd Street
Chamber “E”	Regulator Manhole	Ditmars Boulevard & 98th Street
Chamber “F”	Regulator Manhole	Ditmars Boulevard & 99th Street
5	Regulator Weir	100th Street (22nd Road) & Ditmars Boulevard
6	Regulator Weir	Ditmars Boulevard & 108th Street
7	Regulator Weir	34th Avenue & 108th Street
8	Regulator Weir	37th Avenue & 108th Street
9	Regulator Weir	43rd Avenue & 108th Street
10	Regulator Weir	Long Island Expressway & 108th Street
11	Regulator Weir	94th Street & Long Island Expressway
12	Regulator Weir	99th Street & 63rd Drive
13	Tide Gate Chamber	111th Street & Corona Avenue
14	Regulator Weir & Sluice Gate	72nd Avenue & Park Drive East
15	Regulator Weir & Sluice Gate	77th Avenue & Park Drive East
16	Regulator Weir	Junction Boulevard & Long Island Expressway, North Side
17	Regulator Weir	97th Street & Long Island Expressway, North Side

Table 1-1. Pumping Stations Regulators, Tide Gates, and Overflow Chambers (Continued)

No.	**Name of Structures**	**Location**
18	Regulator Weir	98th Street & Long Island Expressway, North Side
19	Regulator Weir	99th Street & Long Island Expressway, North Side
20	Regulator Weir	Xenia Street & Long Island Expressway, South Side
21	Regulator Weir	Junction Boulevard & Long Island Expressway, South Side

22	Regulator Weir	98th Street & Long Island Expressway, South Side
23	Regulator Weir	99th Street & Long Island Expressway, South Side
24	Regulator Weir	102nd Street & Long Island Expressway, South Side
25	Regulator Weir	Yellowstone Boulevard & Long Island Expressway, North Side
26	Regulator Weir	Saul tell Avenue & Long Island Expressway, North Side
27	Regulator Weir	Union Turnpike & 135th Street
Low Level Service Area		
-	Roosevelt Island Main Pumping Station	Roosevelt Island (E. Channel Shoreline)
-	Borden Avenue Pumping Station	Borden Avenue & Review Street
-	Triborough Bridge Storm Water Pumping Station	North of Triborough Place, East of 31st Street
-	North Roosevelt Pumping Station	North end of Roosevelt Island
-	South Roosevelt Pumping Station	South end of Roosevelt Island
L-1	Regulator	Greenpoint Avenue & Newtown Creek
L-2	Regulator	35th Street West of Review Avenue
L-3	Regulator	Borden Avenue & Dutch Kills
L-3A	Regulator	Borden Pumping Station Influent
L-3B	Tide Gate & Diversion Chamber	30th Street & Hunters Point Avenue
L-3C	Regulator	Behind Borden Pumping Station
L-4	Regulator	47th Avenue & Dutch Kills
L-5	Regulator	49th Avenue & 27th Street
L-6	Regulator	Borden Avenue & 27th Street
L-7	Tide Gate Chamber	East Side 11th Street & Creek
L-8	Regulator	West Side 11th Street & Creek
L-9	Regulator	Vernon Boulevard & Creek
L-10	Regulator	5th Street & 55th Avenue
L-11	Regulator	2nd Street & 51st Avenue
L-12	Regulator	East of 2nd Street & 50th Avenue
L-12A	Regulator	West of 5th Street & 49th Avenue
L-13	Regulator	48th Avenue & East River
L-14	Regulator	47th Road & East River
L-15	Regulator	West of 5th Street & 47th Avenue
L-16	Regulator	5th Street North of 46th Avenue
L-17	Regulator	44th Drive & East River
L-18	Regulator	43rd Avenue & Vernon Boulevard
L-19	Regulator	41st Avenue & Vernon Boulevard
L-20	Regulator	38th Avenue & Vernon Boulevard

Table 1-1. Pumping Stations Regulators, Tide Gates, and Overflow Chambers (Continued)

No.	Name of Structures	Location
L-21	Regulator	37th Avenue & Vernon Boulevard
L-22	Regulator	Vernon Boulevard & Broadway
L-23	Diversion & Tide Gate Chamber	30th Road & Vernon Boulevard
L-24	Regulator	Wellington Court & Vernon Boulevard

MH-5	Regulator Manhole	30th Street South of L-24
L-25	Regulator	9th Street & 26th Avenue
L-26	Regulator	3rd Street & 26th Avenue
L-27	Regulator	27th Avenue & 1st Street
L-28	Regulator	1st Street & Astoria Boulevard
L-29	Regulator	8th Street & Astoria Boulevard
MH-15K	Regulator Manhole	Astoria Boulevard 400 feet west of L-29
L-30	Regulator	Hoyt Avenue South & Shore Road
L-31	Diversion & Tide Gate Chamber	Ditmars & Shore Road
L-32	Diversion & Tide Gate Chamber	21st Avenue & Shore Boulevard
L-33	Diversion & Tide Gate Chamber	South Side 34th Street & 20th Avenue
L-34	Regulator	North Side 34th Street & 20th Avenue
L-35	Regulator	Rust Street & 56th Drive
L-36	Regulator	56th Road & 43rd Street
L-37	Regulator	Hunters Point Avenue & Van Dam Street
L-38	Overflow Chamber No. 5	Hunters Point Avenue & 30th Place
-	Overflow Chamber No. 2	47th Avenue & 29th Street
-	Regulator	47th Avenue & Van Dam Street
L-39	Overflow Chamber No. 3	47th Avenue & 30th Street
L-40	Overflow Chamber No. 4	47th Avenue & 31st Street
L-41	Regulator	Borden Avenue & 30th Street
L-42	Overflow Chamber No. 1	27th Street & Skillman Avenue

The plant was originally constructed as a 40 MGD primary treatment facility in 1938. The plant was upgraded to an activated sludge facility in 1940. Subsequent expansions in 1949, 1954 and 1975 resulted in the 150 MGD facility in operation today. In 1992, regulations banning sludge dumping at sea resulted in the construction of a dewatering facility. The current plant site layout is shown in Figure 1-2.

The Bowery Bay WPCP is designed for 85 percent removal of suspended solids and Biochemical Oxygen Demand (BOD) utilizing the Step Aeration Activated Sludge Process. The facility is designed to treat 300 MGD (2 times design dry weather flow) through the primary treatment and chlorination facilities and 225 MGD (1.5 times design dry weather flow) through the secondary treatment facilities.

In an effort to achieve the aggregate TN effluent limits specified in the SPDES permits, the NYCDEP developed a Nitrogen Control Action Plan (NCAP). The objective of the NCAP was to implement actions to meet the TN limits, and other permit requirements, as quickly as possible. The NCAP included the retrofit step-feed BNR work; separate centrate treatment in an existing aeration tank and the study of BNR related technologies.

The retrofit step-feed BNR work under the NCAP was intended to be an immediate action for nitrogen removal with a relatively low capital investment while other BNR technologies were evaluated. The facilities included in NYC DEP's basic step-feed BNR retrofit program were Bowery Bay, Hunts Point, Tallman Island, Wards Island (Aeration Tank 13 only), Red Hook, 26th Ward, and Oakwood Beach. The retrofit work included: (1) addition of baffles to existing aeration tanks to create anoxic and oxic zones, (2) installation of mixers in the anoxic zones of the aeration tanks to provide for mixing, and (3) provision for a froth control system for control of *Nocardia* foaming. The retrofit step-feed BNR system provided for some nitrogen removal at Bowery Bay.

The existing Bowery Bay wet stream process includes preliminary screening, raw sewage pumping, secondary screening, primary settling and grit removal, step-feed activated sludge biological treatment, final settling and effluent chlorination. A process flow diagram is shown in Figure 1-3.

Dry weather flows and regulated wet weather flows are conveyed to the Bowery Bay WPCP's high and low level wet wells. Flow from the high and low level Main Sewage pumps is metered through two separate 72" discharge headers before combining in one 102" Main Sewage Header. A temporary 48 inch header was installed with flow measurement for low level Main Sewage pumps 1 and 2 only which combines with the 102 inch Main Sewage Header.

The combined influent flow mixes with the thickener overflow prior to the Division Structure, which splits flow to the North and South Batteries through Parshall flumes followed by the secondary screens. The normal influent flow split is 60% to the South Battery and 40% to the North Battery. Flow from the secondary screens passes into the primary tank influent channels. Grit and grease are removed in the primary settling tanks and flow is distributed to the aeration tanks. Return Activated Sludge is fed into the first pass of the aeration tanks and the primary tank effluent is fed to the remaining three passes. The plant has a total of ten aeration tanks, six South and four North. Normally, all six South aeration tanks and three North aeration tanks are in service to treat the plant influent with the provision of one aeration tank for separate centrate treatment. The aerator effluent from the tanks passes into seventeen final settling tanks, eleven South and six North. Final effluent from the settling tanks combines in a common channel feeding three chlorine contact tanks where the effluent is disinfected with sodium hypochlorite prior to discharge to the East River. Activated sludge is wasted from the RAS discharge line. The Waste Activated Sludge and primary sludge are pumped separately to gravity thickeners. Sludge from the thickeners is anaerobically digested and then dewatered onsite.

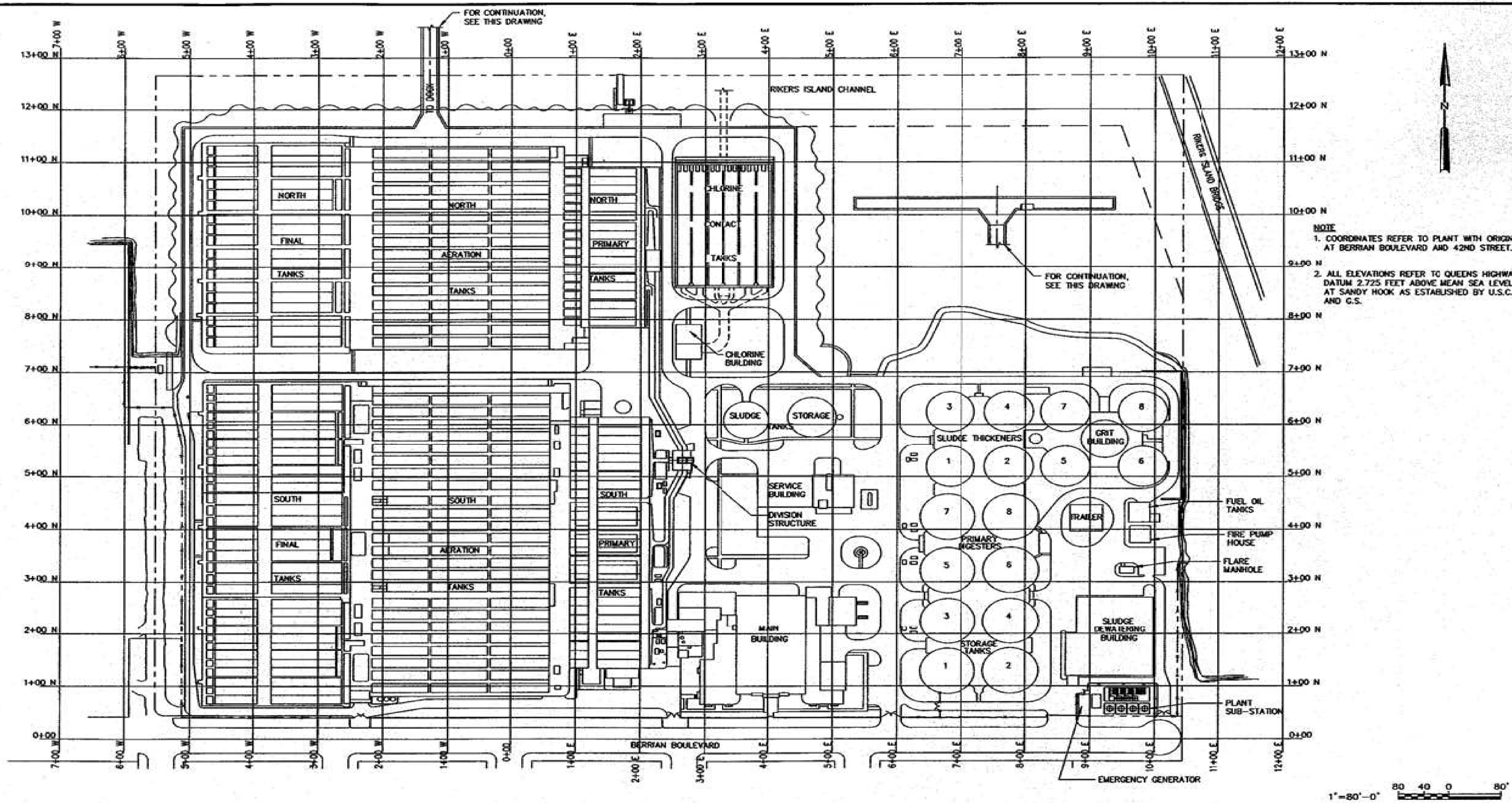


FIGURE 1–2: BOWERY BAY WPCP
EXISTING FACILITY SITE PLAN

HAZEN AND SAWYER
Environmental Engineers & Scientists

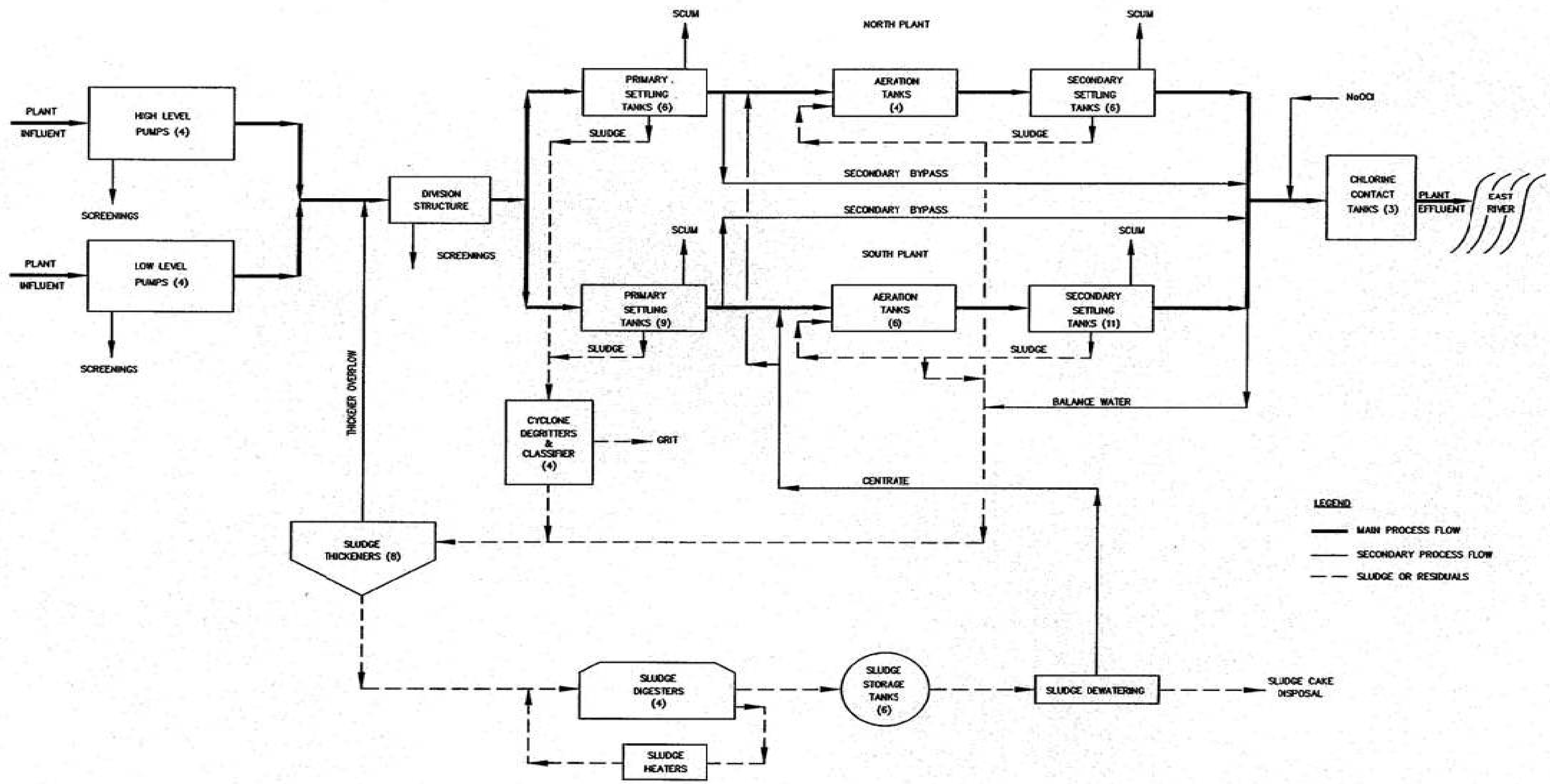


FIGURE 1–3: BOWERY BAY WPCP
EXISTING FACILITY PROCESS FLOW DIAGRAM

HAZEN AND SAWYER
Environmental Engineers & Scientists

1.2 EFFLUENT PERMIT LIMITS

The Bowery Bay WPCP is currently operating under SPDES permit No. NY0026158. The plant is one of four facilities located on the Upper East River (UER) that are under an aggregate total nitrogen limit. The current permit requires the plant to remove 85% of CBOD and Suspended Solids and all four UER WPCP's to meet a combined effluent total nitrogen limit aggregate.

Based on the LISS Total Maximum Daily Limit (TMDL) the effluent nitrogen goals for the UER aggregate, including offset for the Lower East River (LER) and Non-Point Sources, are 72, 600 lbs/day in 2004; 48,950 lbs/day in 2009 and 32,350 lbs/day in 2014. Utilizing a trading ratio of 2:1 between the UER and the LER, the negotiated Administrative Consent Order limits including LER offset are 73,200 lbs/day in 2010, 64,100 lbs/day in 2012 and 53, 100 lbs/day in August 2014. After 2014, the long-term limit will be determined based on the actual operation of the UER plants.

As a result of the Phase I LISS plan, the four Upper East River facilities (Wards Island, Tallman Island, Hunts Point and Bowery Bay) have effluent nitrogen limits in their current SPDES permits, requiring nitrogen removal. Instead of individual effluent limits, the four facilities are combined under an effluent aggregate.

The Bowery Bay WPCP is undergoing a plant stabilization and a BNR upgrade that is anticipated to be complete in December 2010. Phase 1 construction is currently underway. With the removal of an aeration tank on November 1, 2002 for spray water work at the Hunts Point WPCP, the total nitrogen aggregate for the UER WPCPs increased to a twelve month rolling average of 95,900 lbs/day with a twelve month rolling average goal of 88,600 lbs/day. The BNR upgrade will include additional facilities that will provide the capability of the four UER plants to meet the long-term nitrogen aggregate limits.

1.3 PERFORMANCE GOALS FOR WET WEATHER EVENTS

The goals of this manual are to establish operating procedures for Bowery Bay that will:

- Maximize flows to the plant as early as possible to prevent overflows at the collection system regulators,
- Maintain stable operation and maximize removals during wet weather events,
- Reduce solids losses in the secondary system to allow for a stable recovery back to dry weather operations following a wet weather event.

1.4 PURPOSE OF THIS MANUAL

The purpose of this manual is to provide a set of operating guidelines to assist the Bowery Bay operating staff in making operational decisions that will best meet the performance goals stated in Section 1.3 and the requirements of the SPDES discharge permit.

1.5 USING THIS MANUAL

Section 2 of this manual is designed to be used as a quick reference tool for wet weather events during the Bowery Bay upgrade construction. This manual is divided into sections that cover major unit processes at Bowery Bay. Each section includes the following information:

- A list of unit processes and equipment covered in the section
- Steps to take before a wet weather event and who is responsible for these steps
- Steps to take during a wet weather event and who is responsible for these steps
- Steps to take after a wet weather event and who is responsible for these steps
- Discussion of why the recommended steps are performed
- Identification of the specific conditions or circumstances that trigger the recommended steps
- Identification of potential process problems

Section 3 – Planned Plant Upgrades, identifies the major improvements as part of the plant upgrade. These improvements include a Modified BNR upgrade. These improvements are presented in the order in which they are scheduled to be completed and available for operation. Since the final design of these facilities is not yet complete, detailed operating protocols are not presented.

1.6 REVISIONS TO THIS MANUAL

This manual is a living document. Users of the manual are encouraged to identify new steps, procedures and recommendations to add to the descriptions contained herein. Modifications that improve upon the manual's procedures are also encouraged. With continued input from all users of the manual, it will become an even more useful and effective tool.

In addition to the revisions based on plant operating experience, this manual will be revised as upgrade work is completed that affects the plants ability to treat wet weather flows. The Bowery Bay WPCP is currently undergoing a Step-feed BNR upgrade. As required by the Consent Order, a revised WWOP, including specific procedures based on actual operating experience of the upgraded WPCP will be issued eighteen months after the completion of the construction.

2.0 Existing Facility Wet Weather Operation Procedures and Guidelines

This section presents reduced flow capacities, equipment summaries and wet weather operating protocols for each major unit operation of the plant. The protocols are divided into steps to be followed before, during and after a wet weather event. Also included are the bases for the protocols, events that trigger the protocols and a description of potential problems. Figures 2-1, 2-2 and 2-3 summarize the protocols for before, during and after wet weather events. For a summary of protocols for each major unit operation refer to the following sections.

2.1 REDUCED PLANT FLOWS

During the upgrade construction at the Bowery Bay WPCP, a number of unit processes will be unavailable for service. Unavailability of these unit processes will reduce the influent flow to the plant or the flow through the secondary treatment system. The present plant operation of the high level wet well is to place all screens in service and operate three main sewage pumps. In this operating configuration, the screen channel influent gates are left open because the regulator weir setting prevents the screen channels from overflowing. With less screens and pumps available, it will be necessary to throttle the screen channel influent gates to prevent flooding because the regulator weir may not be sized to bypass the additional flow. On the low level wet well, the screen channels are presently throttled with all screens and three pumps in service. Failure to properly throttle the gates results in flooding of the screen channel floor. With a reduction in operating equipment, it will be necessary to start throttling the screen channel inlet gates earlier to prevent flooding of the screen channels.

When aeration and final tanks are removed for construction, it will not be necessary to increase the secondary system bypass flow unless additional tankage is removed from service for emergency maintenance. The Bowery Bay secondary system has the hydraulic capability to treat 225 mgd with two aeration tanks and four final tanks out of service.. The North Battery secondary bypass is a fixed weir; the South Battery secondary bypass is the combination of fixed weirs and a gate. If a third final tank is out of service in the North Battery, treatment efficiency may be reduced and it is important to monitor the final tank operation during wet weather. If two North Battery aeration tanks are out of service, the channel levels in the North Battery will increase sending flow over the bypass weir earlier. If all North Aeration Tanks are in service and only three final tanks are operating, a reduction in flow to the North Battery may be required to protect the secondary system solids. With eleven final tanks in the South Battery, if a third final tank is removed from service, the clarifier treatment efficiency should not be impacted. If solids washout does occur in the south final tanks, reduction of flow to the South Battery may be required to protect the secondary system solids.

INFLUENT SCREENING

- One Bar Screen at each wet well in Service (Two screens total) set to operate on differential level.
- Monitor Screen Operation and flow through the screen channel.
- Confirm additional 10-yard containers are available.

MAIN SEWAGE PUMPING

- Maintain the wet well level between 5 and 7 feet.
- High Level operates 1-2 pumps.
- Low Level operates 1 Pump.
- Monitor Wet Well Levels
- Confirm Additional Pumps are available.

PRIMARY SETTLING TANKS

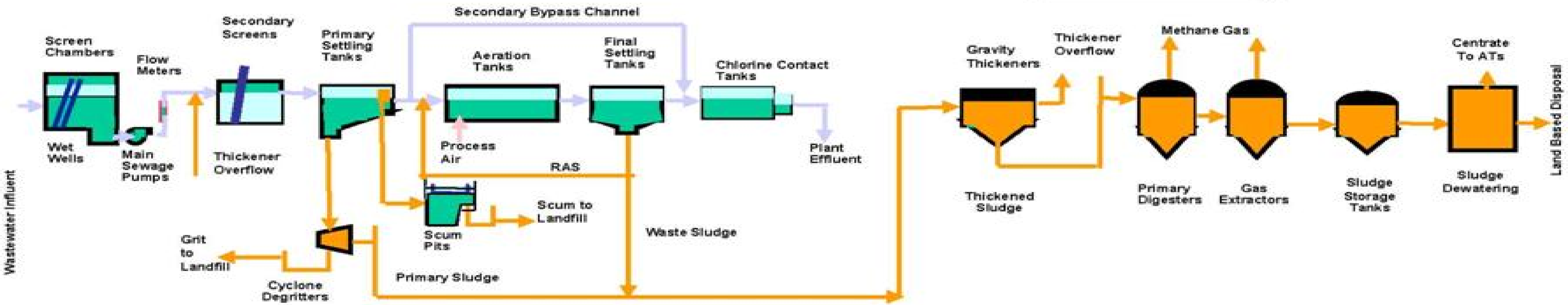
- All Primary Tanks are in service.
- Ensure that sludge pumps are working.
- Check Operation of Sludge Collectors.
- Repair any equipment out of service.

GRIT REMOVAL

- **Eight Grit Cyclones and three Classifiers in Operation.**
- Verify that empty grit containers are available. If not, contact the MVO to bring empties and remove full containers.
- Monitor the output from the cyclones to the classifiers. Clear any blockages in the cyclones.
- Repair any equipment failures.

SECONDARY BYPASS CHANNEL

- Verify that the combined channel flow meter has been calibrated.



AERATION TANKS

- All Aeration Tank in service.
- Current operation is to feed primary effluent to the Aeration tanks at 33% to passes B,C and D. Aeration tank #8 is operated to treat centrate with the effluent fed to the final tanks and Aerator #7.
- With Aeration Tank #8 treating centrate when any North battery Aeration Tank (7,8,9 or 10) is removed from service for construction, the remaining three tanks must be switched to treat primary effluent with centrate being fed to Pass B of the three North Aeration Tanks in service.

FINAL SETTLING TANKS

- All final Tanks in Service.
- Observe effluent Quality.
- Check RAS lifts for proper flow.
- Check RAS pumps in service for proper operation.
- Check tank collectors for proper operation.

EFFLUENT DISINFECTION

- **Chlorine residual is checked every hour on the hour throughout the day.**
- Check operation of Sodium Hypochlorite feed pump.

SLUDGE HANDLING

- Minimum of 5 thickeners in service.
- **Four primary digesters, four storage tanks in service.**
- Normal Dewatering Operation is five days/week with 2-4 centrifuges in service.

DEP

Figure 2-1: Operating Procedures Before Wet Weather Event at the Bowery Bay WPCP

HAZEN AND SAWYER

INFLUENT SCREENING

- All six Bar Screens in Service set to operate on hand.
- Monitor Screen Operation and flow through the Screen channel.
- Close Low Level Channel Influent Gates to prevent screen channel overflow.

MAIN SEWAGE PUMPING

- Maintain the High and Low wet well levels between 7 and 9 feet.
- High Level and Low level Operate 3 Pumps.
- Notify chlorination station operator prior to putting a fifth pump in service.
- Refer to Table 2-1 for maximum hydraulic capacities.

PRIMARY SETTLING TANKS

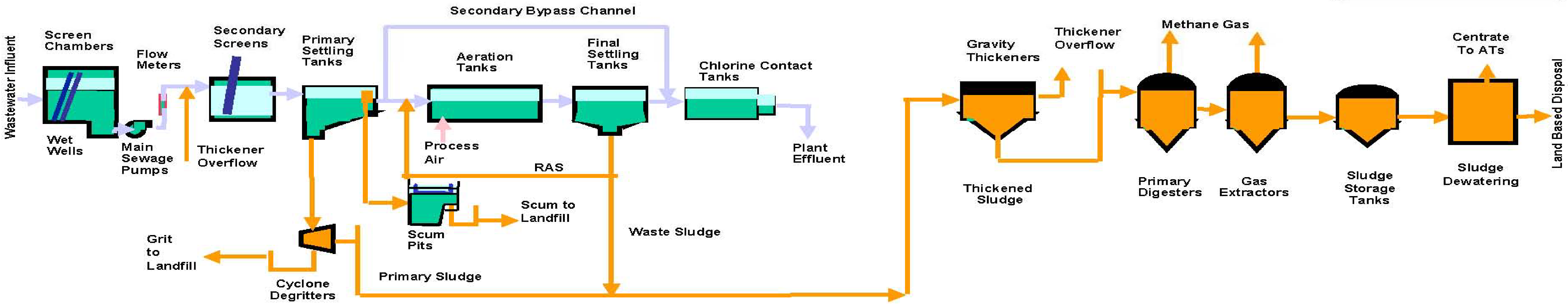
- Check the level of the Primary tank influent channel. Notify the supervisor if the channel is near flooding so the influent flow can be reduced.
- Check the effluent weirs, if flooding is occurring notify supervisor.
- Check sludge pumps for proper operation. Switch pumps in service as necessary.

GRIT REMOVAL

- Eight Grit Cyclones and four Classifiers (All Equipment) in Operation
- Using the tow motor, shift full containers out from under the grit hopper and replace with empties.
- If all containers are full remove the full containers with the tow motor and let the grit fall on the floor.

SECONDARY BYPASS CHANNEL

- Refer to Table 2-1 for maximum hydraulic capacities. Maximum hydraulic and BNR operation Bypass flow may vary.
- When flow reaches the secondary system maximum, (225 mgd with all tanks in service), open the South Bypass Control Gate and verify the correct combined bypass flow.



AERATION TANKS

- Currently no changes are made to the aeration tank operations during a wet weather event. Manual gate operation limits the operator's ability to make rapid adjustments.
- Too high a flow through the secondary system may result in washout of nitrifying bacteria.

FINAL SETTLING TANKS

- Check sludge collectors. If a collector shears a pin, a chain breaks or comes off the sprocket, close the influent gates to isolate the tank.
- Check the effluent quality. Notify the supervisor if solids are washing out over the weirs.
- Check the RAS lifts for clogging.
- Check the RAS pump flow rate.

EFFLUENT DISINFECTION

- Chlorine residual is checked every 30 minutes.
- Adjust chlorine dose as flow increases. When notified by the SEE that a sixth Main Sewage Pump will be started, increase the chlorine dose in anticipation of bypassed flow.

SLUDGE HANDLING

- When influent flow reaches 225 mgd, secure the WAS flow to the thickeners. The primary sludge feed to the thickeners remains on.
- There is no change to the Digester and Sludge Dewatering operations during a wet weather event.

Figure 2-2: Operating Procedures During Wet Weather Event at the Bowery Bay WPCP

HAZEN AND SAWYER

INFLUENT SCREENING

- As the influent flow drops, reduce the number of screens in service.
- When the influent flow drops, return the channel inlet gates to fully open.
- Clean up screenings that have fallen on the floor.

MAIN SEWAGE PUMPING

- Maintain the maximum pumping rate until the wet well level starts to fall.
- As the influent flow drops, reduce the pump operating steps and the number of pumps in service.
- Maintain the wet well level between 5 and 7 feet.

PRIMARY SETTLING TANKS

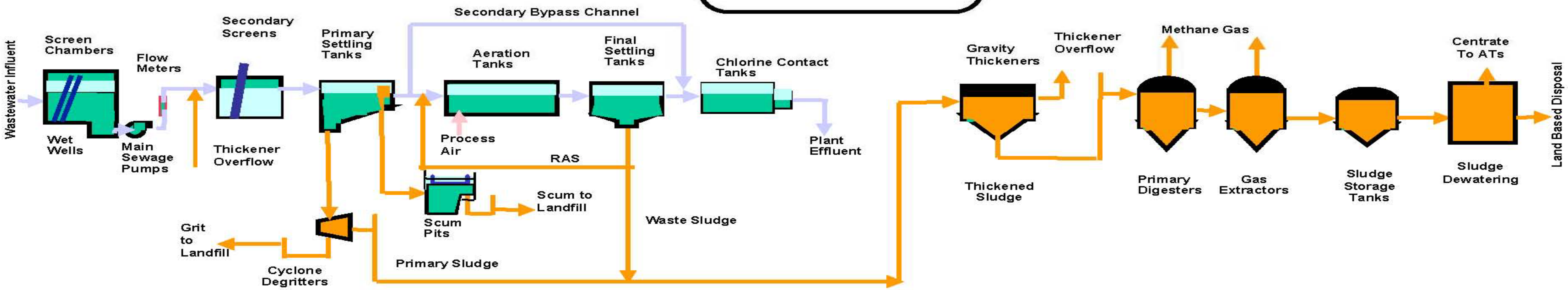
- Check tank collectors for normal operation. Notify supervisor of sheared pins or chain broken or off the sprocket.
- Repair broken equipment.
- Remove scum from Primary Tanks and change full scum containers using the tow motors.
- Contact the MVO to remove full containers and replace with empties.

GRIT REMOVAL

- Replace all full containers with empties.
- Shovel grit that has overflowed onto the floor back into the container.
- Clear clogged cyclones.
- Repair broken equipment.

SECONDARY BYPASS CHANNEL

- When the influent flow drops below the secondary system maximum treatable flow, close the South Bypass Valve.



AERATION TANKS

- Aeration tank primary effluent feed settings remain the same.
- Adjust sludge wasting rates based on the aeration tank inventory loss during the storm.

FINAL SETTLING TANKS

- Repair any broken equipment.
- If the grease load on the tanks is heavy, drop the scum collectors and remove the grease.

EFFLUENT DISINFECTION

- As flow decreases, reduce the chlorine dose.
- Reduce the frequency of checking the chlorine residual.
- Check Sodium Hypochlorite tank storage levels. Notify supervisor of need for delivery.

SLUDGE HANDLING

- When the influent flow drops below 225 mgd, place the WAS flow to the thickeners back on.
- There is no change to the Digester and Sludge Dewatering operations during a wet weather event.

DEP

Figure 2-3: Operating Procedures After Wet Weather Event at the Bowery Bay WPCP

HAZEN AND SAWYER

Table 2-1 below lists the unit process equipment that will be available for service during construction and the corresponding maximum hydraulic capacity associated with the equipment. It should be noted that the maximum flow through the secondary system that will not cause a BNR upset might be lower than the hydraulic maximum of the equipment in service.

Table 2-1. Minimum Hydraulic Capacities for Equipment in Service[1]

Process Equipment	**Total Number of Units in Service**		**Minimum Plant Influent Flow**	**Minimum Secondary Treatment Flow**
Bar Screens	Hi-Level	Low Level		
	3/3	3/3	300 MGD	
	3/3	2/3	250 MGD	
	2/3	3/3	250 MGD	
	2/3	2/3	200 MGD	
	1/3	3/3	200 MGD	
	3/3	1/3	200 MGD	
Main Sewage Pumps	Hi-Level (45)[3]	Low Level (70-L, 40-S)[2]		
	4/4	1/1L, 3/3S	300 MGD	
	4/4	0/1L, 3/3S	300 MGD	
	4/4	1/1L, 2/3S	300 MGD	
	4/4	0/1L, 2/3S	260 MGD	
	4/4	1/1L, 1/3S	290 MGD	
	4/4	0/1L, 1/3S	220 MGD	
	3/4	1/1L, 3/3S	300 MGD	
	3/4	0/1L, 3/3S	255 MGD	
	3/4	1/1L, 2/3S	285 MGD	
	3/4	0/1L, 2/3S	215 MGD	
	3/4	1/1L, 1/3S	245 MGD	
	3/4	0/1L, 1/3S	175 MGD	
	2/4	1/1L, 3/3S	280 MGD	
	2/4	0/1L, 3/3S	210 MGD	
	2/4	1/1L, 2/3S	240 MGD	
	2/4	0/1L, 2/3S	170 MGD	
	2/4	1/1L, 1/3S	200 MGD	
	2/4	0/1L, 1/3S	130 MGD	
	1/4	1/1L, 3/3S	235 MGD	
	1/4	0/1L, 3/3S	165 MGD	
	1/4	1/1L, 2/3S	195 MGD	
	1/4	0/1L, 2/3S	125 MGD	
	1/4	1/1L, 1/3S	155 MGD	
	1/4	0/1L, 1/3S	85 MGD	
When LL MSP is upgraded	Hi-Level (45)[3]	Low Level (70-L, 40-S)[2]		
	4/4	2/2 L, 2/2S	300 MGD	

	4/4	1/2L, 2/2S	300 MGD	
	4/4	0/2L, 2/2S	260 MGD	
	4/4	2/2L, 1/2S	300 MGD	
	4/4	1/2L, 1/2S	290 MGD	
	4/4	0/2L, 1/2S	220 MGD	
	3/4	2/2 L, 2/2S	300 MGD	
	3/4	1/2L, 2/2S	285 MGD	
	3/4	0/2L, 2/2S	215 MGD	
	3/4	2/2L, 1/2S	300 MGD	
	3/4	1/2L, 1/2S	245 MGD	
	3/4	0/2L, 1/2S	175 MGD	
	2/4	2/2 L, 2/2S	300 MGD	
	2/4	1/2L, 2/2S	240 MGD	
	2/4	0/2L, 2/2S	170 MGD	
	2/4	2/2L, 1/2S	280 MGD	
	2/4	1/2L, 1/2S	200 MGD	
	2/4	0/2L, 1/2S	130 MGD	
	1/4	2/2 L, 2/2S	265 MGD	
	1/4	1/2L, 2/2S	195 MGD	
	1/4	0/2L, 2/2S	125 MGD	
	1/4	2/2L, 1/2S	225 MGD	
	1/4	1/2L, 1/2S	155 MGD	
	1/4	0/2L, 1/2S	85 MGD	
Primary Settling Tanks	South	North		
	8/9	6/6	300 MGD	
	7/9	6/6	240 MGD	
	9/9	5/6	300 MGD	
	9/9	4/6	240 MGD	
	9/9	3/6	240 MGD	
	8/9	5/6	260 MGD	
	8/9	4/6	220 MGD	
	8/9	3/6	220 MGD	
	7/9	5/6	240 MGD	
	6/9	6/6	240 MGD	
	9/9	2/6	220 MGD	
	8/9	2/6	200 MGD	
	6/9	5/6	220 MGD	
	5/9	6/6	220 MGD	
	5/9	5/6	200 MGD	
Aeration Tanks	South	North		
	6/6	3/4		225 MGD
	5/6	4/4		225 MGD
	5/6	3/4		225 MGD
	4/6	4/4		225 MGD
	4/6	3/4		190 MGD

	5/6	2/4		190 MGD
	3/6	4/4		190 MGD
	3/6	3/4		190 MGD
Final Settling Tanks	South	North		
	10/11	6/6		225 MGD
	9/11	6/6		225 MGD
	11/11	5/6		225 MGD
	11/11	4/6		225 MGD
	10/11	5/6		225 MGD
	10/11	4/6		225 MGD
	9/11	5/6		225 MGD
	9/11	4/6		225 MGD
	8/11	4/6		200 MGD
	9/11	3/6		200 MGD
	11/11	3/6		225 MGD
	10/11	3/6		200 MGD
	9/11	3/6		200 MGD
	7/11	6/6		225 MGD
	7/11	5/6		200 MGD
	8/11	6/6		200 MGD
	8/11	5/6		200 MGD
Chlorine Contact Tanks	2/3		300 MGD	
	1/3		150 MGD	
[1] Minimum Secondary Treatment Flow may be less than the hydraulic minimum to prevent loss of nitrification from biomass washout.				
[2] Capacity of the large (L) pump is 70 MGD. Capacity of the small (S) pump is 40 MGD. [3] Capacity of the Hi-Level pump is 45 MGD.				

2.2 INFLUENT SCREENING

2.2.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Hi Level Screens	2 – Chamber Influent Sluice Gates (Auto) 3 – Channel Influent Sluice Gates (Manual) 3 – Channel Outlet Sluice Gates (Manual) 3 – Bar Screens 1 – Belt Conveyors 1 – Bubbler System 3 – 10 Cubic Yard Containers on Dollies
Low Level Screens	3 – Channel Influent Sluice Gates (Auto) 3 – Channel Outlet Sluice Gates (Manual) 3 – Bar Screens 1 – Belt Conveyors 1 – Bubbler System 3 – 10 Cubic Yard Containers on Dollies

2.2.2 Wet Weather Operating Procedures High Level Wet Well

WHO DOES IT?		WHAT DO WE DO
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•During dry weather operation, maintain the wet well level between 5-7 feet. The zero level is the bottom of the wet well. The bubbler levels are not actual elevations from mean sea level. •One bar screen is in service during peak diurnal dry weather flow. •The bar screen mechanism is set for level differential. •Visually inspect the screen to confirm proper operation. •Visually monitor the flow through the screen channel. •Visually inspect the 10-yard container. If the container is full, use the tow motor to switch containers. •Confirm that additional empty 10-yard containers are available.

During Wet Weather Event		
SEE's (with two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•Maintain the wet well level between 7-9 feet. At 9 feet the influent flow will bypass the High Level wet well via the regulator. It is not necessary to throttle the influent channel gates to prevent the wet well from flooding. •Place all three bar screens in service on Hand. •Visually confirm that the screen channels are not approaching the overflow level. •If screen blinding occurs, close the channel influent sluice gate until the screen clears. •If the screening conveyor fails, place wood under the chute and fill wheelbarrows with screenings. •Dump the screenings into the 1.5 cubic yard containers. Use the forklift to empty the 1.5 cubic yard containers into the 10 cubic yard containers. •If there are no containers available let the screenings fall on the floor.
After Wet Weather Event		
SEE	SSTW/STW	•As the flow to the plant decreases, remove the additional screens from service until only one High Level screen remains operating. •Contact the MVO to remove the full containers and replace them with empties. •Clean up any screenings that have fallen on the floor.
Why Do We Do This?		
•To protect the Main Sewage Pumps from damage by large objects. •To allow the plant to pump the maximum flow through the preliminary treatment tanks without flooding the High Level wet well and the High Level screen channels.		
What Triggers The Change?		
• An increase in wet well level due to an increase in flow to the WPCP.		
What Can Go Wrong?		
•Screen failure, screen blinding, screen channel flooding. •Screenings conveyor failure. •Screenings overflowing the containers. •Influent gate failures.		

2.2.3 Wet Weather Operating Procedures Low Level Wet Well

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•During dry weather operation, maintain the wet well level between 5-7 feet. The zero level is the bottom of the wet well. The bubbler levels are not actual elevations from mean sea level. •One bar screen is in service during peak diurnal dry weather flow. •The bar screen mechanism is set for level differential. •Visually inspect the screen to confirm proper operation. •Visually monitor the flow through the screen channel. •Visually inspect the 10-yard container. If the container is full, use the tow motor to switch containers. •Confirm that additional empty 10-yard containers are available.
During Wet Weather Event		
SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•Maintain the wet well level between 7-9 feet. At 11 feet the influent screen channel floods onto the floor. •Place all three bar screens in service on Hand. •When three main sewage pumps are in service at the maximum step maintain the screen channel level by adjusting the channel inlet sluice gate. •Visually confirm that the screen channels are not approaching the overflow level. •If screen blinding occurs, lose the channel influent sluice gate until the screen clears. •If the screening conveyor fails, rake the screenings from the stopped conveyor into wheelbarrows. Dump the screenings into the 1.5 cubic yard containers. Use the forklift to empty the 1.5 cubic yard containers into the 10 cubic yard containers. •If the incline conveyor fails, move the conveyor out of the way and place 6-yard containers at the horizontal conveyor belt discharge. •If there are no containers available let the screenings fall on the floor.

<table>
<tr><td colspan="3">After Wet Weather Event</td></tr>
<tr><td>SEE</td><td>SSTW/STW</td><td>•As the wet well levels return to normal, the additional screens are removed from service until only one Low Level screen is operating •Return the channel inlet gates to the fully open position.
•Contact the MVO to remove the full containers and replace them with empties.
•Clean up any screenings that have fallen on the floor.</td></tr>
<tr><td colspan="3">Why Do We Do This?</td></tr>
<tr><td colspan="3">•To protect the Main Sewage Pumps from damage by large objects.
•To allow the plant to pump the maximum flow through the preliminary treatment tanks without flooding the Low Level wet well or the bar screen channels.</td></tr>
<tr><td colspan="3">What Triggers The Change?</td></tr>
<tr><td colspan="3">•An increase in wet well level due to an increase in flow to the WPCP.
•Flooding of the bar screen channels.</td></tr>
<tr><td colspan="3">What Can Go Wrong?</td></tr>
<tr><td colspan="3">•Screen failure, screen blinding, screen channel flooding.
•Screenings conveyor failure. •Screenings overflowing the containers.
•Influent gate failures.
•The wet well can flood with sewage overflowing the screening channels.</td></tr>
</table>

2.3 INFLUENT WASTEWATER PUMPING

2.3.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
High Level Main Sewage Pumps	4 - Gate Valves (Manual) 4 - Check Valves (Auto) 4 - 53.3 MGD Main Sewage Pumps 1 - 72-inch Discharge Header
Low Level Main Sewage Pumps	4 - Gate Valves (Manual) 4 - Check Valves (Auto) 4 - 46.8 MGD Main Sewage Pumps 1 - 72-inch Discharge Header with Magnetic Flow Meter 1 - 48-inch

2.3.2 Wet Weather Operating Procedures High Level Main Sewage Pumps

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•During dry weather operation, maintain the wet well level between 5-7 feet. The zero level is the bottom of the wet well. The bubbler levels are not actual elevations from mean sea level. •One or two main sewage pumps are in service during normal diurnal dry weather flow. The number of pumps in service and operating step are selected and adjusted manually. •Confirm that additional High •Level Main Sewage Pumps are available for service. •Monitor the wet well level.
During Wet Weather Event		
SEE’s (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•As the wet well levels rise, adjust the operating step of the pumps in service. If the operating pump steps are maximized, place additional High Level pumps in service. •Notify the chlorination station operator prior to placing a fifth main sewage pump in service. •At 300 mgd, there should be three Low Level and three High Level pumps in service. •Adjust the operating step of the Main Sewage Pumps based on wet well levels. •Pump to minimum hydraulic capacity as per Table 2-1. During construction the minimum hydraulic capacity will vary based on equipment availability. Refer to Table 2-1 for minimum hydraulic capacities.

After Wet Weather Event		
SEE	SSTW/STW	•Maintain the maximum pumping rate until the wet well level starts to fall. •Reduce the pump operating steps, as wet well levels fall, to maintain normal wet well level. •When the pumps are lowered to step 2 start taking pumps out of service until one or two High Level pump are operating depending on the time of day.
Why Do We Do This?		
• To allow the plant to pump the maximum flow through the preliminary treatment tanks without flooding the wet well. • To minimize the need for flow storage in the collection system and reduce the storm sewer overflows to the East River.		
What Triggers The Change?		
• An increase in wet well level due to an increase in flow to the WPCP.		
What Can Go Wrong?		
•Main Sewage Pump failure on start-up or while operating. •Screen blinding requiring adjustment of the pump operating step until the screen is cleared.		

2.3.3 Wet Weather Operating Procedures Low Level Main Sewage Pumps

<table>
<tr><td colspan="2">WHO DOES IT?</td><td rowspan="2">WHAT DO WE DO?</td></tr>
<tr><td>SUPERVISORY</td><td>IMPLEMENTATION</td></tr>
<tr><td colspan="3">Before Wet Weather Event</td></tr>
<tr><td>SEE</td><td>SSTW/STW</td><td>•During dry weather operation, maintain the wet well level between 5-7 feet. The zero level is the bottom of the wet well. The bubbler levels are not actual elevations from mean sea level.
•One or two Main Sewage Pumps are in service during normal diurnal dry weather flow. The number of pumps in service and operating step are selected and adjusted manually.
•Confirm that additional Low Level Main Sewage Pumps are available for service.
•Monitor the wet well level.</td></tr>
<tr><td colspan="3">During Wet Weather Event</td></tr>
<tr><td>SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)</td><td>SSTW/STW</td><td>•As the wet well levels rise, adjust the operating step of the pumps in service. If the operating pump steps are maximized, place additional Low Level pumps in service.
•Notify the chlorination station operator prior to placing a fifth main sewage pump in service.
•At 300 mgd, there should be three Low Level and three High Level pumps in service.
•Adjust the operating step of the Main Sewage Pumps based on wet well levels.
•Pump to minimum hydraulic capacity as per Table 2-1. During construction the minimum capacity will vary based on equipment availability. Refer to Table 2-1 for minimum hydraulic capacities.</td></tr>
<tr><td colspan="3">After Wet Weather Event</td></tr>
<tr><td>SEE</td><td>SSTW/STW</td><td>•If the channel influent gates have been throttled, maintain the maximum pumping rate until the gates are fully open and the wet well levels start to fall.
•Reduce the pump operating steps, as wet well levels fall, to maintain normal wet well level.
•When the pumps are lowered to step 2 start taking pumps out of service until only one Low Level pump is operating.</td></tr>
<tr><td colspan="3">Why Do We Do This?</td></tr>
<tr><td colspan="3">•To allow the plant to pump the maximum flow through the preliminary treatment tanks without flooding the Low Level wet well or the bar screen channels.
•To minimize the need for flow storage in the collection system and reduce the storm sewer overflows to the East River.</td></tr>
<tr><td colspan="3">What Triggers The Change?</td></tr>
<tr><td colspan="3">• An increase in wet well level due to an increase in flow to the WPCP.</td></tr>
<tr><td colspan="3">What Can Go Wrong?</td></tr>
<tr><td colspan="3">•Main Sewage Pump failure on start-up or while operating.
•Screen blinding requiring adjustment of the pump operating step until the screen is cleared.</td></tr>
</table>

2.4 SECONDARY SCREENS

2.4.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Secondary Screens	1 – Division Structure 5 – Parshall Flumes 5 - Influent Sluice Gates 5 – Secondary Screens 4 – Belt Conveyors 5 – 10-yard containers

2.4.2 Wet Weather Operating Procedures

<table>
<tr><td colspan="2">WHO DOES IT?</td><td rowspan="2">WHAT DO WE DO?</td></tr>
<tr><td>SUPERVISORY</td><td>IMPLEMENTATION</td></tr>
<tr><td colspan="3">Before Wet Weather Event</td></tr>
<tr><td>SEE</td><td>SSTW/STW</td><td>•Normally all five secondary screens operate continuously.
•Four screens have conveyors that dump into the 10-yard containers. The fifth screen dumps into a wheelbarrow that is dumped into the 10-yard containers.
•The bar screen mechanisms are set on timer.
•Visually inspect the screens to confirm proper operation.
•Visually monitor the flow through the screen channels.
•Visually inspect the 10-yard containers. If containers are full, use the tow motor to switch containers.
•Confirm that additional empty 10-yard containers are available.</td></tr>
<tr><td colspan="3">During Wet Weather Event</td></tr>
<tr><td>SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)</td><td>SSTW/STW</td><td>•Set the bar screen to hand.
•If a conveyor fails, rake the screenings into a wheelbarrow and dump it into the 10-yard containers.
•If no containers are available, let the screenings dump onto the floor.</td></tr>
<tr><td colspan="3">After Wet Weather Event</td></tr>
<tr><td>SEE</td><td>SSTW/STW</td><td>•Contact the MVO to remove the full containers and replace them with empties.
•Clean up any screenings that have fallen on the floor.</td></tr>
<tr><td colspan="3">Why Do We Do This?</td></tr>
<tr><td colspan="3">•To protect the downstream equipment from damage by large objects.
•To allow the plant to pump the maximum flow through the preliminary treatment tanks without flooding the Secondary Screen channels.</td></tr>
<tr><td colspan="3">What Triggers The Change?</td></tr>
<tr><td colspan="3">•Flooding of the bar screen channels.</td></tr>
<tr><td colspan="3">What Can Go Wrong?</td></tr>
<tr><td colspan="3">•Screen failure, screen blinding, screen channel flooding.
•Screenings conveyor failure.
•Screenings overflowing the containers.
•Influent gate failures.
•Overflow at the Division Structure onto the floor.</td></tr>
</table>

2.5 PRIMARY SETTLING TANKS

2.5.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
South Battery Primary Tanks (1-9)	9 – 124' long x 50' wide x 11.64' deep Primary Settling Tanks 3 – Feed Channels 45 – 15-inch Inlet Sluice Gates (5 per PST) 9 – 18-inch Inlet Sluice Gates (1 per PST) 27 – Chain and Flight Collectors (3 per PST) 9 – Sludge Trough Cross-Collector (1 per PST) 27 – Scum Collectors (3 per PST) 12 – Primary Sludge Vortex Pumps 3 – Primary Sludge Plunger Pumps 2 – Grease Pits 2 – 10-yard containers
North Battery Primary Settling Tanks (10-15)	6 – 124' long x 50' wide x 11.64' deep Primary Settling Tanks 2 – Feed Channels 30 – 15-inch Inlet Sluice Gates (5 per PST) 6 – 24-inch Inlet Sluice Gates (1 per PST) 18 – Chain and Flight Collectors (3 per PST) 6 – Sludge Trough Cross-Collector (1 per PST) 18 – Scum Collectors (3 per PST) 12 – Primary Vortex Sludge Pumps 3 – Primary Sludge Plunger Pumps 2 – Grease Pits 2 – 10-yard containers

2.5.2 Wet Weather Operating Procedures 2.6.2 Wet Weather Operating Procedures

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•All primary tanks are in service during normal operation. •Skim grease from the tank and remove it from the scum pits into the containers as needed. •Ensure that the sludge pumps are working. •Check the operation of the sludge collectors. •Repair any critical/priority equipment out of service. •Confirm additional 10-yard containers are available.
During Wet Weather Event		
SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•Check the level of the primary tank influent channel. Notify the supervisor if the channel is near flooding so the influent flow can be reduced. •Check the effluent weirs; if flooding is occurring notify the supervisor. •Check the sludge pumps for proper operation. Switch pumps in service as necessary. If the sludge pump suction line appears clogged shut the pump and back flush through the pump from the discharge of a second pump. •If the sludge discharge line to the grit cyclones clogs, switch the valves to pump through the second line. •If the tank cross collector fails, remove the tank from service.
After Wet Weather Event		
SEE	SSTW/STW	•Check the tank collectors for normal operation. Notify the supervisor of sheared pins or chain broken or off the sprocket. •Begin the process to repair broken equipment. •Remove scum from the Primary Tanks and change full scum containers using the tow motors. •Contact the MVO to remove the full containers and replace them with empties.
Why Do We Do This?		
•To maximize the amount of flow that receives primary treatment. •To protect the downstream processes from abnormal wear due to grit abrasion. •To prevent grit and grease accumulation in the aeration tanks.		
What Triggers The Change?		
•An increase in flow to the primary settling tanks.		
What Can Go Wrong?		
•Broken shear pins, broken or slipped collector chains. •Plugged sludge pump suction and discharge lines. •Grease and grit carryover to the aeration tanks.		

2.6 GRIT REMOVAL

2.6.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Grit Removal	8 – 20" Sludge Cyclone Degritters 4 – Grit Screw Classifiers 4 – Discharge Chutes 12 – 10 yard containers

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•Six grit cyclones feeding three grit classifiers is the normal operation. •Verify that empty grit containers are available. If not, contact the MVO to bring empties and remove the full containers. •Monitor the output from the cyclones to the classifiers. Clear any blockages in the cyclones. •Repair any critical equipment failures.
During Wet Weather Event		
SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•Place all eight cyclones and all four classifiers in service. •Check the cyclones and classifiers for proper operation. •If a cyclone clogs, open the primary sludge crossover line to the other cyclones. •Using the tow motor, shift full containers out from under the grit hopper and replace them with empties. Contact the MVO to bring empties and remove full containers. •If all containers are full remove the full containers with the tow motor and let the grit fall on the floor.
After Wet Weather Event		
SEE	SSTW/STW	•Replace all full containers with empties. •Shovel the grit that has overflowed onto the floor back into the container. •Contact the MVO to bring empty containers and remove full containers. •Clear clogged cyclones. •Begin the process to repair broken equipment.
Why Do We Do This?		
•To protect the downstream equipment from abnormal wear and to prevent accumulation of grit in the aeration tanks.		
What Triggers The Change?		
•Increased grit load in the preliminary settling tanks due to increased flows and first flush of the collection system.		
What Can Go Wrong?		
•Grit cyclones can clog. •Grit classifier failure. •Grit container overflows onto the floor. •No empty containers requiring grit to be piled on the floor.		

2.7 SECONDARY SYSTEM BYPASS

2.7.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
South Secondary System Bypass	1 – Automated Control Gate (Manually Control) 1 – Combined Channel Flow meter
North Secondary System Bypass	1 – Overflow weir

2.7.2 Wet Weather Operating Procedures

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	Instrumentation Technician	•Verify that the combined channel flow meter has been calibrated.
During Wet Weather Event		
SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•See Table 2-1, page 13, for minimum hydraulic capacities. The actual flow that can be passed through the secondary system may be lower than the hydraulic capacity in order to protect the nitrogen treatment biomass. The actual bypass flow will be determined by the loss of nitrification at various flows. •When flow reaches the secondary system minimum as per Table 2-1, open the South Bypass Control Gate accordingly, and verify the correct combined bypass flow. •If the channel flow meter fails, use the temporary measurement ruler installed on the wall and convert the inches of water into MGD based on the chart provided.
After Wet Weather Event		
SEE	SSTW/STW	•When flow drops below the secondary system minimum as per Table 2-1, close the South Bypass Gate. •Repair any failed equipment.
Why Do We Do This?		
•To maximize the flow that receives secondary treatment without causing nitrification failure or violations and 85% removal. •To maximize the flow that receives secondary treatment without causing hydraulic failure. •To maximize the flow that receives preliminary treatment and chlorination.		
What Triggers The Change?		
•Influent flows are higher than the hydraulic or BNR maximum that can be treated through the secondary system.		
What Can Go Wrong?		
•The South Bypass gate is not opened soon enough resulting in too much flow through the secondary system. •The South Bypass gate fails closed causing hydraulic overload of the secondary system. •The South Bypass gate fails open resulting in too much flow being bypassed. •The North Bypass weir is blocked causing hydraulic overload of the secondary system. •The channel flow meter fails resulting in estimation of bypass flow.		

•The channel flow meter is not calibrated causing incorrect bypass flow.

2.8 AERATION TANKS

2.8.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
South Aeration Tanks (1-6)	6 – 4 pass aeration tanks Influent channels 24 – Manual Step Feed Gates Diffusers 4 – Blowers (Old); 3 – (New) temporary blowers as of 4/09 or 5/09. 3 – Submersible Waste Sludge pumps 6 – Submersible Return sludge pumps (both waste sludge pumps and return sludge pumps were temporary installed under Contract 57).
North Aeration Tanks (7-10)	4 – 4 pass aeration tanks Influent channels 16 – Manual Step Feed Gates Diffusers 4 – Blowers (Old); 3 – (New) temporary blowers 1 – Waste Sludge pumps 2 – Hydraulic Balance Pumps (2 temporary waste sludge pumps and 4 temporary return sludge pumps will be installed under Contract 59 for phase III upgrade).

2.8.2 Wet Weather Operating Procedures

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•Current normal operation is to feed primary effluent to the Aeration tanks at 33% to passes B, C and D.
During Wet Weather Event		
SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•Typically, wasting rates are adjusted or shut off. •The froth control hoods are normally shut off.
After Wet Weather Event		
SEE	SSTW/STW	• Adjust the sludge wasting rates based on the aeration tank inventory loss during the storm.
Why Do We Do This?		
•To maintain a desired solids inventory in the aerators. •Spray hoods are not effective during wet weather events.		
What Triggers The Change?		
N/A		
What Can Go Wrong?		
•Loss of nitrification due to loss of biomass from too much flow through the secondary system. Blower failure resulting in loss of treatment performance from lack of aeration. •Waste sludge pump failure. •Clogged or broken diffusers.		

2.9 FINAL SETTLING TANKS

2.9.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
South Final Settling Tanks (1-11)	11 – Final Settling Tanks 6 – temporary RAS pumps (1 per aerator) 41 – Chain and Flight Collectors (4 per FST 1-4 and 8-11, 3 per FST 5-7) 11 – Sludge Trough Cross-Collectors (1 per FST) 41 – Inlet Sluice Gates (4 per FST 1-4 and 8-11, 3 per FST 5-7) 41 – Rotating Scum Collectors 11 – Common RAS Telescoping Valves
North Final Settling Tanks (12-17)	6 – Final Settling Tanks 4 – temporary (Will be installed in contract 59) RAS pumps (1 per aerator) 18 – Chain and Flight Collectors (3 per FST) 6 – Sludge Trough Cross-Collectors (1 per FST) 18 – Inlet Sluice Gates (3 per FST) 18 – Rotating Scum Collectors 6 – Common RAS Telescoping Valves

2.9.2 Wet Weather Operating Procedures

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•Normal operation is for all tanks in service. •Observe the effluent quality. •Check the RAS bell weirs for proper flow. •Check the RAS pumps in service for proper operation. •Check the tank collectors for proper operation. •Skim grease by dropping the scum collectors.
During Wet Weather Event		
SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•Check the sludge collectors. If a collector shears a pin, a chain breaks or comes off the sprocket, close the influent gates to isolate the tank. •Check the effluent quality. Notify the supervisor if solids are washing out over the weirs. •Check the RAS bell weirs for clogging. •Check the RAS pump flow rate.
After Wet Weather Event		
SEE	SSTW/STW	•Begin the process to repair any critical equipment failures •If the grease load on the tanks is heavy, drop the scum collectors and remove the grease.
Why Do We Do This? •To prevent solids build-up and washout in the clarifiers.		
What Triggers The Change?		
•Solids build-up in the clarifiers from a clogged RAS bell weir. •Solids washout over the clarifier effluent weirs.		
What Can Go Wrong?		
•Clogged RAS lifts. RAS pump failure. •Solids washout at the final effluent weirs. •Broken chains and flights. •Chains off the sprocket. •Sheared collector pins.		

2.10 PLANT EFFLUENT CHLORINATION

2.10.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Plant Effluent Chlorination	3 – 232’ long x 50’ 3’’ wide x 12’ 6” deep Chlorine Contact Tanks 12 – Influent Slide Gates 2 – Sodium Hypochlorite Pumps 4 – 9,000 gallon Sodium Hypochlorite Storage Tanks 1 – Elevated Effluent Water Storage Tank 12 – 12-inch diameter relief lines

2.10.2 Wet Weather Operating Procedures

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•Monitor the Sodium Hypochlorite Storage Tank levels. •Normal monitoring for chlorine residual is every two hours. •Check the operation of the Sodium Hypochlorite feed pump.
During Wet Weather Event		
SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•Adjust the chlorine dose as flow increases. When notified by the SEE that a sixth Main Sewage Pump will be started, increase the chlorine dose in anticipation of bypassed flow. It will be necessary to put a second hypochlorite pump in service to maintain the chlorine residual due to the high demand from the secondary bypass. •Check the chlorine residual every hour •Check the Sodium Hypochlorite Storage tank level. If low, isolate the tank and place a different tank on-line.
After Wet Weather Event		
SEE	SSTW/STW	•As flow decreases, reduce the chlorine dose. •As flow decreases, return to the normal monitoring frequency for the chlorine residual (See "Before Wet Weather Event"). •Check the Sodium Hypochlorite tank storage levels. Notify the supervisor of the need for a delivery.
Why Do We Do This?		
•To meet the elevated chlorine residual demand from additional flow and from bypassed flow that has only received Preliminary Treatment.		
What Triggers The Change?		
•Increased chlorine demand caused by an increase in flow and secondary bypassing of flow.		
What Can Go Wrong?		
•The chlorine dose is not high enough to anticipate the increased demand resulting in a low residual. •Secondary bypassing can occur without the chlorination operator being forewarned. •Failure of a hypochlorite feed pump. •Chlorine residual is too high after the storm event.		

2.11 SOLIDS HANDLING: THICKENING

2.11.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Gravity Thickeners	1 – Inlet Distribution Box 8 – 70' Diameter Gravity Thickening Tanks 8 – Inlet Slide Gates 14 – Thickened Sludge Pumps (before construction) 8 – Thickener Collector Mechanisms

2.11.2 Wet Weather Operating Procedures

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•Normal operation is with a minimum of six out of eight thickeners in service. •Thickeners receive primary sludge and WAS via separate lines that meet at the influent distribution box.
During Wet Weather Event		
SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	•No changes are currently made to thickening operations during wet weather events. •The primary sludge flow to the thickeners remains in service.
After Wet Weather Event		
SEE	SSTW/STW	•No changes are currently made to thickening operations during wet weather events.
Why Do We Do This?		
•To prevent flooding of the thickener overflow weirs.		
What Triggers The Change?		
•Increased flow to the division structure, which requires additional head for the Gravity Thickener Overflow to drain properly.		
What Can Go Wrong?		
•The gravity thickeners will flood and start to short circuit solids. •Collector mechanism failure. •Thickened Sludge Pump failure. •Waste sludge pump failure. •Thickened sludge is over pumped when no WAS is sent to the thickeners and water enters the digester.		

2.12 SOLIDS HANDLING: DIGESTION

2.12.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Sludge Digestion	4 – Primary Digesters 2 – Secondary Digesters 4 – Sludge Storage Tanks 4 – Sludge Heaters 6 – Sludge Recirculation Pumps 2 – Sludge Transfer Pumps

2.12.2 Wet Weather Operating Procedures

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•All equipment is in service. Four digesters are operated as primary digesters with heating and recirculation. •Four tanks are operated as sludge storage tanks. Storage tanks 3 and 4 are the only tanks that feed dewatering.
During Wet Weather Event		
SEE's (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	• No changes are currently made to the Sludge Digestion Operation during wet weather.
After Wet Weather Event		
SEE	SSTW/STW	• No changes are currently made to the Sludge Digestion Operation during wet weather.
Why Do We Do This?		
N/A		
What Triggers The Change?		
N/A		
What Can Go Wrong?		
•Hot loop pump failure. •Sludge recirculation pump failure. •Plugged sludge heaters. •Gas recirculator failure. •Over pressurization of the digesters resulting in gas venting. •Lifting of the digester cover.		

2.13 SOLIDS HANDLING: DEWATERING

2.13.1 Unit Processes and Equipment List

UNIT PROCESS	EQUIPMENT
Sludge Dewatering	4 – Centrifuges 5 – Sludge Pumps 1 – Sludge Feed Wet Well 2 – Polymer Storage Tanks 4 – Polymer Mixing Tanks 5 – Polymer Feed Pumps 2 – Conveyor Systems 2 – Truck Loading Hoppers 1 – Centrate Wet Well 3 – Centrate Wet Well Pumps 1 – Ferric Chloride Storage Tank 1 – Ferric Chloride Feed Pump

2.13.2 Wet Weather Operating Procedures

WHO DOES IT?		WHAT DO WE DO?
SUPERVISORY	IMPLEMENTATION	
Before Wet Weather Event		
SEE	SSTW/STW	•The number of centrifuges in service will vary from 2-4 depending on the sludge demand. •The centrifuge building normally operates five days per week but it will operate longer during periods of high sludge production.
During Wet Weather Event		
SEE’s (With two separate influent wet wells in operation, a second SEE is assigned to the shift during wet weather events.)	SSTW/STW	• No changes are currently made to the Sludge Digestion Operation during wet weather.
After Wet Weather Event		
SEE	SSTW/STW	• No changes are currently made to the Sludge Digestion Operation during wet weather.
Why Do We Do This?		
N/A		
What Triggers The Change?		
N/A		
What Can Go Wrong?		
•Struvite blocking the centrate return line. •Polymer pump failure. •Sludge feed pump failure. •Centrifuge failure.		

3.0 Planned Plant Upgrades

The Bowery Bay WPCP is undergoing a plant stabilization and a BNR upgrade. A site plan and process flow diagram for the upgraded facilities are presented in Figures 3-1 and 3-2, respectively.

The plant upgrade will result in no increase to the current 300 mgd maximum capacity. This section summarizes the major improvements to be implemented as part of the overall plant upgrade.

3.1 INFLUENT SCREENING AND MAIN SEWAGE PUMPING

The present capacity of the main sewage pumps at Bowery Bay is 46.8 mgd for pumps 2-4 and 53.3 mgd for pumps 5-8. Main sewage pump No. 1 was installed under contract 57 with a capacity of 75mgd. LL MSP No. 2 will be upgraded to 75mgd under the same contract. A diversion sewer was installed that allows flow to be rerouted from before the high level wet well to the low level wet well. This will allow for a short-term shutdown of the high level wet well.

3.2 PRIMARY SETTLING TANKS

The number of primary settling tanks will remain at 15.

3.3 AERATION TANKS

The number of Aeration Tanks at Bowery Bay will remain at ten. The tanks will have anoxic/oxic switch zones constructed to allow the flexibility of changing the aerobic volume for nitrification. The tanks will also undergo an aeration system upgrade with new blowers, air piping, airflow measurement and control, new diffusers to allow the influent and centrate nitrogen load to be completely nitrified in the aeration tanks. Automated gates will also be installed to allow automatic control of excess storm flow to pass D. This is done to protect the biomass to prevent washout of the nitrifiers. Step Feed BNR Operation may require that secondary bypassing occur at flows lower than 225 mgd. If necessary, this will be performed based on the loss of nitrification following storm conditions and the secondary system bypass flow will be determined from actual operating experience.

3.4 FINAL SETTLING TANKS

The existing seventeen final settling tanks were upgraded with new chains, flights and effluent weirs, and will undergo an upgrade consisting of scum removal and increased RAS withdrawal capacity.

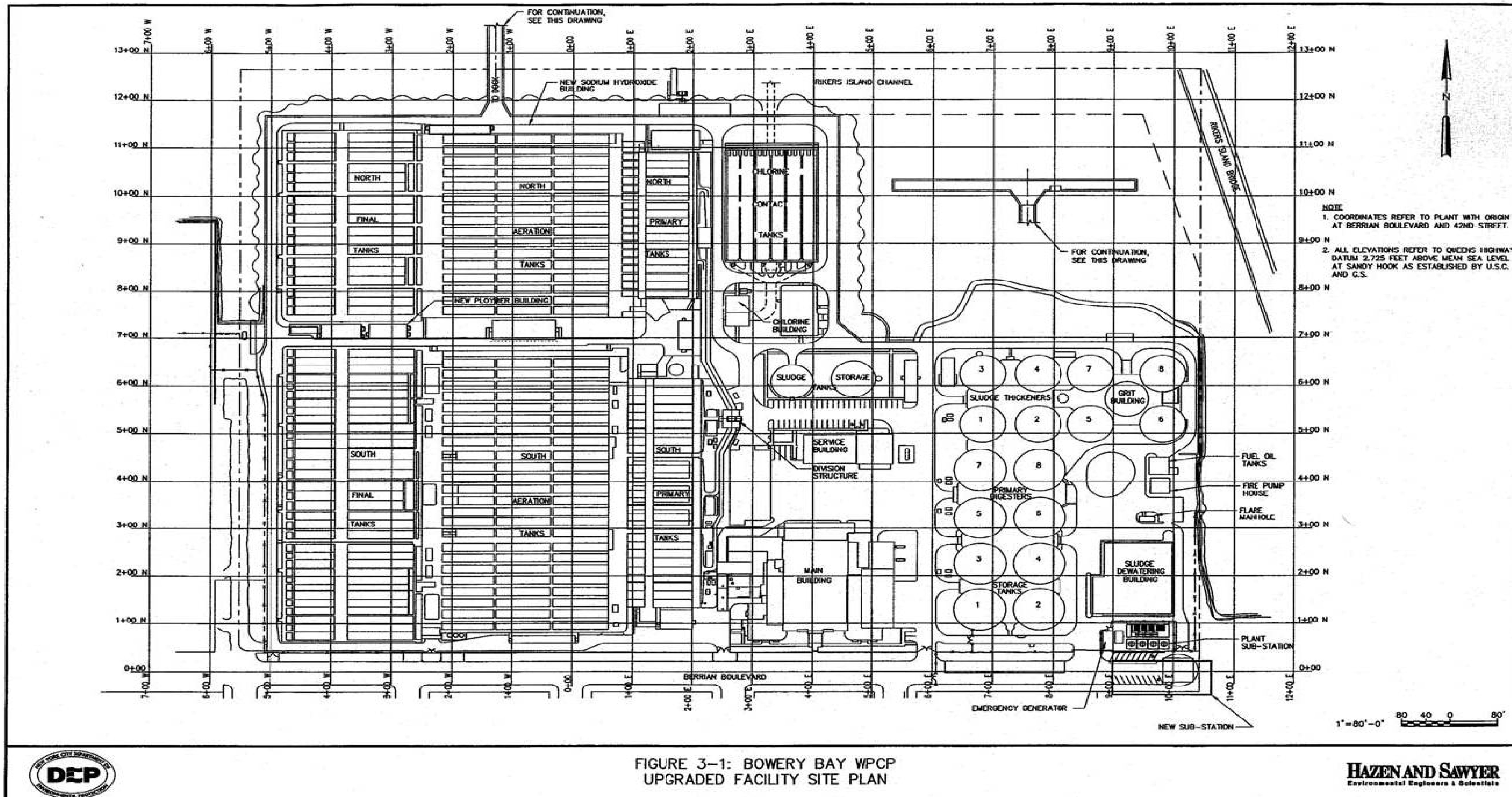


FIGURE 3-1: BOWERY BAY WPCP
UPGRADED FACILITY SITE PLAN

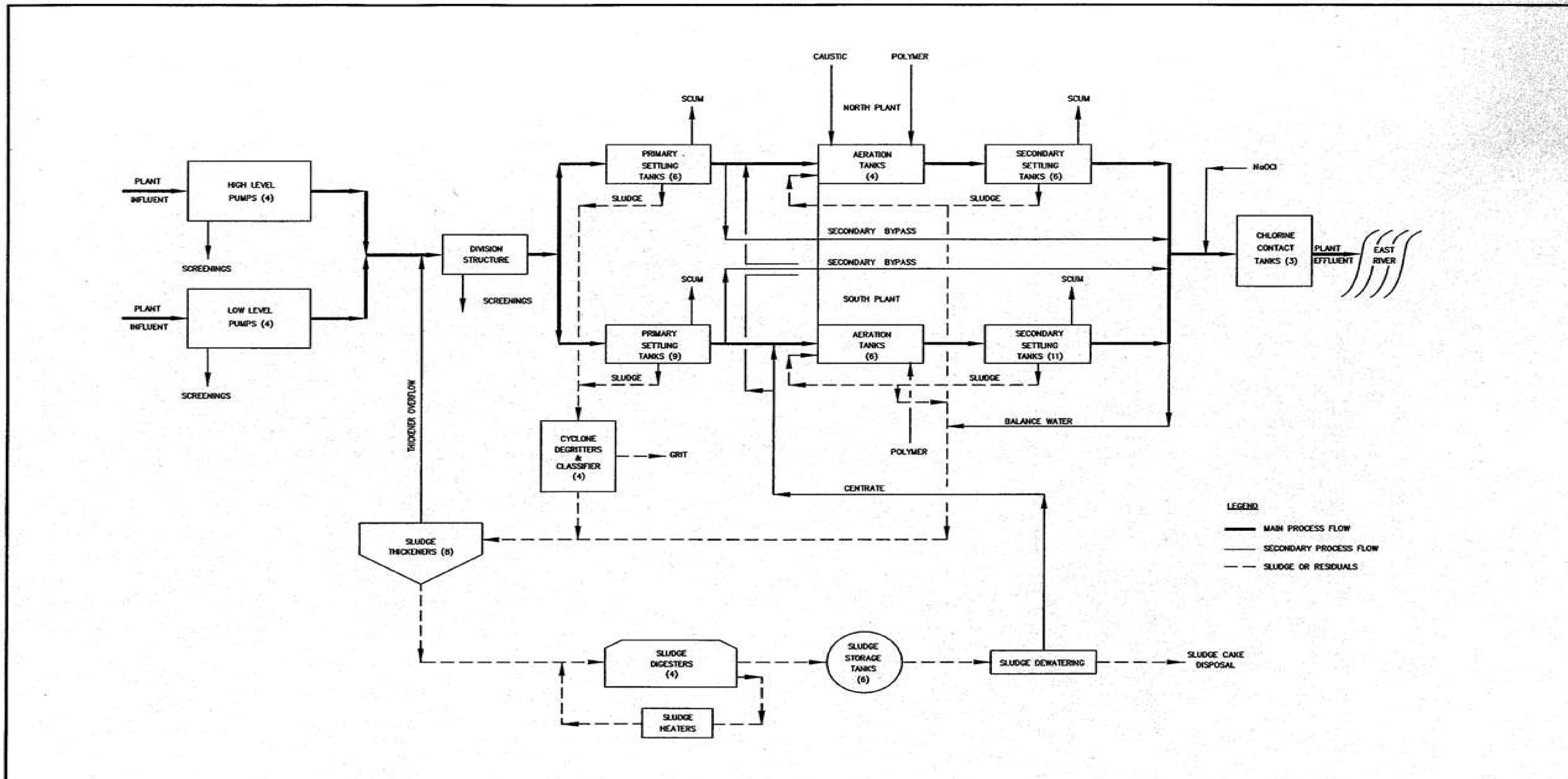


FIGURE 3–2: BOWERY BAY WPCP
UPGRADED FACILITY PROCESS FLOW DIAGRAM

HAZEN AND SAWYER
Environmental Engineers & Scientists

3.5 PLANT EFFLUENT CHLORINATION

The existing chlorine contact tanks were upgraded and improved to reduce short-circuiting, increase mixing efficiency and increase the flow measurement accuracy. The Sodium Hypochlorite storage and feed system will be rehabilitated and upgraded.

3.6 CHEMICAL ADDITION SYSTEMS

A new Froth Control Building will be constructed between the North and South Final Settling Tanks and will supply sodium hypochlorite to the new froth control hoods located in Pass A and B of each aeration tank as well as the two RAS distribution boxes.

A new chemical building will be constructed to house the sodium hydroxide and the polymer systems. Sodium hydroxide will be the alkalinity source to the separate centrate treatment aeration tank.

3.7 RAS AND WAS SYSTEMS

A new RAS pump station will be constructed with the capacity to return a maximum of 150-mgd, which is the recommended capacity from the Comprehensive Nitrogen Management Plan Plant Upgrading Guidance Technical Memorandum.

A new WAS system will be constructed with flow meters and controls to maintain a constant SRT in the aeration tanks possibly in the future upgrades.

3.8 GRAVITY THICKENERS

The gravity thickeners are undergoing a complete rehabilitation with new mechanisms, overflow piping and thickened sludge pumps. A new gravity thickener overflow return line will be constructed that feeds directly into the Division Structure.

3.9 SLUDGE DIGESTION AND STORAGE

The four existing anaerobic sludge digesters heat exchangers are to be replaced. Storage tanks 1 through 4 will be upgraded with new pumps in order to pump to the sludge boats. Open roof storage tanks 1, 4, 9 and 10 will be covered and an odor control system provided.

The digester gas system will be overhauled and two new digester gas flares will be constructed.

APPENDIX A

CORONA AVENUE VORTEX FACILITY WWOP

Corona Avenue Vortex Facility
Corona, New York

Wet Weather Operating Plan
Corona Avenue Vortex Facility
Addendum to Bowery Bay WWOP

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1. INTRODUCTION

The purpose of a wet weather operating plan (WWOP) is to provide a set of operating guidelines to assist operating personnel in making operational decisions that will best meet the wet weather operating performance goals. This WWOP is also a SPDES requirement for the Corona Avenue Vortex Facility (CAVF) as well as for the Bowery Bay Water Pollution Control Plant (WPCP).

During wet weather events, numerous operational decisions must be made to effectively manage and optimize treatment of wet weather flows and combined sewer overflows (CSOs). However, each wet weather event produces a unique combination of flow patterns and facility conditions. Therefore, no plan or manual can provide specific, step-by-step procedures for every possible wet weather scenario. However, a WWOP can provide a consistent method of operation for various situations. The WWOP is intended to provide a basis for consistent wet weather operating practices, and that will maximize the utility of the CAVF during wet weather conditions.

This WWOP for the CAVF provides for operation during dry and wet weather flow periods.

The CAVF was designed as a prototype, demonstration facility for the study of floatables removal from CSOs from the lower deck sewer of Outfall CS-3 (SPDES No. BB-006) in the Bowery Bay WPCP drainage area. The combined collection system drainage area of CSO Outfall BB-006 consists of approximately 3,730 acres serving the southeastern portion of the Bowery Bay WPCP service area.

The CAVF was not designed to provide end-of-pipe CSO treatment. However, the facility does remove a portion of the floatables and settleable solids that would otherwise be discharged into Flushing Bay through Outfall BB-006.

The CAVF is located in the Borough of Queens, New York City on Corona Avenue near the junction of Corona Avenue and Saultell Avenue, and within the service area of the Bowery Bay WPCP. Figure 1-1 presents an aerial view of the facility location. The facility is located entirely within Corona Avenue and is completely underground. A schematic of the facility is presented in

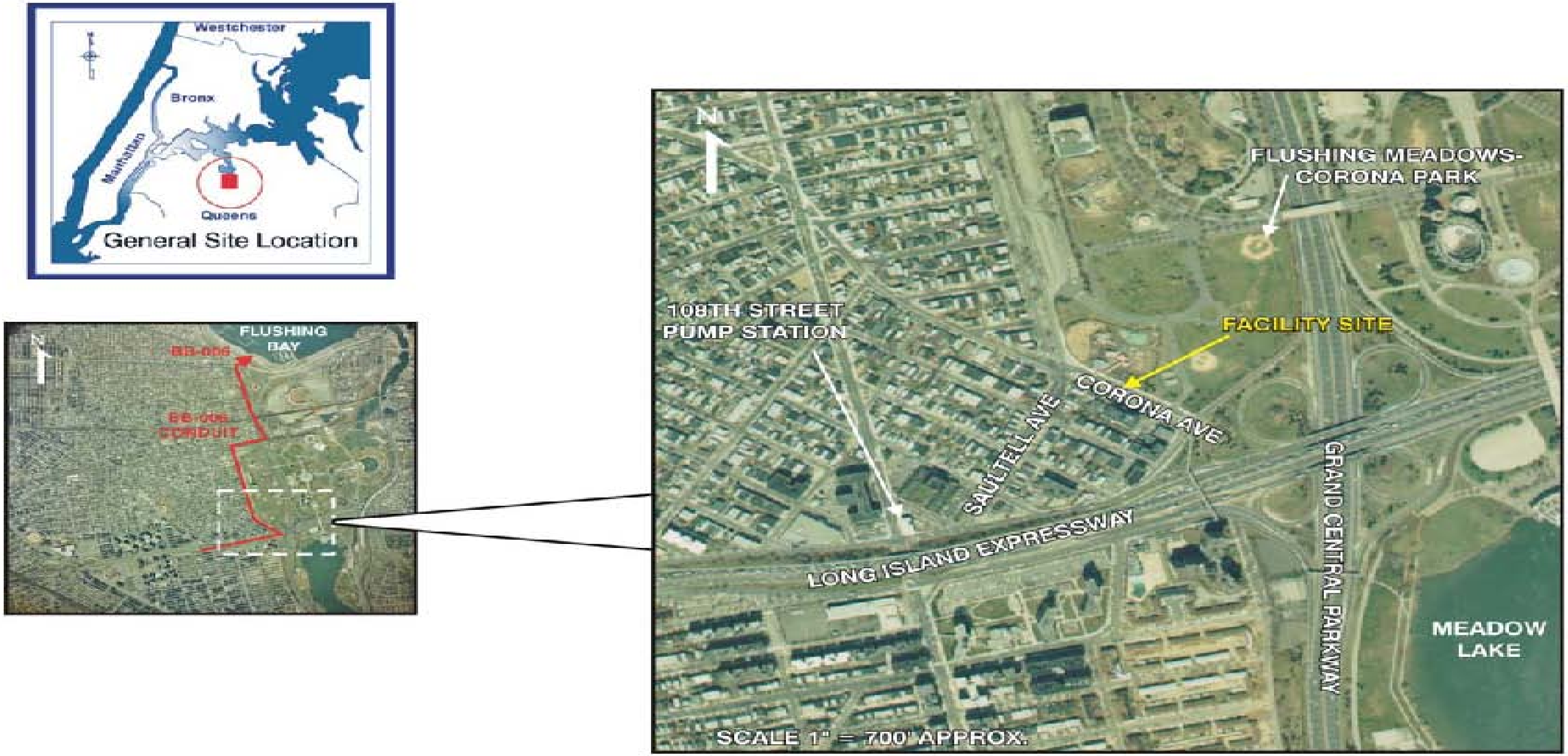
Figure 1-2. It consists of three, 43-ft diameter vortex concentrators that operate in parallel. As a testing facility the units were designed to permit one, two or all three units to be operated during wet weather events. The three vortex units represent the following vortex design configurations: the EPA Swirl Concentrator; the Storm King hydrodynamic separator of British design; and the FluidSep vortex separator, of German design. The hydraulic capacity of each vortex unit is approximately 130 million gallons per day (mgd). The peak hydraulic capacity of the overall facility is approximately 400 mgd.

The original WWOP was conceptual in nature. The procedures presented in this WWOP reflect operating experience with the prototype facility. These procedures will continue to be revised as additional operating experience is gained.

1.1 Background

In the early 1990s the New York City Department of Environmental Protection (NYCDEP) selected vortex technology for potential use in developing its city-wide combined sewer overflow treatment strategy. The three vortex design configurations selected for evaluation were the EPA Swirl Concentrator; the Storm King hydrodynamic separator of British design; and the FluidSep vortex separator, of German design. The three types of vortex units were constructed as part of the CAVF, and parallel operation of the units began in 1998. The primary objective of the CAVF was to evaluate the effectiveness of each of the vortex technologies to determine if they are appropriate for use in New York City to remove floatables from CSO discharges.

The CAVF is designed to treat flows up to about 400 mgd, and serves the lower deck of Outfall CS3 (SPDES No. BB-006) in the Bowery Bay WPCP drainage area. The hydraulic capacity of each vortex unit is approximately 130 mgd. Outfall BB-006 is a combined sewer outfall that discharges overflow to Flushing Bay from the Bowery Bay High Level Interceptor System. An upper deck sewer originating from Regulator BB-R10 and a lower deck sewer from Regulator BB-R11 combine to form the 10'-6"x 9'-0" four barrel outfall. Outfall BB-006 is tidally affected, and the capacity of the outfall is restricted at high tide. The CAVF was designed to operate passively, withstand flooding from extreme conditions, and is provided with water submersible



FACILITY SITE LOCATION

DEP	CORONA AVENUE VORTEX FACILITY WET WEATHER OPERATING PLAN	Figure 1-1 URS

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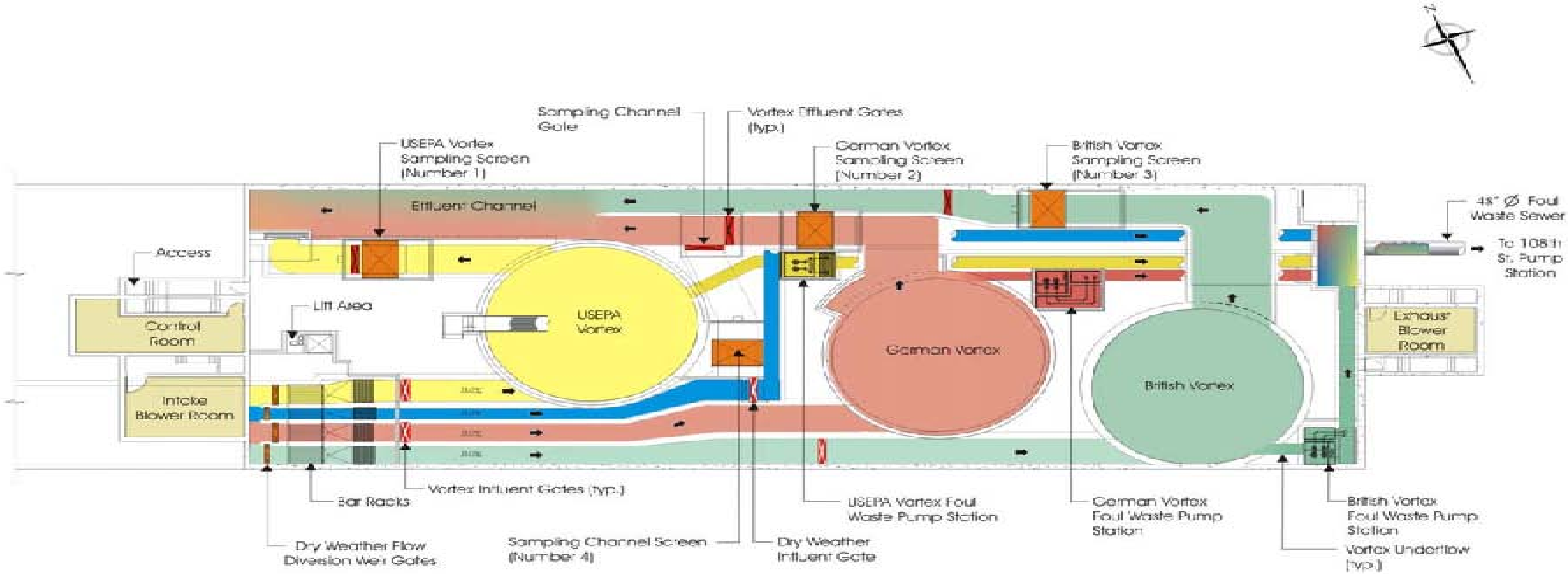
equipment, elevated local switches and panels, and electrical components located in a separate, isolated control room.

Vortex separation technology uses the inherent energy within the flow-stream and induced by the specific geometry of the device to remove floatables and settleable solids from influent CSO. The vortex units have no moving parts, and rely on the inertial forces induced by the flow-path to remove a concentrated stream of pollutants from the CSO stream. During CSO events, flows into the CAVF are routed tangentially into each vortex unit. The vortex devices differ from sedimentation tanks in that they are designed to use the differences in inertia between the particles and the liquid as well as gravitational forces to effect solid-liquid separation at high flow rates.

Flows enter the vortex units through large inlet pipes, and exit each vortex device via a route at the base of the unit, and a route at the surface of the unit. Solids, including settleable solids, tend to concentrate inward towards the center, exiting at the base of the units as an underflow stream. The CAVF was designed to transfer the underflow from the CAVF to a gravity sewer, the Foul Waste Sewer, which discharges to the wet well of the 108th Street Pumping Station. The underflow is transported to the Foul Waste Pit through a combination of gravity flow and pumping. Gravity can deliver the underflow to the Foul Waste Sewer when the vortex units are running. When flow to the vortex units subsides after a rain event the units will partially drain by gravity after which foul waste pumps are activated to fully drain the units.

From the foul waste effluent chamber, the combined underflow of the three vortex units flows by gravity to the 108th Street Pumping Station. From the 108th Street Pumping Station, the underflow is pumped to the collection system of the Bowery Bay WPCP, and is conveyed to the WPCP for final treatment. As the underflow mixes with the combined sewage in the interceptor a portion of it is released in CSO’s through inline regulators. The operators can also choose to retain the underflow in the CAVF units and not discharge it to the Foul Waste Sewer. Because of the potential loss of underflow through CSO’s the operators currently retain the underflow in the units and discharge it to the Foul Waste Sewer after wet weather flows and the hydraulic gradeline in the interceptor subside.



CORONA AVENUE VORTEX FACILITY SCHEMATIC PLAN

CORONA AVENUE VORTEX FACILITY
WET WEATHER OPERATING PLAN

FIGURE 1-2

As a demonstration facility, the CAVF was constructed with features and equipment to facilitate the collection of data for the evaluation of floatables and pollutant capture efficiencies. A sampling and monitoring program of the CAVF was performed from December 6, 1999 to October 3, 2002. The results of the program are presented in a September 29, 2003 report entitled Evaluation of Corona Avenue Vortex Facility.

1.1.1 Drainage Area and Collection System

The combined collection system drainage area of Outfall BB-006 consists of approximately 3,730 acres serving the southeastern portion of the Bowery Bay WPCP service area. Outfall BB-006 receives flow from two subsystems: the upper deck drainage area which originates at Regulator BBR10, and the lower deck drainage area which originates from Regulator BB-R11.

The discharges from both decks combine at a transition chamber downstream of the CAVF, and discharge to Flushing Bay through a four-barrel 10'-6" W x 9' -0" H (inner dimensions) sewer. The lower deck drainage area is 1,528 acres, and contributes approximately 67 percent of the combined sewage that overflows to Flushing Bay through Outfall BB-006.

Prior to the construction of the CAVF, the collection system of the BB-006 drainage area was regulated by 15 regulators as follows:

Upper Deck - Regulator BB-R10 (Upper Deck)

Lower Deck -Regulators BB-R11, BB-R12, BB-R16, BB-R17, BB-R18, BB-R19, BB-R20, BB-R21, BB-R22, BB-R23E, BB-R22W, BB-R24, BB-R25, and BB-R26

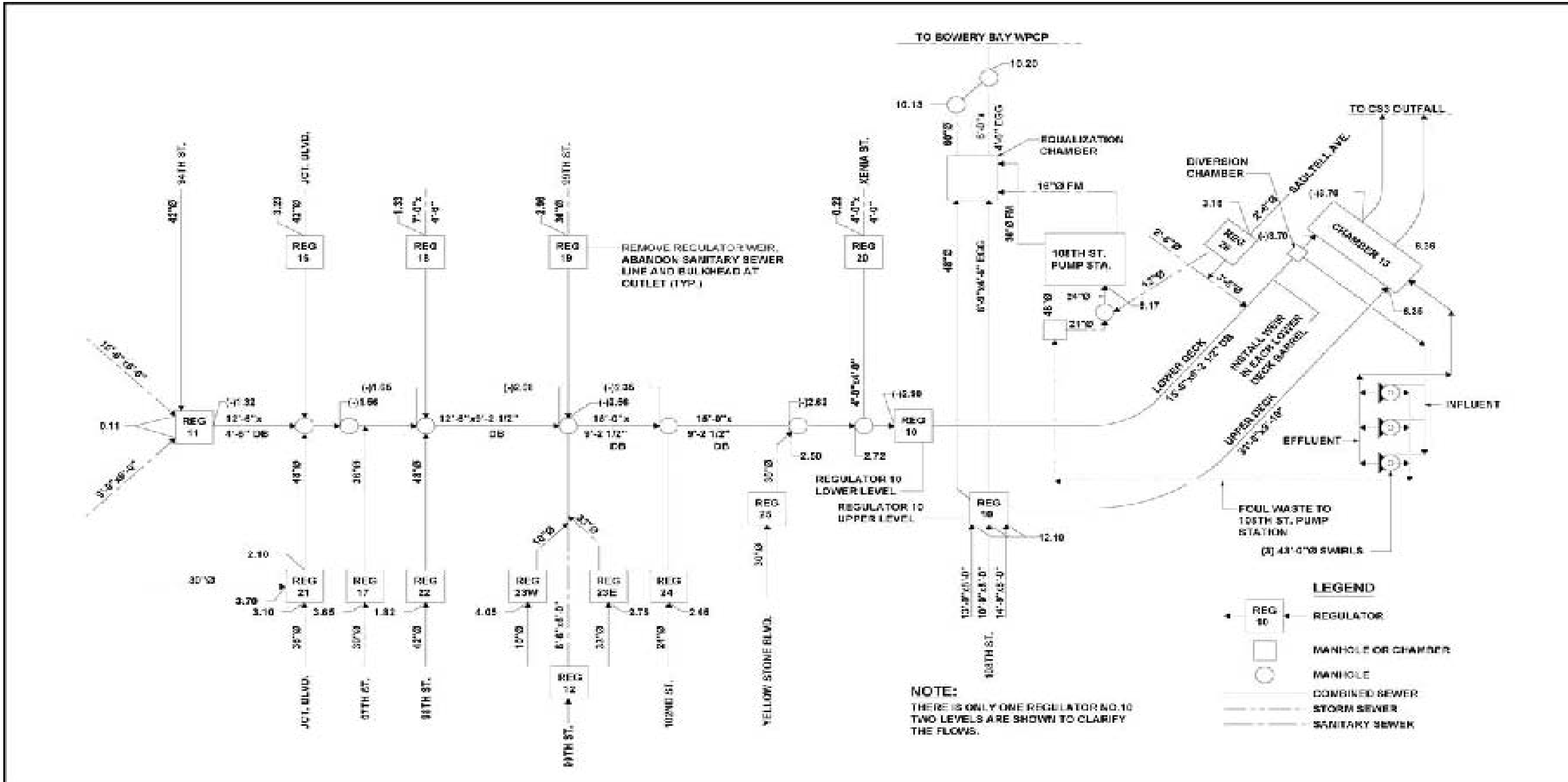
The construction of the CAVF changed the collection system such that the CAVF serves as the CSO regulator for the lower deck sewers. Modifications of the collection system have been made such that dry weather as well as combined flows only from the regulator BBHL-11 is coming to 108 ST. pump station and the thirteen lower deck regulators are now directed to the existing lower deck overflow sewer to the existing lower deck overflow sewer. The diversion weirs in these thirteen regulators have been removed, and the dry weather outlets have been permanently bulkheaded. A schematic diagram of the collection system of the BB-006 drainage area after the construction of the CAVF, the existing CSO system, is shown in Figure 1-3. Figure 1-4 shows the drainage area of the CAVF overlaid on an aerial photograph; the location of the Outfall BB-006 is also shown.

1.1.2 Facility Capacity

A wet weather bypass weir is located within the CAVF Diversion Structure and limits the maximum CSO flow to the CAVF to approximately 400 mgd. Flows that exceed this capacity pass through a baffle, spill over the wet weather bypass weir, and discharge to Flushing Bay through Outfall BB-006. The maximum hydraulic capacity of the BB-006 lower deck combined sewer outfall conduit is approximately 650 mgd.

During wet weather flows within the capacity of the CAVF enter the facility through the influent channel, and as the water surface elevation rises, the one, two or all three vortex units begin operating automatically, each one coming on line at preset water surface elevations. The diverted flow passes through the vortex units, and floatables and settleable solids are captured. Overflows from the vortex units are returned to the BB-006 lower deck sewer, downstream of the wet weather bypass weir, for discharge into Flushing Bay through Outfall BB-006. The underflow, which contains floatables and settleables from each vortex unit, is pumped to the Foul Waste Effluent Chamber, after the event (during dry weather) where it then flows by gravity to the 108th Street Pumping Station. This additional wet weather flow being conveyed to the 108th Street Pumping Station is within the overall capacity of the station.

Presently, dry weather flow, up to an average of about 10 mgd, also enters the CAVF. This flow bypasses the vortex units and is discharged to the Foul Waste Chamber then to the 108th Street Pumping Station.



DEP	CORONA AVENUE VORTEX FACILITY - SCHEMATIC OF EXISTING CSO SYSTEM	FIGURE 1-3
	CORONA AVENUE VORTEX FACILITY WET WEATHER OPERATING PLAN	URS

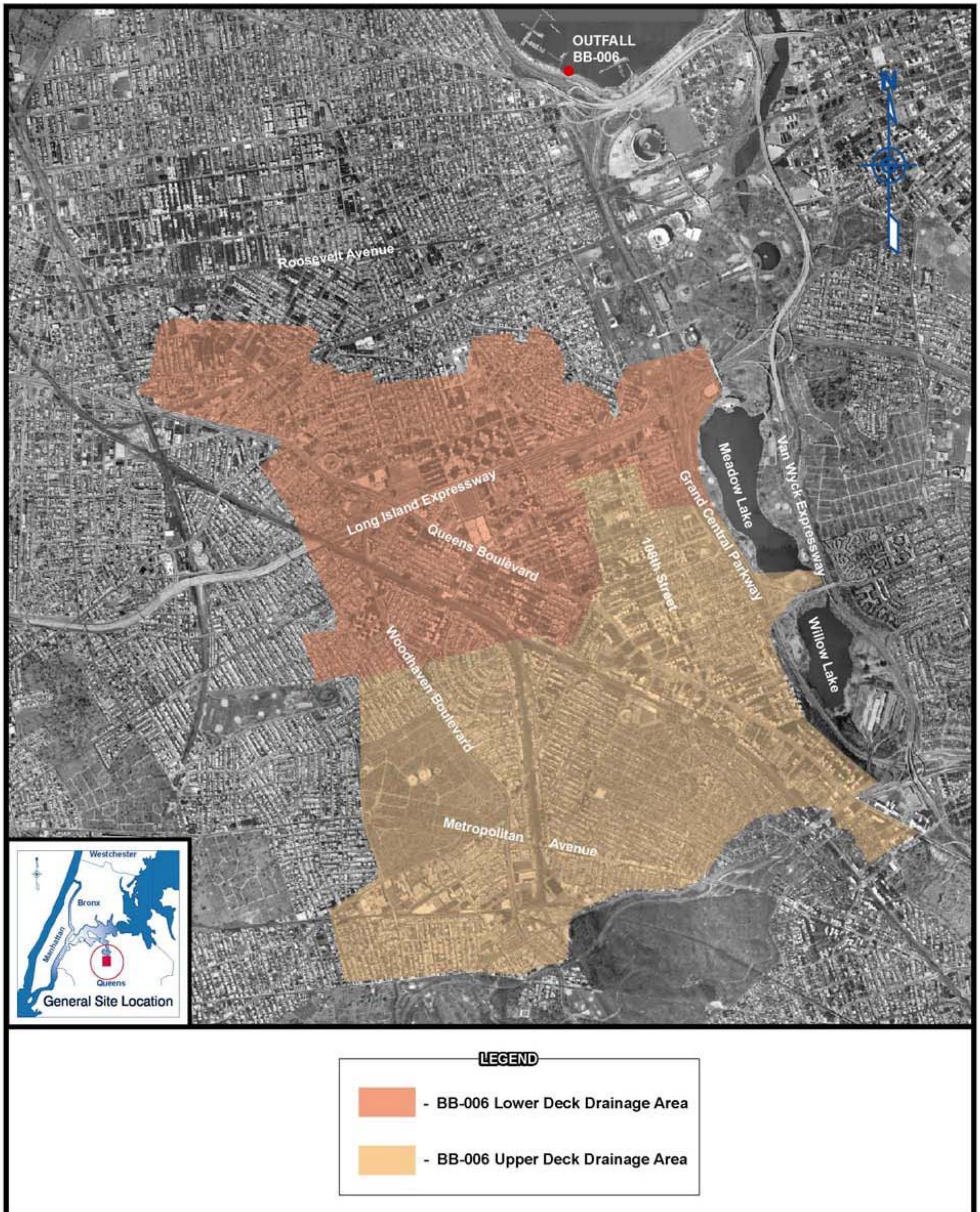


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FIGURE 1-4
Wet Weather Operating Plan

OUTFALL BB-006 DRAINAGE AREA

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1.1.3 CSO Outfall Characteristics

Prior to construction of the CAVF, CSO from the lower deck system of the BB-006 sewers upstream of the CAVF was discharged into Flushing Bay through Outfall BB-006. Outfall BB-006 is equipped with timber tide gates.

Construction of the CAVF has not significantly altered the way in which combined sewage overflows to Flushing Bay through Outfall BB-006. However, there are two notable differences, as follows:

Prior to discharging to Flushing Bay through Outfall BB-006, combined sewage, up to approximately 400 mgd, is routed through the CAVF, where floatables and settleable solids removal takes place.

During storms in which the vortex units overflow, a portion of settleable solids and floatables are removed and retained in the units. The effluent is discharged to Outfall BB-006. . The foul waste pumps pump the underflow from each vortex unit to the Foul Waste Effluent Chamber after the storm event. The underflow then flows by gravity from the Foul Waste Effluent Chamber through the 48-inch Foul Waste Sewer to the 108th Street Pumping Station.

1.1.4 Floatables and Settleable Solids Removal

In a typical vortex facility design, the foul waste line discharges by gravity to a sewer. The underflow, or foul waste, is equal to up to 10 percent of the vortex influent flow, and includes solids and floatables removed in the vortex unit. However, since the invert elevations of the CAVF vortex units are approximately 10 to 20 feet lower than the invert of the elevation of the 48-inch diameter line that discharges to the 108th Street Pumping Station, the vortex units cannot be completely drained by gravity.

Each vortex unit is equipped with its own foul waste chamber that collects the underflow. Each of the foul waste chambers is furnished with two foul waste pumps (1 main, 1 standby) to pump the underflow to a common foul waste effluent chamber that is part of the CAVF.

The foul waste pumps are rated at 10 hp submersible pumps and have vertical, semi-open chopper impellers and cutter bars, and bottom inlet and side discharges. Their rated capacities are:

USEPA Vortex - 575 gpm @ 28 ft TDH
Storm King Vortex (British) - 500 gpm @ 30.8 ft TDH
FluiSep Vortex (German) - 475 gpm @ 31.5 TDH

The foul waste pumps are activated manually after a wet weather event. The pumps discharge the underflow to the Foul Waste Chambers which transports the underflow to the 108th Street Pumping Station. In order to prevent solids from settling out in the foul waste chambers, the chambers are equipped with liquid mixing eductors that utilize City water as the operating liquid. Flow to the eductors is controlled by solenoid valves that are activated when the foul waste pumps are activated.

1.1.5 Combined Sewage Diversion to the CAVF

The CAVF Diversion Structure is located in the intersection of Saultell Avenue and Corona Avenue. It consists of the diversion chamber, located within the previously existing 15'-0" x 9'-22" Double Barrel Lower Deck CSO line to Outfall BB-006, and the influent and effluent channels to the vortex facility. The Diversion Structure diverts dry weather flow in the CS3 Lower Deck combined sewer to the CAVF. During wet weather, the Diversion Structure also diverts combined sewage to the vortex units. The maximum hydraulic capacity of the CS3 Lower Deck combined sewer and the CSO outfall line is approximately 650 mgd. The diversion structure is designed to limit the maximum flow rate to the CAVF to approximately 400 mgd.

Combined sewage is diverted to the CAVF by a 6'-2½" high wet weather bypass weir located within the lower deck of the BB-006 sewer, at the influent chamber (Diversion Structure) to the CAVF.

This weir directs CSO into the CAVF, up to a capacity of approximately 400 mgd. Flows in excess of this capacity pass through a baffle, overflow the weir, and discharge to Flushing Bay through Outfall BB-006.

1.1.6 Wet Weather Flow Control

The CAVF is provided with four manually operated dry weather flow diversion slide gates (SG-9, SG-10, SG-11, SG-12). These slide gates are installed in the influent channels, upstream of manually cleaned bar racks. Their purpose is to direct the dry weather flow to the dry weather flow/sampling channel, thereby preventing it from entering any of the vortex units. Under normal conditions, when it is desired to direct dry weather flow to a vortex unit, then the corresponding slide gate may be raised and the direct dry weather flow/sample channel slide gate (SG-12) lowered.

The CAVF is equipped with twelve sluice gates, nine motor operated and three manually operated. A total of six gates (SG-1 through SG-6) are provided in the influent and effluent channels of the vortex units. These gates are used to control or isolate the flow of combined sewage to each vortex unit. Two gates (SG-7, SG-8) are provided in the sampling channel: one for effluent, and one for the dry weather flow bypass. Three gates (SG-13 through SG-15), one for each vortex unit foul waste pump chamber, are provided. One gate (SG-16) is provided for the emergency floor drain to the 48inch diameter foul waste sewer. An additional gate (SG-17) is provided at the 108th Street Pumping Station for the 48-inch diameter foul waste sewer influent to the pumping station. Under typical operating conditions, the sluice gates are in the open position. In its current configuration, the CAVF cannot be isolated from flow. However, the CAVF was designed to operate passively, withstand flooding from extreme conditions, and is provided with water submersible equipment, elevated local switches and panels, and electrical components located in a separate, isolated control room.

1.2 Performance Goals for Wet-Weather Events

The CAVF is intended primarily as a floatables removal demonstration facility, and as a CSO regulator. However, the facility will also remove a portion of the floatables and settleable solids that would otherwise be discharged into Flushing Bay through Outfall BB-006.

Settleable solids are defined as those heavier solids associated with street runoff and having a specific gravity of 2.65 at a particle size of 0.4 to 1.0 mm. Particles that have lower specific gravity but are proportionately larger in size will also be removed. During overflow events, the performance of the units as a solid separator is expected to decrease as storms progress. This occurs because solids separation operations are more efficient at high solids concentrations, and solids concentrations during overflow events are likely to be relatively low after the initial period of a rainstorm.

1.3 Purpose of this Manual

The purpose of this manual is to provide a set of operating guidelines to assist NYCDEP staff in making operational decisions which will best meet the performance goals stated in Section 1.2 and the requirements of the New York SPDES discharge permit.

1.4 Using the Manual

This manual is designed to allow use as a general reference during wet weather events, and is meant to supplement the facility operation and maintenance manual with which operating personnel should be familiar. This manual is broken down into sections that cover operation of the CAVF. The following information is included:

- Steps to take before, during and after a wet weather event;
- Discussion of why the recommended control steps are performed;
- Identification of specific circumstances that trigger the recommended changes; and
- Identification of things that can go wrong with the equipment.

This WWOP is a living document, and is subject to modification. Users of the WWOP are encouraged to identify new steps, procedures, and recommendations to further improve the wet-weather operating efficiency of the CAVF. Modifications, which improve upon the manual=s procedures, are encouraged. With continued input from experienced operations staff, this WWOP will become a more useful and effective tool.

2. FACILITY OPERATION

This section presents wet weather operating procedures followed for the CAVF. This section is divided into operation of the facility during dry weather, operation during rising level event (onset of wet weather), and during falling level event (end of wet weather with receding water levels). The operating procedures address the basis for the protocol, events or observations that trigger the protocol, and a discussion of what can go wrong.

2.1 Operation of the CAVF During Dry Weather Conditions

During dry weather conditions (no storm flow) the flow in the BB-006 sewer is diverted from the BB-006 sewer through the Diversion Structure by the 6'-22" high wet weather bypass weir located within the lower deck of the BB-006 sewer, at the influent chamber to the CAVF. This weir directs CSO into the CAVF, up to a capacity of approximately 400 mgd during wet weather. Flows in excess of this capacity pass through a baffle, overflow the weir, and discharge to Flushing Bay through Outfall BB-006.

Why Do We Do This?

To direct dry-weather flow to the 108th Street Pumping Station rather than the CAVF.

What Triggers the Change?

During dry weather conditions, level in the Dry Weather Diversion Chamber is less than El. (-) 1.50, therefore level transmitters do not send signal to trigger the computer control system.

What Can Go Wrong?

- The dry weather diversion weir has been designed to passively control flow to the vortex facility. Therefore, operational problems are not anticipated.

- During dry weather conditions, make sure that the dry weather diversion slide gates are closed. Sluice gate 7 should be shut; sluice gate 8 should be open.

- During dry weather conditions, make sure that the sluice gate at the 108th Street Pumping Station is in the open position.

2.2 Operation of the CAVF During Wet Weather Events

Routing of flow through the facility is managed by sewage elevations. Tanks in service will fill and convey flow as sewage levels rise.

Why Do We Do This?
To allow the tanks to receive flow and remove some floatables and solids from the CSO stream.

What Triggers The Change?
Rising water surface levels in the Dry Weather Diversion Chamber and in the CAVF trigger the change.

What Can Go Wrong?
Excessive flows and high tides will result in flooding of the facility, which takes personnel and time to clean and can create odors.

2.3 Operation of the CAVF After Wet Weather Event

After a wet weather event, Collection Facilities crew use the underflow pumps to pump out the tanks and remove captured solids and floatables. This flow goes to the 108 St. pumping station for transfer to Bowery Bay for treatment.

Why Do We Do This?
To remove solids and floatables captured during the wet weather event and prevent odors.

What Triggers The Change?

The end of the wet weather event and the available capacity in the interceptor to Bowey Bay.

What Can Go Wrong?

If sewage is left in Vortex tanks for an extended period of time, odors can be encountered.

APPENDIX C

STAKEHOLDER MEETING MINUTES

Flushing Bay and Creek Stakeholder Team
Meeting No. 1
April 5, 2006

The first Flushing Bay and Creek Stakeholder team meeting of the Long Term Control Plan (LTCP) of the NYC Department of Environmental Protection was held on April 5, 2006, at 6:30 p.m. at the Olmsted Center in Queens. The purpose of the meeting was to introduce the Long-Term Control Plan project and discuss the implications for Flushing Bay and Creek.

Stephen Whitehouse, a subconsultant facilitating the project's public participation, opened the meeting. He described the consultant team performing the project—a joint venture of Greeley and Hansen, O'Brien and Gere, and Hazen & Sawyer with supporting subconsultants—and then introductions were made around the room. Stakeholders ranged from longtime residents of the area to engineers to community and environmental advocates.

Stephen explained that the purpose of the LTCP project is to improve the quality of the city's open waters and tributaries by developing a long-term plan to invest in infrastructure that will reduce the number and volume of combined sewer overflow (CSO) events. He reviewed the definition and location of CSOs in New York City and noted that the City's sewer and wastewater infrastructure is funded by city ratepayers. Stephen gave an overview of water quality legislation and the City's regulatory history leading to the 2004 Consent Order with NY State Department of Conservation that, among other requirements, defined the scope of the LTCP. He explained that, through the LTCP project, waterbodies would be monitored and modeled; the public would be consulted through this stakeholder team process; and alternative facility, maintenance, and operations plans would be developed and evaluated in terms of costs and performance. He noted that both the 1992 and 2004 consent orders required tank construction and floatables controls; the 2004 consent order also includes specific wet weather capacity upgrades, sewer system improvements, and ongoing monitoring of compliance.

Philip Hwang, of O'Brien and Gere, introduced the water quality issues of Flushing Bay and Creek, which is classified by New York State as a Class 1 waterbody, which means that its waters should support fishing and secondary contact. The primary water quality issues in the study area include nuisance odor generation, floatables, coliform, and low dissolved oxygen. The project area is served by two treatment facilities, at Tallman's Island and Bowery Bay. Philip discussed the recent and current water quality improvement projects including: Corona Ave Vortex Facility, Flushing Bay Storage Tank, College Point sewer separation, participation in COE "Flushing Bay Restoration Project", and Floatables Containment, including catch basin hooding affecting all outfalls.
An extensive water quality survey was performed in the summer of 2000; it assessed Flushing Bay and Creek's hydrodynamics, dissolved oxygen levels, temperature, nitrogen, photosynthesis/respiration, and hydrogen sulfide, among other data. Philip pointed out that waterbodies are classified and planned for holistically, by the quality of the water body as a whole rather than by the water quality at any one point (including at any particular CSO discharge point).

Philip noted that the Flushing Bay and Creek Waterbody/Watershed plan has a June 2007 target date for submission to NYSDEC.

Flushing Bay and Creek Stakeholders' Concerns :

> Odors are a problem in Flushing Bay and Creek. Is this unique to this study area? Steve replied that odor problems exist throughout the city in places with sediments exposed at low tide, such as areas in Newtown Creek and the Gowanus Canal.

> Many were concerned about dredging and the area between the World's Fair Marina and LaGuardia Airport. The depth of the waterbody is reduced due to siltation, which limits barge activity in the Creek. Many noted the Army Corps of Engineers (ACOE) has been studying dredging the Bay for environmental enhancement. Christopher Villari of NYCDEP noted that by the terms of their current authorization the ACOE cannot dredge while there are CSO events continuing to deposit sediments. Discussion of this complex issue dominated the meeting.

> Is modeling taking into account different dredging alternatives? For instance, how would dredging affect the flow of the waterbody? Phil said this will be modeled. He noted that although alternatives suggested by public input will be modeled, they would be evaluated in terms of costs as well as public input.

> A stakeholder requested a list of the alternatives being modeled. Steve explained that alternatives have not yet been developed, but are expected by the third stakeholder team meeting.

> A stakeholder suggested that the water quality modeling be a community effort, both in terms of generating alternatives and the actual running of the model, to help eliminate any scheduling bottlenecks. Philip explained that this bottleneck is due to the number of model operators rather than the number of computers available.

Administration

The next meeting will occur in approximately eight weeks, with a tentative date of Tuesday, June 6. The Flushing Bay and Creek stakeholder team will meet approximately four times over the next six months. The next meeting will include a physical description of how the sewers infrastructure works in terms of flows and water quality. The third meeting will include a discussion of emerging alternatives. Meetings will be scheduled as far in advance as possible.

Meeting notes will be made available through the study area web site. Stakeholders are encouraged to visit the password-protected site to download background material on the LTCP in the meantime.

The meeting adjourned at 8:45 p.m.

Flushing Bay and Creek Stakeholder Team
Meeting No. 2
June 6th, 2006

The second Flushing Bay and Creek Stakeholder Team meeting of the Long Term Control Plan (LTCP) of the NYC Department of Environmental Projection was held on June 6, 2006 at 6:30 p.m. at the Olmsted Center in Flushing Meadows Park. The purpose of the meeting was to discuss the baseline conditions of the waterbody.

John Leonforte, of DEP, opened the meeting by welcoming everybody. Stephen Whitehouse of Starr Whitehouse, a subconsultant facilitating the project's public participation, directed everyone's attention to the meeting minutes and asked if there were any changes. There were none.

Philip Hwang, a project consultant at O'Brian and Gere, began reviewing the 14 EPA best management practices which inform the LTCP project. One stakeholder asked for a clarification on the EPA guidelines for combined sewer system replacement which stipulates a preference for separate sanitary and storm sewers when combined sewers are replaced. He expressed concern that the first flush of stormwater, if untreated, would have a significant, negative impact on water quality.

Another participant spoke about DEP's system for reporting CSOs and other water system incidents. He wondered if the department had case-by-case records and suggested that open records would promote public involvement.

Philip Hwang gave a review of Flushing water quality projects. He spoke about the operation and capacity of the Flushing Creek CSO tank, which will be completed in November 2006. The tank will hold 43 million gallons of combined sewage during rain events and afterwards will pump the volume to the Tallman Island plant for treatment. It will allow for 100% capture for 90% of rainstorms in NYC for average year. The facility will be housed beneath the new DPR facility and restored athletic fields.

One stakeholder asked about the periodic CSO events, which will occur when the tank's capacity is exceeded. Philip specified that the CSO materials will be screened and there will be a series of baffles before discharge. The participant wondered why previous plans for disinfection by chlorination were not carried forward. Philip answered that DEP felt that the risks involved with the present technology for chlorination of storm flows were too great; the facility retains space for future disinfection equipment.

Philip went on to discuss the Corona Avenue Vortex facility, a pilot facility with vortex technology. After 10 years of performance testing, the technology appears to have limited effectiveness. He also discussed the Interim Floatable Containment Program currently in effect, which, on the Flushing Bay Watershed, consists of 3 booms and 1 net. An stakeholder asked for clarification on the difference between booms and nets. Philip explained that a net is an actual structure while a boom is a three foot skirt, otherwise open. Stephane Gibbons of DEP confirmed that booms effectively collect floatables and that there are regularly scheduled collections as well as special collections after rainfalls.

Philip then described the watershed model, which requires baseline conditions for the overflow volumes into Flushing Bay and Creek. The model is based on 1988 precipitation data, chosen as a representative year, and calibrated to 1989, 2002, and 2004 events. With this model, the project managers will be able to evaluate the effectiveness of various CSO controls. The drainage area of Flushing Bay and Creek is served by two sewer systems, Bowery Bay and Tallman Island. There are two distinct watershed models for these two sewer systems, and they include only major sewers and structures such as regulators, pumping stations, and treatment plants.

A participant asked for clarification on the use of 1988 climate data in the models. It was explained that 1988 was a year where the data was representative of a larger period of time. While some of the input data is from 1988, the model reflects up-to-date conditions and was created recently.

Philip also explained the water quality models under development, which will predict the water quality in Flushing Bay and Creek for compliance with dissolved oxygen and pathogen standards. The waterbody model combines two models, the East River Tributary Model (ERTM), which is a fine resolution model of smaller CSO-impacted waterbodies of New York City's East River, and the System Wide Eutrophication Model, (SWEM), which is a coarse resolution model that encompasses a larger area that ERTM, and that simulates the boundary conditions for ERTM. The models also make use of data stations, which are sampled periodically. When asked, Philip noted that they are not sampled in real time.

Data was displayed along linear transects, for June through August, the months when the DO levels are lowest. Simulations for June exhibited relatively high levels of DO, above 4mg/L at least 90% of the time, with the exception of the mouth of Flushing Creek. Simulations in July are worse than June, particularly in Flushing Bay. Conditions in August resemble those in June. The simulations showed no fecal and coliform violations during bathing season. Stephen specified that these are EPA standards for primary contact recreation, and not Health Department standards for public bathing.

Philip also addressed the issue of odors in the Inner Bay, the result of CSO discharges. He showed a map of the concentrations of Clostridium perfringens, a bacterium associated with sewage pollution. A member of the public asked whether concentration of bacteria alone accounted for odor. Philip specified that low and high tide conditions as well as air and water temperature levels contributed to odor.

A stakeholder asked whether tidal water flows would help to move unwanted sediment away from the shoreline if they moved at higher velocity. If the sediment was in deeper water, he speculated, the concentration would be lower. He suggested that removing the submerged breakwater near to LaGuardia or contouring the bottom would ease the flow of sediment. DEP representatives responded that a more cost effective approach to improving the water is by decreasing CSO events. Philip added that it is unlikely that contouring would help the problem.

Philip discussed the purpose of LTCP planning: to abate odors, reduce floatables, and comply with DO standards. He briefly went over types of alternatives for accomplishing these goals. A member of the public inquired as to whether any alternatives had been considered and ruled out in Flushing. Philip said that the list was comprehensive. Stephen mentioned methods of detention of storm water that can be carried out by property owners, which are incremental and operates on a different scale of implementation, was not included.

One stakeholder asked another question about how the displacement of water functioned in Gowanus Canal and if that was a model that the Flushing Bay project could emulate. Stephen explained that water is actually pumped into the near end of the Gowanus Canal, which has large benefits for DO levels and marginal ability to reduce sediment.

Lastly, the group discussed how to increase attendance at the meetings. Several members of the public volunteered to contact members of their community who may be interested in participating in the LTCP project.

Administration:
The next meeting will be in six to seven weeks, on July 27th or August 1st. The model results will be available then and the meeting will focus on the evaluation of different alternatives and their effects. After this meeting, and perhaps a fourth, the waterbody/watershed plan will be completed for submission to NYC DEC, as a part of the State review process towards the creation of the LTCP. The State will conduct a public hearing on the plan.

Meeting notes will be drafted and circulated via email. They will also be posted on the study area website.

Long Term Control Plan
Flushing Bay and Creek Stakeholder Team
Meeting No. 3
August 1st, 2006

The third Flushing Bay and Creek Stakeholder Team meeting for the Long Term Control Plan (LTCP) of the NYC Department of Environmental Projection was held on August 1, 2006 at 6:30 p.m. at the Olmsted Center in Flushing Meadows Corona Park. The purpose of the meeting was to review alternatives for CSO abatement in Flushing Bay and Creek before they are evaluated. Mark Klein, of DEP, opened the meeting. Stephen Whitehouse of Starr Whitehouse reviewed the background of the Long Term Control Plan.

After discussing baseline conditions, Philip Hwang, of O'Brien and Gere, went over the comprehensive list of alternatives. The first set of alternatives fall under the category of source control and include: preventing pollutants from entering sewers, street sweeping, catch basin cleaning, industrial pre-treatment, and public education. Philip said that many of these were already implemented. A stakeholder asked whether public education programs were underway; he views litter in storm sewers as a continuing problem. Mark replied that educational programs are ongoing. Another stakeholder suggested stenciling storm sewers, which he has observed in other cities, to deter residents from disposing of waste in storm sewers. Mark said that an interagency group is considering this measure.

The second group of alternatives falls under the category of inflow control, or reducing storm water, including Best Management Practices (BMP) such as green roofs, plantings, rain barrels, and permeable pavements. Philip said that in order to achieve a large scale of CSO abatement, wide-scale application is necessary. Mark added that many of these alternatives are outside of DEP's jurisdiction as they fall into the portfolio of other Agencies, such as City Planning and the Department of Buildings. Also, they would be implemented on private property, outside the purview of DEP. One stakeholder expressed frustration that these alternatives are not being considered for Flushing Bay and Creek. Stephen said that DEP is hoping to learn more about the quantifiable effects of BMP. Until then, an enforceable plan, such as the LTCP, cannot be based on alternatives of uncertain results. A stakeholder suggested that BMP implementation in other cities, such as Seattle, could be used as precedents. Stephen stressed that DEP is exploring BMP through other projects, such as the Jamaica Bay Watershed Protection Plan.

Philip reviewed other categories of alternatives: sewer system optimization; sewer separation both partial and complete, which would both require massive refitting; storage, including tanks, large pipelines, and storage tunnel; treatment; receiving water improvements; and solids and floatable control.

Philip spoke about the alternatives under consideration for Flushing Bay.

- Construction of an 8 foot relief sewer to relieve capacity issues along 17,000 foot stretch of the High Level Interceptor (HLI). A stakeholder asked whether that would alleviate the problem of back flow in residential basements. Mark said that backup more likely stems from local collection issues and that residents should contact the local Community Board's District Service Cabinet.
- Diversion of the HLI to the East River, which is less polluted than Flushing Bay.
- Implementation of bendable weirs, which retain flow in the sewers and limits outflows. Philip located the proposed sites for the weirs.
- Implementation of treatment at the largest outfalls, using coagulates to settle solids and facilitate retention.
- Installation of inflatable dams which are used to keep sewage in pipes
- Construction of outfall storage at the largest outfalls

Philip went over the impact that each of these would have on the baseline conditions of the waterbody. He said that the improvements conveyed by the existing facility plan, the 28MG Flushing Creek CSO retention tank, are already included. The construction of the relief pipes, the bending weirs, and inflatable dams at the two largest outfalls provide the greatest benefit.

Philip also described the alternatives being considered for Flushing Creek:

- Construction of the Flushing Creek CSO Retention Facility, currently underway, with a total of 43 MG of storage. Philip noted that approximately a third of the tank influent originated as stormwater. A stakeholder asked why the separate sewer systems in the drainage area were not treated separately. Philip said that it has been examined and discarded.
- Enhancement of the Tallman Island Conveyance System.
- Separation of Storm Sewers in the Kissena Corridor to reduce CSO volume at the Flushing Creek Tank
- Rerouting of overflow at TI-022 which is a high frequency, though low volume, outfall to the Flushing Creek CSO tank
- Installation of bendable weirs and inflatable dams

Philip went over the impact of each of these improvements on the baseline, both in terms of number of events per year and percent of CSO reduction from the baseline.

Philip said that the team looked at alternatives that would remove increments of up to 100% of CSOs, as prescribed by the LTCP process. In Flushing, the 100% abatement project consists of an underground tunnel. One stakeholder was concerned with the tunnel, describing prior experience with a similar tunnel in Milwaukee which resulted in ground contamination. Philip said that other U.S. cities have avoided that problem by lining the tunnels. Philip explained that the waste would be diverted to a treatment plant within two dry weather days. When asked about capacity in the treatment plants, John Leonforte, of DEP, said that there is currently excess capacity and that the policy is to design a new facility when a plant reaches 50% capacity. A stakeholder urged the team to consider the impact of rising groundwater and suggested that the team looked at the USGS projections for groundwater, which slates it to double over the next 10 years, a result of discontinuation of pumping. Chris Villari, of DEP, said that he would follow up.

Then Philip went over the cost-benefit analysis that the team will be using to select the best alternatives. The team will examine each alternative to weigh the level of improvement in CSO volume and water quality against the project cost. This analysis will be presented at the next meeting.

The stakeholders asked that water quality analysis be carried out with and without the submerged breakwater near Laguardia Airport. Chris suggested that he present the most recent Army Corps of Engineer study of the breakwater at the next meeting. He added that removing the breakwater is not beneficial. One stakeholder asked if there were dissenting studies. Chris responded that all of the studies since the 1990s suggest that the breakwater has no effect on water quality.

A stakeholder asked about the construction schedule for the Flushing Tank. The team responded that the target completion date was November, 2006 but that they would confirm.

The team chose a tentative next meeting date of September 28th.

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Long Term Control Plan
Flushing Bay and Creek Stakeholder Group
Meeting No. 4
March 28th, 2007

The fourth meeting of the Flushing Bay and Creek Stakeholder group for the New York City Department of Environmental Protection's (DEP) Long Term Control Plan (LTCP) for Combined Sewer Overflows (CSOs) was held on March 28th, 2007 at 7:00pm in Training Room S of the Olmsted Center in Flushing Meadows Park. Stephen Whitehouse, Starr Whitehouse, introduced the project team. He gave a brief overview of the Long Term Control Plan and said that DEP was under consent order to deliver draft Waterbody/Watershed Facility (WB/WS) plans to the New York State Department of Environmental Conservation (DEC) for their review by June 2007. He said that the project team was currently on schedule. Stephen explained that the Flushing Bay and Creek Stakeholder group was one of ten waterbody-focused stakeholder groups in the LTCP. He said that Flushing Bay has not been thoroughly examined in other CSO planning efforts and that the project team had needed more time than anticipated to evaluate alternatives for the WB/WS plan, which is the reason for the gap between this and the last meeting. Stephen asked if there were any changes to the notes from the August 1, 2006 meeting. A stakeholder asked that, in the notes, stakeholders be identified by name. Stephen said that a decision was made at the onset of the process to protect the privacy of the stakeholders as it was felt that individuals would speak more freely if they were not identified. There were no other changes to the notes. The notes were finalized.

Next, Chris Villari, DEP, gave a presentation about the breakwater, or finger dike, in Flushing Bay, in response to a stakeholder's request. He said that the analysis he would present on breakwater influence on tidal exchange was from a study previously requested by Helen Marshall, Queens Borough President, to the Army Corps of Engineers. Chris explained the Army Corps's method relies on modeling, simulating the mixing of the Outer Bay, Inner Bay, and Creek. He explained half life analysis, which was used in the model. Half life analysis measures tidal mixing by tracking where and when the concentrations of a tracer, in this case a simulated dye test, have fallen to half of the initial concentration due to dilution. Two scenarios, existing conditions and conditions with the removal of the breakwater, were analyzed. Chris showed a map of the nodes which were used to gather data in the model. He stressed that each point represents multiple layers of nodes up and down the water column. Chris shared the results for one node. In both the existing and breakwater removal scenarios, there was immediate dilution at the boundaries of the waterbody and a dilution effect with the tide. The effect in both scenarios is similar. Then Chris shared maps that showed the time it takes to reach half life concentration across the entire Bay, comparing existing conditions and breakwater removal scenarios. He said that the removal of the breakwater has a larger impact on Flushing Creek than Flushing Bay and that the dike appears to speed up dilution in the creek. A stakeholder noted that the tidal interchange must be limited as the tidal effect is the result of the East River hitting the Bay at a 90 degree angle. Chris agreed. A second stakeholder said that the results do not take into account the velocity by which the CSOs hit the water. Chris said that CSOs slow down once they hit the Bay. He used the metaphor of a belly flop and said that the way the water slows a person jumping into a pool is the same way that the Bay slows down the CSOs. The second stakeholder said that the historical depth has been lost because of CSO sediments. A third stakeholder asked whether the dike creates more sediment. He said that model assumes a certain bathsymetry which does not consider the possibility that the dike may contribute to sediment build-up. Chris said that since CSO is known to be the major sediment source, removing it will significantly impact sediment build-up. The analysis presented did not take into account the impact of the LTCP, which would significantly reduce CSOs. He stressed that, only once the LTCP is implemented and CSOs are reduced will the Army Corps reconsider dredging. He summed up the study: current comparative data suggests little difference between the two scenarios but, dredging could potential change that. However, dredging will not take place until parts of the LTCP are implemented. Chris added that the finger dike is currently considered to be significant wildlife habitat and the DEC will not allow DEP to remove it for that reason. The second stakeholder expressed dissatisfaction with the study. However, he said that he would like to see dredging.

Next, Stephen spoke about how source control, or Low Impact Development, is being integrated into the LTCP. He said that DEP is conducting pilot projects, through the Jamaica Bay Watershed Protection Plan which will allow them to analyze the impact of source control in the specific context of New York City. With a high ratio of impermeable surface, extensive subterranean infrastructure, specific soil and ground water conditions, and rain patterns consisting of intense storms, DEP believes that the New York City context requires significant research before implementing extensive source control methods. Pilots are currently underway. When that data is collected and analyzed, a program will be put together for a more widely implemented source control program. A placeholder for source control in the LTCP document, which is due after the WB/WS plans, will ensure that source control is seriously considered for all waterbodies. A stakeholder expressed frustration that source control would not be integrated into the WB/WS plans and questioned whether stakeholder opinions are valuable for the project team. Stephen said that stakeholder advice is seriously considered. In particular, stakeholders across the project have promoted source control and, because of their interest, DEP and DEC are looking to integrate it into the LTCP. Ed Duggan, consultant to DEC, stated that DEC will be a strong advocate for source control depending on the outcome of the pilots. He said that the WB/WS plans, which the group is currently working towards, will initiate immediate water quality improvement projects. The LTCP will have more ambitious goals, according to DEC. Ed stressed that the implementation of source control will be long term, ongoing, and part of the LTCP.

Then, Philip Hwang of O'Brien and Gere presented a summary of the alternatives that are being evaluated for Flushing Creek and Flushing Bay:

First, he spoke about alternatives for Flushing Creek. He reviewed the existing facility plan. The 28 million gallon (MG) Flushing Creek CSO Retention Facility will go online this spring.

Philip also spoke about Tallman Island Water Pollution Control Plant (WPCP) conveyance enhancements. These enhancements will allow more flow to reach the WPCP. A design contract for this project will start this spring. The projected cost is $40M. The Existing Facility Plan and the conveyance enhancements together will provide 84% CSO reduction from Baseline conditions in Flushing Creek.

Philip reviewed dredging options for Flushing Creek. The approximate area that would be dredged was shown on a map of Flushing Creek. The cost of dredging is estimated at $10.5M. There are two options for dredging on the Creek: to three feet below Mean Lower Low Water (MLLW) to abate odors; or to six feet below MLLW, which would allow for in-stream aeration.

He also spoke about possible in-stream aeration of Flushing Creek. Dredging is a prerequisite to in-stream aeration, to allow sufficient vertical depth for mixing of the oxygen. Philip showed several potential aeration facility locations which meet technical requirements but stressed that the team was not yet engaged in site selection. He said the project is similar to the one in English Kills in Newtown Creek. In-stream aeration would cost around $41.5M.

Secondly, Philip described alternatives to improve water quality in Flushing Bay. Philip showed a map of the potential extent of dredging and said that this project's dredging mandate was limited to removing sediments that are exposed at low tide and caused by CSOs alone. A study of bacteria typically found in CSOs guided the project team's choice of dredging sites. Philip noted that the correlation between dredging sites and large CSO outfalls was expected, given the criteria for dredging.

A stakeholder asked whether dredging would restore the Bay's historic bathymetry. Philip said that dredging would extend to three feet below MLLW with the goal of eliminating odors He added that dredging was limited by DEC's determination of what consists of protected marine habitat sites. Those sites cannot be dredged. Chris added that a DEP dredging program, separate from the LTCP, is currently being formulated and that more extensive dredging would be examined in more detail under that program.

Stephen stressed that the project team was currently engaged in an initial planning process. With every alternative that is chosen, there will be considerable follow-up planning work and public outreach.

Philip described an alternative for an 8' relief sewer for the High Level Interceptor to increase conveyance capacity to the Bowery Bay WPCP. The cost is approximately $245M and it would provide a 10% CSO reduction in Flushing Bay.

Then, Philip spoke about bending weirs, which are metal plates loaded on springs, and are attached to the existing weirs. These bending weirs raise the maximum water level in the interceptor, and thus allow more flow to be contained in the interceptor, rather than being discharged out of an outfall. When the water level in the interceptor gets too high, a spring will allow the weir to bend. The weirs keep more volume in the sewer during storm events and require little in terms of operation and maintenance. Philip showed a map of possible locations for bending weirs. He said that the weirs will reduce baseline CSOs by 18% in the Bay.

Next, Philip described inflatable dams that will allow the sewer pipes to act as storage at Outfalls BB-006 and BB-008. These dams normally stay inflated to retain volume in the outfall pipes. After a storm event, the sewage will be pumped to the treatment plant. When the level of water gets too high, the dam automatically deflates. There are some inflatable dams in the Hunt's Point area of the Bronx.

Philip said that inflatable dams alternative would include other components such as screening, pumping stations, force mains, and netting facilities for outfalls BB-006 and BB-008, two of the largest overflow sites. This alternative would cost approximately $455.7 million and would reduce CSO by 29% in Flushing Bay.

A stakeholder asked whether the team had considered separating the combined sewer system. Philip said that separation was considered, but it did not provide significant water quality benefits and therefore was discarded as an alternative.

Next, Philip reviewed tunnel options to capture flows from BB-006 and BB-008 in Flushing Bay. These tunnels would range from 25 MG to 87 MG in capacity, and from 50% to 85% capture of CSO in Flushing Bay. The tunnels would be about 150 feet deep, and would capture CSO volume during storm event. After the storm, combined sewage in the tunnels would be pumped to Bowery Bay WPCP for treatment. The tunnels for Flushing Bay would form a loop underneath Flushing Bay.

Philip then reviewed Bay and Creek Tunnel Alternatives. He showed a possible tunnel alignment to capture flows from both Flushing Bay and Flushing Creek. These tunnels were sized to permit zero to eleven overflow events per year. Philip said that tunnels were considered as alternatives, as opposed to aboveground tanks, because tunnels can capture more than one outfall, and aboveground tanks require much surface area. A stakeholder expressed concern that storage tunnels are very expensive and perform poorly, citing the example of the storage tunnel constructed in Milwaukee, where groundwater infiltrated into the tunnel, and thus diminished the capacity to store combined sewage. Philip agreed that it building a reliable tunnel is a challenge, but said that if designed and built properly, tunnels are an effective technology for abating CSOs.

Philip said that, at the next meeting, he would present the recommended plan and discuss the cost/benefit analysis that informed the plan. Several stakeholders expressed concern that source control would not be included in the WB/WS plan. It was agreed that, at the next meeting, a representative from DEP working on source control will present that work in more detail. A stakeholder asked whether source control would be paid for from the same source of money as the other projects. Stephen affirmed that it would. Another stakeholder asked why the New York City Department of Parks and Recreation is responsible for water quality in Meadow Lake in Flushing Meadow Park. Stephen said that, as it was their jurisdiction, they were responsible. A stakeholder stated concern that tanks and tunnels would be less efficient than modeled as groundwater would seep into them and decrease their capacity.

A next and last meeting date was set for June 6th. Notes will be available prior to the meeting.

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Long Term Control Plan
Flushing Bay and Creek Stakeholder Group
Meeting No. 5
June 6th, 2007

The fifth meeting of the Flushing Bay and Creek Stakeholder group for the New York City Department of Environmental Protection's (DEP) Long Term Control Plan (LTCP) for Combined Sewer Overflows (CSOs) was held on June 6th, 2007 at 6:30pm in Training Room S of the Olmsted Center in Flushing Meadows Corona Park. Stephen Whitehouse, Starr Whitehouse, began the meeting. Stephen asked if there were any changes to the notes from the March 28, 2007 meeting. A stakeholder asked that the meeting notes reflect the conversation that was had about concerns with groundwater seeping into underground storage facilities. There were no other changes to the notes. The notes were finalized.

Next, John McLaughlin, DEP, presented his work on stormwater capture pilots, also known as Best Management Practices (BMPs) or LIDs (Low Impact Developments). John said that the pilot projects being developed in the Jamaica Bay Watershed Protection Plan will enable DEP to collect data and monitor the impact of BMPs. BMPs are part of a larger comprehensive planning effort in Jamaica Bay, meant to address rapid wetland loss. John listed increased upland and aquatic habitat and increased green space as other benefits of BMPs. John reviewed different pilots: street-side stormwater infiltration, porous pavement, enhanced tree pit openings and constructed urban wetlands. For the latter, DEP is carrying out extensive site analysis, looking at city-owned properties and other land characteristics to determine where to site these pilots. John also spoke about green roofs. He said that an initial analysis shows that green roofs are more effective on large, flat roofs, such as are found in industrial buildings. There are no pilot projects for the Flushing Bay area currently in the Waterbody/Watershed Facility (WB/WS) plan. John said that the data from the pilot program in Jamaica Bay will be extrapolated and incorporated at later stages into the LTCP. John spoke about a number of projects with the Mayor's Office of Sustainability and Long Term Planning's PLANYC, including rain barrel distribution and the use of oysters and ribbed mussels for nitrogen and pathogen uptake. A stakeholder asked which agencies are involved in these efforts. John said that the Mayor's Office is assembling an inter-agency taskforce on BMPs.

Next, Phillip Hwang, O'Brien and Gere, presented the analysis behind the WB/WS plan for Flushing Bay and Creek. He reviewed the alternatives considered by the project team for Flushing Bay, including: bending weirs; inflatable dams; storage tunnels; dredging; floatable controls; eight foot relief pipes; and BMPs and LIDs. Flushing Creek alternatives include: the existing facility plan and conveyance enhancements; BMPs and LIDS; dredging and floatables control; bending weirs; and Kissena Corridor sewer separation. Philip said that the different alternatives are grouped to create different plans and the project team modeled their effect. Then, Philip shared the cost benefit analysis, which weighs projected benefits against probable total project cost. The project team targeted the plan that achieves the maximum benefit per dollar, or the knee of the curve.

The first graph showed the overall CSO volume reduction, where the plan with the 25MG underground storage facilities showed a clear knee of the curve. Philip showed a graph of dissolved oxygen (DO) in Flushing Bay against probable total project costs. Philip noted that there is a dip in percent attainment of DO in the month of July from plan 8, with inflatable dams, to plan 9, with a 25 MG storage tunnel. Philip showed a graph of DO in Flushing Creek, comparing yearly percent of time in attainment with the percent of time attainment in August, the worst month.

Then, Philip presented the recommended WB/WS plan for Flushing Bay, which includes a 25MG tunnel, bending weirs on key regulators, end-of-pipe netting systems at outfalls BB-006 and BB-008, raising of the weir at regulator 2, some dredging, and an assessment of LIDs and BMPs. Philip said that, while inflatable dams are less expensive, they are more difficult to maintain and thus were selected as the recommended plan. With the construction of the tunnel, it is expected that DO will be above 4mg/L 71% of the time in July and otherwise above 4mg/L 94% to100% of the time. There will be significant odor abatement and fecal and total coliform violations will only occur in November. Philip showed a schematic siting of the 25 MG tunnel and said that, since the project team is in a planning phase, they are not yet sure of the location of the pumping facility. A stakeholder asked why BB-007 is not in the collection loop of the tunnel. Philip said that it was a smaller outfall and it was costly to include it for little benefit, but there will be fewer overflows from BB-007 due to the installation of a bending weir. A number of questions were asked about tunnel construction. Philip said that the construction site will be primarily the 100diameter foot shaft necessary to facilitate the tunnel boring equipment. Philip showed a schematic drawing of the end-of-pipe netting facility. A stakeholder asked whether the material will be taken to the landfill when it is cleaned out of the nets. Phil said that it would. A stakeholder asked whether the facility is the same as the one proposed at Alley Creek. Stephen said that they would check (post-meeting note: the netting facility is of a different type than proposed at Alley Creek). Philip explained the purpose of the bending weirs, to keep more flow in the sewer but to retain flexibility so as to be able to collapse in instances of extremely high flow to avoid flooding. He showed the location of bending weirs, and of CSO-related dredging, near outfalls BB-006 and BB-008. He said that dredging would go to mean lower low water, which is a measure used to determine navigability. Many stakeholders expressed concerned that DEP is not looking at a larger dredging program and stated that they would like more dredging. Specifically, they would like to see dredging at College Point, near to the marinas, and at BB-007. Chris Villari, DEP, said that the DEP Citywide Dredging program would evaluate the true volume of material needed to be removed in order to comply with state regulations. He said that the graphic shown was only an estimate of what, at a minimum, would need to be dredged.

Philip presented the recommended WB/WS/ plan for Flushing Creek, including: the Flushing Creek CSO tank, certified in operation on May 31st; Tallman Island Conveyance Enhancements; dredging of Flushing Creek; and assessments of LIDs and BMPS. The facility plan and conveyance enhancements, already construction, should reduce CSO in the Creek by 84%. Philip showed the area to be dredged in Flushing Creek.

Next, Philip reviewed the probable total project costs for the WB/WS plans. The WB/WS plan for Flushing Bay will costs $660M with an addition $21M for dredging. The Flushing Creek WB/WS plan will cost $332M with an additional $27M for dredging; the $332M consists mainly of the cost of the Flushing Tank and has already been spent. A stakeholder asked how the project will be funded. Stephen said that it would be city money, funded from bonds secured by water rates. The current DEP 10-year budget plan has reserved roughly $2B for CSO projects; the new elements of the recommended WB/WS plan are not included in the current 10-year plan. A stakeholder said that, in renegotiating their lease, Port Authority has made available $30M/year over the next 5 years for neighborhood remediation projects. This is a possible source of funding for BMPs.

- A stakeholder raised a concerns with dredging, including the variability in costs depending on subsurface issues and the sometimes lengthy, New York State Department for Environmental Conservation (DEC) permitting process.
- Another stakeholder asked why the project team had selected the Flushing Bay WB/WS plan with the 25MG storage tunnel, even though modeling suggested that it was not as effective as the inflatable dams. Philip explained that maintenance issues drove the choice. The stakeholder said spoke about problems other cities, including Milwaukee, have had keeping groundwater out of tunnels, decreasing their capacity. Philip said that tunnels have been effective in other cities. The stakeholder mentioned that the water table is high in the area. Stephen said that DEP consultants are looking at this issue.
- A stakeholder asked how the project team attributes water pollution sources to CSOs. Philip Hwang, O'Brien and Gere, said that the project team looks for a certain organism in benthic samples, which is associated with fecal matter.
- A stakeholder asked if the tunnel could also serve as access to the airport.

Stephen reviewed next steps. The project team is on track for submitting the Flushing Bay and Creek WB/WS plan to State DEC before June 30th, as required by the CSO consent order. The meeting notes will be drafted and sent to stakeholders, who will have 30 days to return comments through to Starr Whitehouse. Since the comments will be received after the first submittal of the report, the plan will contain the draft meeting notes; the finalized notes will be included in a later version of the plan. Simultaneous to the submittal for DEC, the plans will be made available electronically to the public. When DEP received comments from DEC, they will revise and resubmit the WB/WS Plan based on DEC's comments. Once the report is resubmitted, DEP and DEC will schedule a public meeting. This meeting will also mark the beginning of a formal 60 day public comment period. DEP/DEC will then develop a responsiveness summary to respond to public comments and finally DEC will approve the WB/WS Plan. The submission of the Flushing Bay and Creek LTCP will be 6 months after DEC approval of the Flushing Bay and Creek WB/WS Plan. The Flushing LTCP is expected to provide a more detailed analysis of the type and scope of possible LIDs/BMPs for the Tallman Island and Bowery Bay drainage areas than the WB/WS plan submitted in June. It will provide refinements to the WB/WS Plan and an enforceable schedule for implementation 2017 is the final submittal date for the city-wide LTCPs, the agglomeration of the plans for each waterbody, but individual projects will begin prior to that date. This gap allows for continued work on projects discussed, particularly BMPs. The project team hopes to downsize the CSO storage tunnel, decreasing total project costs, with the success of BMP implementation. Also, it is possible that the Mayor's Office could drive earlier implementation of BMPs in the area.

Appendix D

Biowin Analysis

Bowery Bay Tunnel Pumpback Assumptions
Impact of CSO Pumpback on Nitrogen Discharges

In an effort to quantify the impact on Nitrogen discharges and compliance with interim limits set forth in the BNR Judicial Consent Order, a *BioWin* modeling effort will be conducted investigating the effluent Nitrogen concentrations from the Bowery Bay Water Pollution and Control Plant (WPCP) with the additional CSO load from the Bowery Bay Tunnel.

Approach to *BioWin* Modeling

During normal operation at Bowery Bay, flow enters the aeration tanks split evenly between Passes B, C, and D, with 33% going to each pass. When wet weather events occur, flow over 1.5 times the annual average influent up to 1.5 times the Design Dry Weather Flow (DDWF), can be directed to the head of Pass D. Flow over 1.5 times the DDWF will bypass the secondary treatment system entirely, up to 2.0 times the DDWF. To summarize, the following flow assumptions were used:

- Influent flow to the plant up to 1.5 times the annual average influent is split evenly between Passes B, C, and D
- If the influent flow to the plant exceeds 1.5 times the annual average influent, excess flow up to 1.5 times the DDWF is diverted to Pass D of the Aeration Tanks
- Any influent flow over 1.5 times the DDWF, up to the plant's capacity, bypasses secondary treatment completely

In order to simulate wet weather, daily data from October of 2005 (a stormy month) was used. Three scenarios were modeled to determine the impact of the CSO pumpback on the Bowery Bay WPCP effluent quality:

- Base Case Steady State run of Bowery Bay
- Dynamic run modeling a storm event at Bowery Bay
- Dynamic run including CSO pumpback to Bowery Bay

For each scenario, BNR operation was assumed at Bowery Bay with centrate being treated at Bowery Bay in a dedicated aeration tank and all tanks online. Wastewater characteristics and global parameters were set equal to those used in the 2045 Upper East River Modeling conducted in March through April of 2006 (see Exhibits 1 and 2).

Scenario 1: Base Case

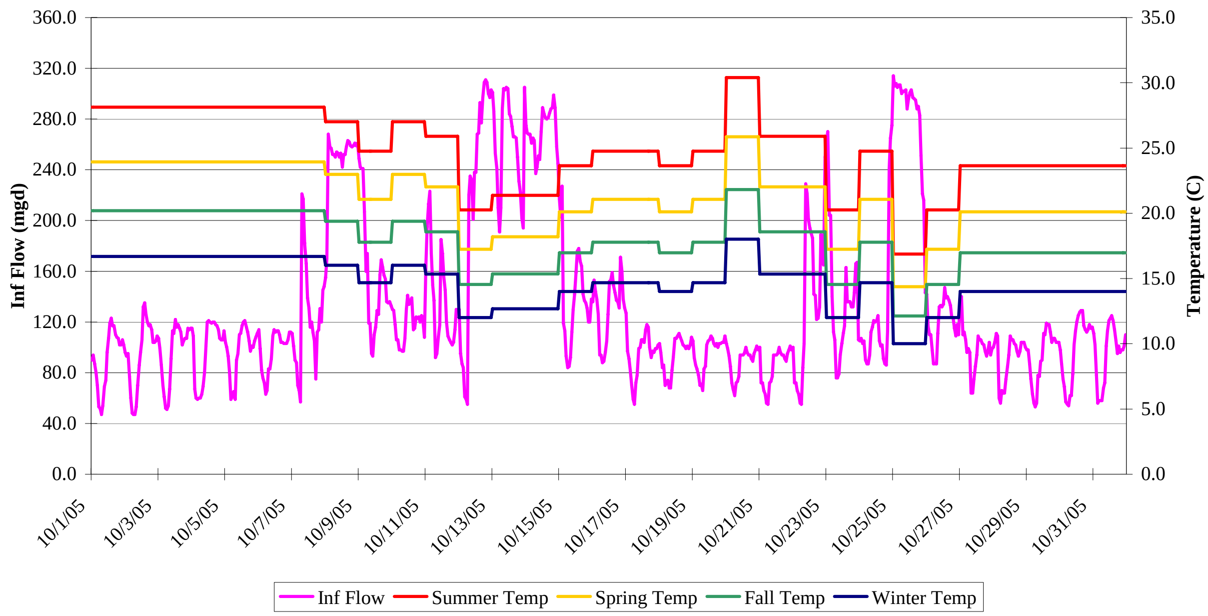
- Steady State run using 2005 daily data (average annual flows and loads)
- 10% increase in flow to account for storms
- Storm flow does not have an associated load
- Four seasons modeled
- Methanol addition to anoxic zones

Scenario 2: Dynamic Run with Storm Events

- Dynamic run using the Bowery Bay October 2005 hourly flow pattern

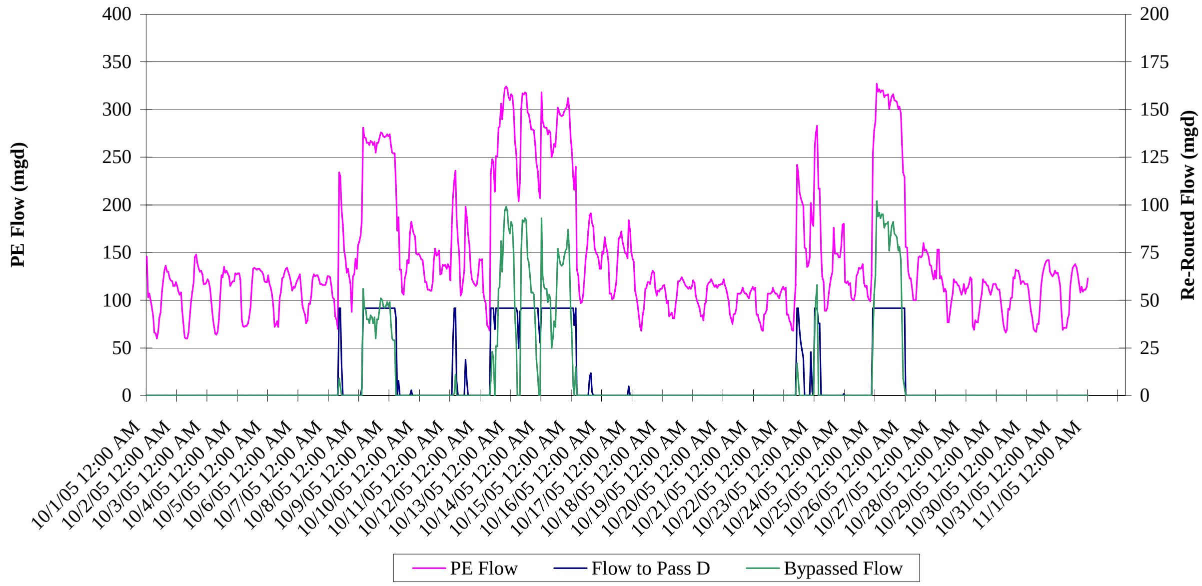
- Primary Effluent loads from the Base Case remain constant, concentrations change based on the flow
- Four seasons modeled with daily temperature inputs from October 2005, ratioed to match the average seasonal temperatures, as shown below in **Figure 1**.
- Methanol addition to anoxic zones

Figure 1: Influent Flow vs Temperature



- Flow pattern assumptions:
  - Flow up to 1.5 times the average influent flow will pass through secondary treatment, split evenly to Passes B, C, and D
  - Flow from 1.5 times the average influent flow to 1.5 times the DDWF will enter secondary treatment through Pass D
  - Flow from 1.5 times the DDWF to 2.0 times DDWF will bypass secondary treatment entirely
  - October 2005 flow patterns shown in **Figure 2** below

Figure 2: October 2005 - BB Flow Patterns
(up to 1.5*Avg Flow through full secondary, 1.5*Avg Flow to 1.5*DDWF to Pass D, above 1.5*DDWF to Bypass)



Scenario 3: Dynamic Run with Storm Events including CSO pumpback

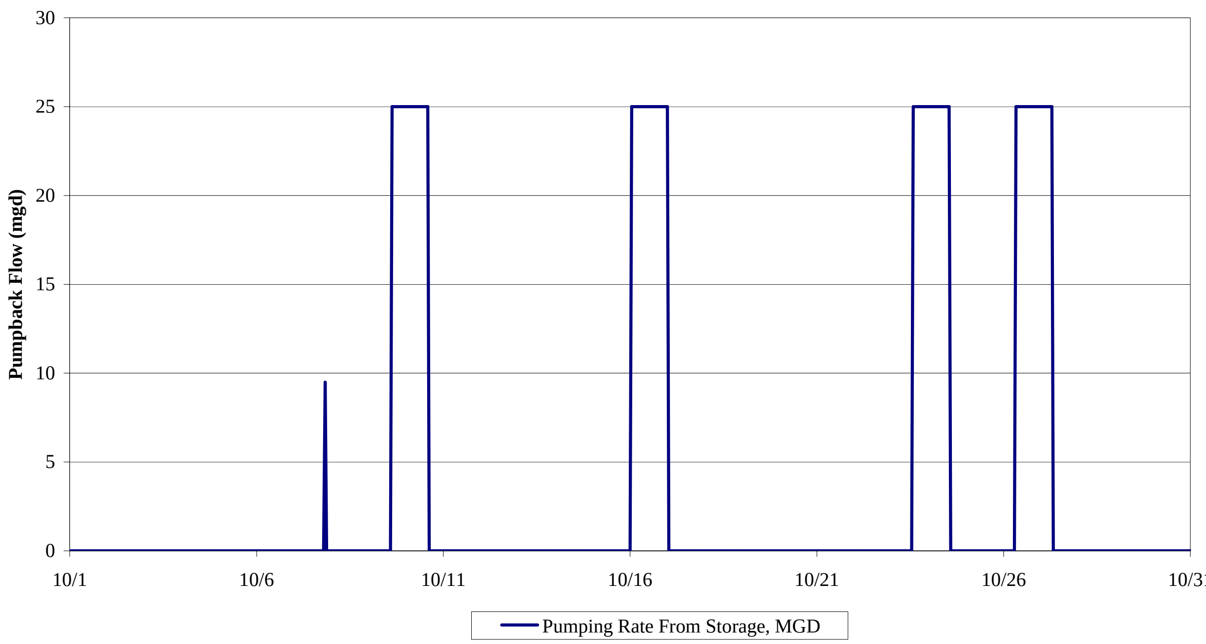
- Dynamic run using the Bowery Bay October 2005 hourly flow pattern
- Primary Effluent loads from the Base Case remain constant in the plant's influent, concentrations change based on the flow
- Four seasons modeled with daily temperature inputs from October 2005, ratioed to match the average seasonal temperatures
- Flow pattern assumptions:
    - Flow up to 1.5 times the average influent flow will pass through secondary treatment, split evenly to Passes B, C, and D
    - Flow from 1.5 times the average influent flow to 1.5 times the DDWF will enter secondary treatment through Pass D
    - Flow from 1.5 times the DDWF to 2.0 times DDWF will bypass secondary treatment entirely
- CSO pumpback input, flow and timing, modeled using InfoWorks and shown in **Figure 3**
- Temperature effect of pumpback taken into account by lowering the temperature of the pumpback by 4 degrees (the 90th percentile temperature drop from the monthly average temperature to the wet weather day temperature seen in the past 4 years). A flow weighted average of pumpback flow and influent flow was used in the model.
- Pumpback concentrations assumed to be the average influent wastewater concentrations during wet weather, See **Table 1**.

Table 1: Assumed pumpback Concentrations

Flow	**COD**	**TKN**	**TP**	**NO3**	**ISS**
mgd	lb/d	lb/d	lb/d	lb/d	lb/d
25	117	13.0	2.5	0.1	6.0

- Methanol addition to anoxic zones

Figure 3: Pumpback Flow



Results:

Steady State results are detailed in **Figure 4** and show an average Total Nitrogen effluent of 8.8 mg/L. Average results from dynamic modeling show slight increases in effluent Total Nitrogen when pumpback is brought into the plant (see **Figure 6**), indicating that pumpback will have a very small impact on plant effluent quality. These increases are summarized in **Figure 7** and **Table 2**.

Figure 4: Steady State Modeling Results

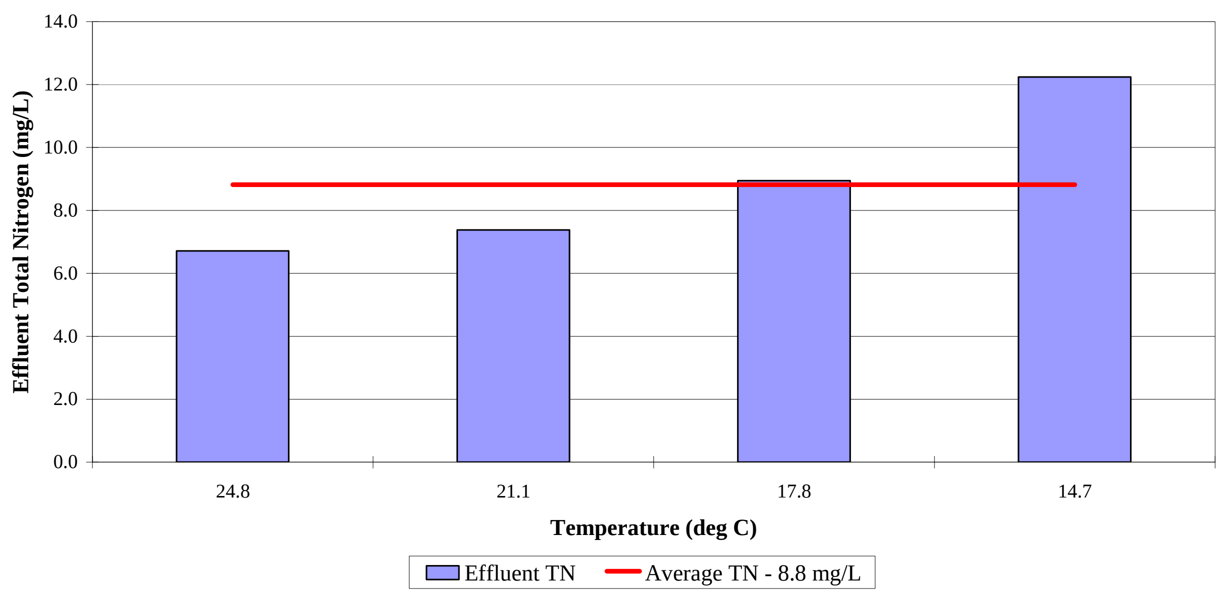


Figure 5: Bowery Bay October 2005 Influent Hourly Flow with Pumpback

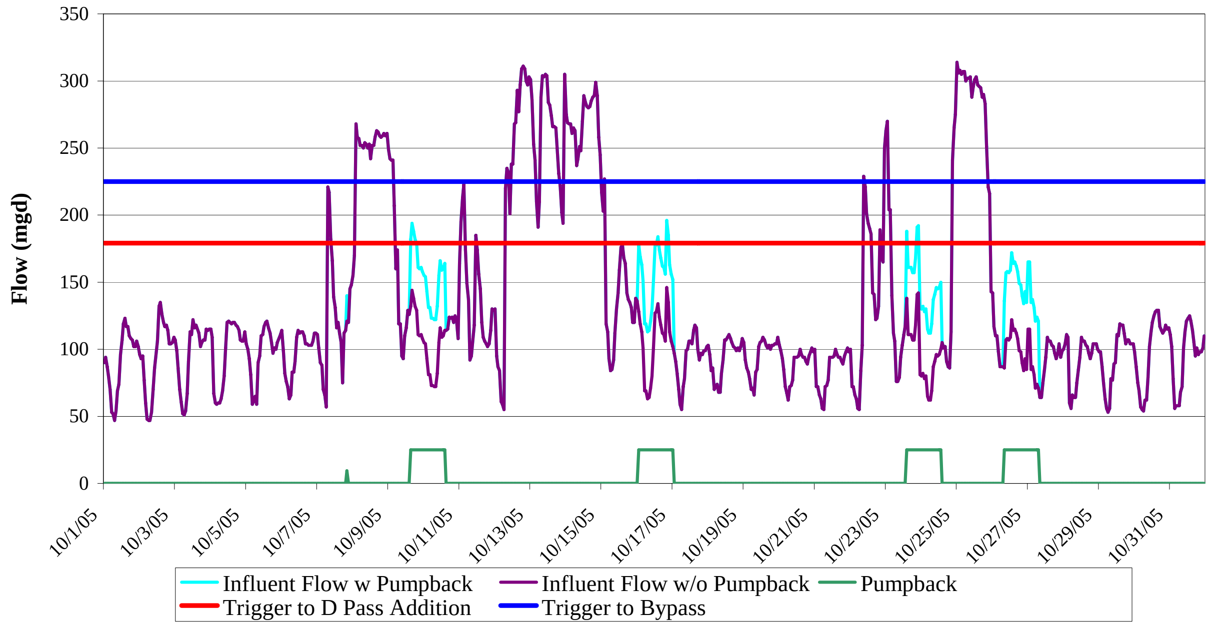


Figure 6: Effluent Total Nitrogen Load During Pumpback

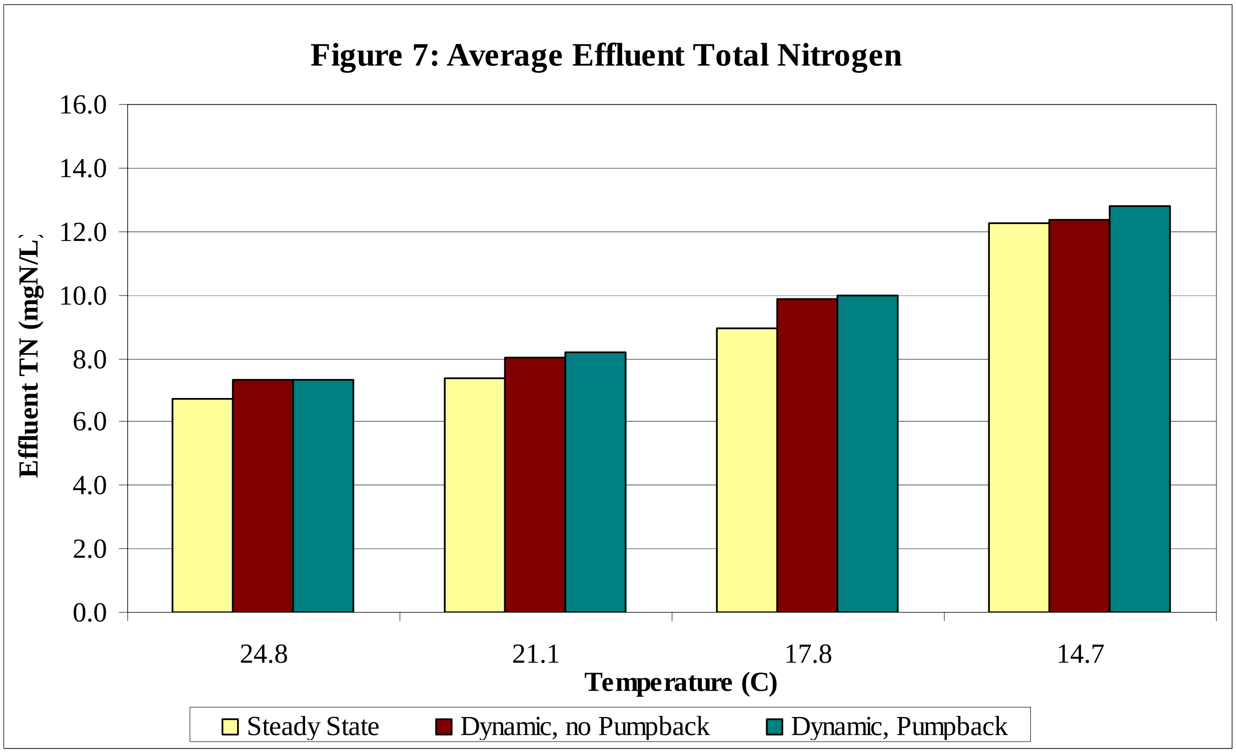


Table 2: Summary of Effluent Nitrogen Concentrations with and without Pumpback

Temp	Steady State	Dynamic, no Pumpback		Pumpback	
	TN Eff	TN Eff	% Increase from	TN Eff	% Increase from
ºC	(mg/L)	(mg/L)	Steady State	(mg/L)	no Pumpback
24.8	6.7	7.3	9%	7.3	0%
21.1	7.4	8.0	9%	8.2	2%
17.8	8.9	9.9	11%	10.0	1%
14.7	12.2	12.4	1%	12.8	4%
Average	8.8	9.4	7%	9.6	2%

Exhibit 1: Assumptions List for *BioWin* Runs

Raw Plant Influent:

- Raw Influent Flow – BB: 2005 Annual Average
- Raw Influent CBOD, BOD, TSS, TKN – BB: CY 2005 Annual Averages with +/- 2 StDev removed

Raw Plant Influent Characteristics

WPCP	Flow	CBOD	TSS	TKN
	(mgd)	(lb/d)	(lb/d)	(lb/d)
Bowery Bay	119.5	133,277	130,636	29,628

GTO Input:

- Based on assumed overflow rate = 800 gpd/ft^2
- Operates with maximum number of thickeners in usage for FY2002
- Assumed BOD = 80 mg/l, TSS = 150 mg/l, and TKN = 25 mg/l

GTO Characteristics

WPCP	Flow	BOD	TSS	TKN
	(mgd)	(mg/l)	(mg/l)	(mg/l)
Bowery Bay	19	80	150	25

PST % Removals:

- CCNY PST BOD + TSS % Removals - Table 2 "Process Performance Evaluation of the PSTs in NYC WPCPs" (August 2002)

PST % Removals

WPCP	CBOD	TSS	TKN
Bowery Bay	28%	41%	11%

Other PSTE Factors:

- Flow for Steady State Runs = Raw Influent + GTO flow + Storm Flow - Primary Underflow
- Primary Effluent Loads kept constant in dynamic runs
- Primary Underflows – 6MGD
- COD=2.2*BOD & 0.85*BOD=CBOD
- % ISS in PE assumed to be 15%

Primary Effluent Characteristics

WPCP	Flow	CBOD	TSS	TKN	COD	ISS
	(mgd)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
Bowery Bay	144	87	76	25	225	11

Wet Weather Flows for Steady State (10% of Raw influent)

WPCP	Flow
	(mgd)
Bowery Bay	11.95

Wastewater Influent Fractions:

- Bowery Bay Influent Fractions - Table 4-5 in "Characterization of the PSTE in NYC WPCPs" Report (August 2001). Fna reported by CCNY is 0.73

Centrate Influent: Future AWT centrate flow and load projections

- Centrate Flow {Projections based on Population increases (1998 OEPA Population Estimates)
- Used in the 2045 Upper East River Modeling conducted in March through April of 2006

Centrate Characteristics

WPCP	Flow (mgd)	BOD (mg/l)	TSS (mg/l)	TKN (mg/l)	COD (mg/l)	ISS (mg/l)
Bowery Bay	0.83	554	1,339	953	1,866	409

Model Conditions:

- Temperatures - NCFP (December 1998)
- Reactor Sizes - BNR Facility Plan (October 2002)
- Model Parameters - "PO-55A Progress Report: September 2000 – June 2001, March 2002" (primary effluent as the supplemental carbon source)

BB Zone Setup	Zone 1	Zone 2	Zone 3	Zone 4
Pass A	17% Switch (Oxic in winter)	17% Switch (Oxic in winter)	62% Oxic	5% Pre-Anoxic
Pass B	17% Switch	17% Switch	62% Oxic	5% Pre-Anoxic
Pass C	17% Switch (Oxic in winter)	17% Switch (Oxic in winter)	58% Oxic	10% Pre-Anoxic
Pass D	17% Switch	17% Switch	17% Switch	50% oxic

- Flow split 0:33:33:33
- RAS and treated centrate to Pass A
- Separate Centrate Treatment in AT 10
- Centrate seeding w/ RAS (RAS seeding flow set equal to the Centrate flow)
- RAS rate = 80% inf Q
- Wastewater characteristics and global parameters were set equal to those used in the 2045 Upper East River Modeling conducted in March through April of 2006 (Mu max=0.45, b=0.04)
- Alkalinity addition to centrate
- Carbon addition to anoxic zones (6:1 ratio)

Seasonal Temperatures for Steady State Modeling

WPCP	Temperature (deg C)			
	Summer	Spring	Fall	Winter
Bowery Bay	24.8	21.1	17.8	14.7

Autotrophic Mu Max:

- Bowery Bay Autotroph Mu Max - NCFP (December 1998)
- All Mu Max Values can also be found in the AWT Revised Program Guidance (April 2003)
- Decay Rate of 0.04/d was used for all plants

Autotrophic Mu Max

WPCP	Mu Max	Arrhenius
Bowery Bay	0.45	1.08

Methanol Addition:

- Methanol Influent COD - 1,188,000 mg/l for a 100% solution

Exhibit 2: Global Parameters

Kinetic:
Autotroph

Name	2.2 Default	Value used in 2.2 Modeling	Arrhenius
Max. spec. growth rate [1/d]	0.90000	**0.45**	1.0720
Substrate (NH4) half sat. [mgN/L]	0.70000	0.70000	1.0000
Aerobic decay rate [1/d]	0.17000	**0.04000**	1.0290
Anoxic/anaerobic decay rate [1/d]	0.08000	0.08000	1.0290
CO2 half sat. for autotrophs [mmol/L]	0.01000	0.01000	1.0000

Heterotroph

Name	2.2 Default	Value used in 2.2 Modeling	Arrhenius
Max. spec. growth rate [1/d]	3.20000	3.20000	1.0290
Substrate half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anoxic growth factor [-]	0.50000	0.50000	1.0000
Aerobic decay [1/d]	0.62000	**0.25000**	1.0290
Anoxic/anaerobic decay [1/d]	0.30000	**0.12000**	1.0290
Hydrolysis rate (AS) [1/d]	2.10000	2.10000	1.0290
Hydrolysis half sat. (AS) [-]	0.06000	0.06000	1.0000
Anoxic hydrolysis factor [-]	0.28000	**0.60000**	1.0000
Anaerobic hydrolysis factor [-]	0.50000	0.50000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.80000	0.80000	1.0290
Ammonification rate [L/(mgN d)]	0.04000	0.04000	1.0290
Fermentation rate [1/d]	3.20000	3.20000	1.0290
Fermentation half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anaerobic growth factor (AS) [-]	0.12500	0.12500	1.0000
Hydrolysis rate (AD) [1/d]	0.10000	0.10000	1.0500
Hydrolysis half sat. (AD) [mgCOD/L]	0.15000	0.15000	1.0000

Methanol utilizers

Name	2.2 Default	Value used in 2.2 Modeling	Arrhenius
Max. spec. growth rate of methanol utilizers [1/d]	6.40000	**2.50000**	1.0290
Methanol half sat. [mgCOD/L]	0.50000	0.50000	1.0000
Aerobic decay rate of methanol utilizers [1/d]	0.24000	0.24000	1.0290
Anoxic/anaerobic decay rate of methanol utilizers [1/d]	0.12000	0.12000	1.0290

PolyP

Name	2.2 Default	Value used in 2.2 Modeling	Arrhenius
Max. spec. growth rate [1/d]	0.95000	0.95000	1.0000
Max. spec. growth rate, P-limited [1/d]	0.42000	0.42000	1.0000
Substrate half sat. [mgCOD/L]	0.10000	0.10000	1.0000
Substrate half sat., P-limited [mgCOD/L]	0.05000	0.05000	1.0000
Magnesium half sat. [mgMg/L]	0.10000	0.10000	1.0000
Cation half sat. [mmol/L]	0.10000	0.10000	1.0000
Calcium half sat. [mgCa/L]	0.10000	0.10000	1.0000

Aerobic decay rate [1/d]	0.10000	0.10000	1.0000
Anaerobic decay rate [1/d]	0.04000	0.04000	1.0000
Sequestration rate [1/d]	6.00000	6.00000	1.0000
Anoxic growth factor [-]	0.33000	0.33000	1.0000

Propionic Acetogen

Name	2.2 Default	Value used in 2.2 Modeling	Arrhenius
Max. spec. growth rate [1/d]	0.25000	0.25000	1.0290
Substrate half sat. [mgCOD/L]	10.00000	10.00000	1.0000
Acetate inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Decay rate [1/d]	0.05000	0.05000	1.0290
Aerobic decay rate [1/d]	0.52000	0.52000	1.0290

Methanogen

Name	2.2 Default	Value used in 2.2 Modeling	Arrhenius
Acetoclastic Mu Max [1/d]	0.30000	0.30000	1.0290
H2-utilizing Mu Max [1/d]	1.40000	1.40000	1.0290
Acetoclastic Ks [mgCOD/L]	100.00000	100.00000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.10000	0.10000	1.0000
H2-utilizing Ks [mgCOD/L]	0.10000	0.10000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Acetoclastic decay rate [1/d]	0.13000	0.13000	1.0290
Acetoclastic aerobic decay rate [1/d]	0.60000	0.60000	1.0290
H2-utilizing decay rate [1/d]	0.13000	0.13000	1.0290
H2-utilizing aerobic decay rate [1/d]	0.60000	0.60000	1.0290

pH Inhibition

Name	2.2 Default	Value used in 2.2 Modeling
Heterotrophs low pH limit [-]	4.00000	4.00000
Heterotrophs high pH limit [-]	10.00000	10.00000
Methanol utilizers low pH limit [-]	4.00000	4.00000
Methanol utilizers high pH limit [-]	10.00000	10.00000
Autotrophs low pH limit [-]	5.50000	5.50000
Autotrophs high pH limit [-]	9.50000	9.50000
PolyP heterotrophs low pH limit [-]	4.00000	4.00000
Poly P heterotrophs high pH limit [-]	10.00000	10.00000
Heterotrophs low pH limit (anaerobic) [-]	5.50000	5.50000
Heterotrophs high pH limit (anaerobic) [-]	8.50000	8.50000
Propionic acetogens low pH limit [-]	4.00000	4.00000
Propionic acetogens high pH limit [-]	10.00000	10.00000
Acetoclastic methanogens low pH limit [-]	5.50000	5.50000
Acetoclastic methanogens high pH limit [-]	8.50000	8.50000
H2-utilizing methanogens low pH limit [-]	5.50000	5.50000
H2-utilizing methanogens high pH limit [-]	8.50000	8.50000

Switching Functions

Name	2.2 Default	Value used in 2.2 Modeling
Heterotrophic DO limit [mgO2/L]	0.05000	0.05000
Aerobic denit. DO limit [mgO2/L]	0.05000	0.05000

Autotrophic DO limit [mgO2/L]	0.25000	0.25000
Anoxic NO3 limit [mgN/L]	0.10000	0.10000
NH3 nutrient limit [mgN/L]	0.00500	0.00500
NO3 nutrient limit [mgN/L]	0.00500	0.00500
PolyP limit [mgP/L]	0.01000	0.01000
VFA sequestration limit [mgCOD/L]	5.00000	5.00000
P uptake limit [mgP/L]	0.15000	0.15000
P nutrient limit [mgP/L]	0.00500	0.00500
Heterotrophic Hydrogen limit [mgCOD/L]	1.00000	1.00000
Propionic acetogens Hydrogen limit [mgCOD/L]	5.00000	5.00000

Stoichiometric:
Autotroph

Name	2.2 Default	Value used in 2.2 Modeling
Yield [mgCOD/mgN]	0.24000	0.24000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

Heterotroph

Name	2.2 Default	Value used in 2.2 Modeling
Yield (aerobic) [-]	0.66600	0.66600
Yield (fermentation, low H2) [-]	0.10000	0.10000
Yield (fermentation, high H2) [-]	0.10000	0.10000
Yield (fermentation of methanol) [-]	0.10000	0.10000
H2 yield (fermentation low H2) [-]	0.35000	0.35000
H2 yield (fermentation high H2) [-]	0.0	0.0
H2 yield (methanol fermentation) [-]	0.35000	0.35000
Propionate yield (fermentation, low H2) [-]	0.0	0.0
Propionate yield (fermentation, high H2) [-]	0.70000	0.70000
CO2 yield (fermentation, low H2) [-]	0.50000	0.50000
CO2 yield (fermentation, high H2) [-]	0.0	0.0
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield (anoxic) [-]	0.54000	0.54000
Yield propionic (aerobic) [-]	0.50000	0.50000
Yield propionic (anoxic) [-]	0.41000	0.41000
Yield acetic (aerobic) [-]	0.40000	0.40000
Yield acetic (anoxic) [-]	0.32000	0.32000
Yield methanol (aerobic) [-]	0.50000	0.50000
Adsorp. max. [-]	1.00000	1.00000

Methanol utilizer

Name	2.2 Default	Value used in 2.2 Modeling
Yield (anoxic) [-]	0.40000	0.40000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

PolyP

Name	2.2 Default	Value used in 2.2 Modeling
Yield (aerobic) [-]	0.63900	0.63900
Yield (anoxic) [-]	0.52000	0.52000
Aerobic P/PHA uptake [mgP/mgCOD]	0.95000	0.95000
Anoxic P/PHA uptake [mgP/mgCOD]	0.35000	0.35000
Yield of PHA on sequestration [-]	0.88900	0.88900
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in part. inert [mgN/mgCOD]	0.07000	0.07000
N in sol. inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in part. inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous part. [-]	0.25000	0.25000
Inert fraction of endogenous sol. [-]	0.20000	0.20000
P/Ac release ratio [mgP/mgCOD]	0.49000	0.49000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield of low PP [-]	0.94000	0.94000

Propionic Acetogen

Name	2.2 Default	Value used in 2.2 Modeling
Yield [-]	0.10000	0.10000
H2 yield [-]	0.40000	0.40000
CO2 yield [-]	1.00000	1.00000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in endogenous residue [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in endogenous residue [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

Methanogen

Name	2.2 Default	Value used in 2.2 Modeling
Acetoclastic yield [-]	0.10000	0.10000
H2-utilizing yield [-]	0.10000	0.10000
N in acetoclastic biomass [mgN/mgCOD]	0.07000	0.07000
N in H2-utilizing biomass [mgN/mgCOD]	0.07000	0.07000
N in acetoclastic endog. residue [mgN/mgCOD]	0.07000	0.07000
N in H2-utilizing endog. residue [mgN/mgCOD]	0.07000	0.07000
P in acetoclastic biomass [mgP/mgCOD]	0.02200	0.02200
P in H2-utilizing biomass [mgP/mgCOD]	0.02200	0.02200
P in acetoclastic endog. residue [mgP/mgCOD]	0.02200	0.02200
P in H2-utilizing endog. residue [mgP/mgCOD]	0.02200	0.02200
Acetoclastic fraction to endog. residue [-]	0.08000	0.08000
H2-utilizing fraction to endog. residue [-]	0.08000	0.08000
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

Other:

General

Name	2.2 Default	Value used in 2.2 Modeling
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Ash content of biomass (synthesis ISS) [%]	8.00000	8.00000
Molecular weight of other anions [mg/mmol]	35.50000	35.50000
Molecular weight of other cations [mg/mmol]	39.10000	39.10000
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.30000	0.30000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.30000	0.30000
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.05000	0.05000
Cation to P mole ratio in organic phosphate [meq/mmolP]	0.01000	0.01000
Bubble rise velocity (anaerobic digester) [cm/s]	23.90000	23.90000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.35000	0.35000

Mass transfer

Name	2.2 Default	Value used in 2.2 Modeling	Arrhenius
Kl for H2 [m/d]	17.00000	17.00000	1.0000
Kl for CO2 [m/d]	10.00000	10.00000	1.0000
Kl for NH3 [m/d]	1.00000	1.00000	1.0000

Physico-chemical rates

Name	2.2 Default	Value used in 2.2 Modeling	Arrhenius
Struvite precipitation rate [1/d]	3.0000E+10	3.0000E+10	1.0000
Struvite redissolution rate [1/d]	3.0000E+11	3.0000E+11	1.0240
Struvite half sat. [mgTSS/L]	1.00000	1.00000	1.0000
HDP precipitation rate [L/(molP d)]	1.0000E+8	1.0000E+8	1.0000
HDP redissolution rate [L/(mol P d)]	1.0000E+8	1.0000E+8	1.0000
HAP precipitation rate [molHDP/(L d)]	5.0000E-4	5.0000E-4	1.0000

Physico-chemical constants

Name	2.2 Default	Value used in 2.2 Modeling
Struvite solubility constant [mol/L]	6.9180E-14	6.9180E-14
HDP solubility product [mol/L]	2.7500E-22	2.7500E-22
HDP half sat. [mgTSS/L]	1.00000	1.00000
Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L]	0.01000	0.01000
Al to P ratio [molAl/molP]	0.80000	0.80000
Al(OH)3 solubility product [mol/L]	1.2590E+9	1.2590E+9
AlHPO4+ dissociation constant [mol/L]	7.9430E-13	7.9430E-13
Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L]	0.01000	0.01000
Fe to P ratio [molFe/molP]	1.60000	1.60000
Fe(OH)3 solubility product [mol/L]	0.05000	0.05000
FeH2PO4++ dissociation constant [mol/L]	5.0120E-22	5.0120E-22

Aeration

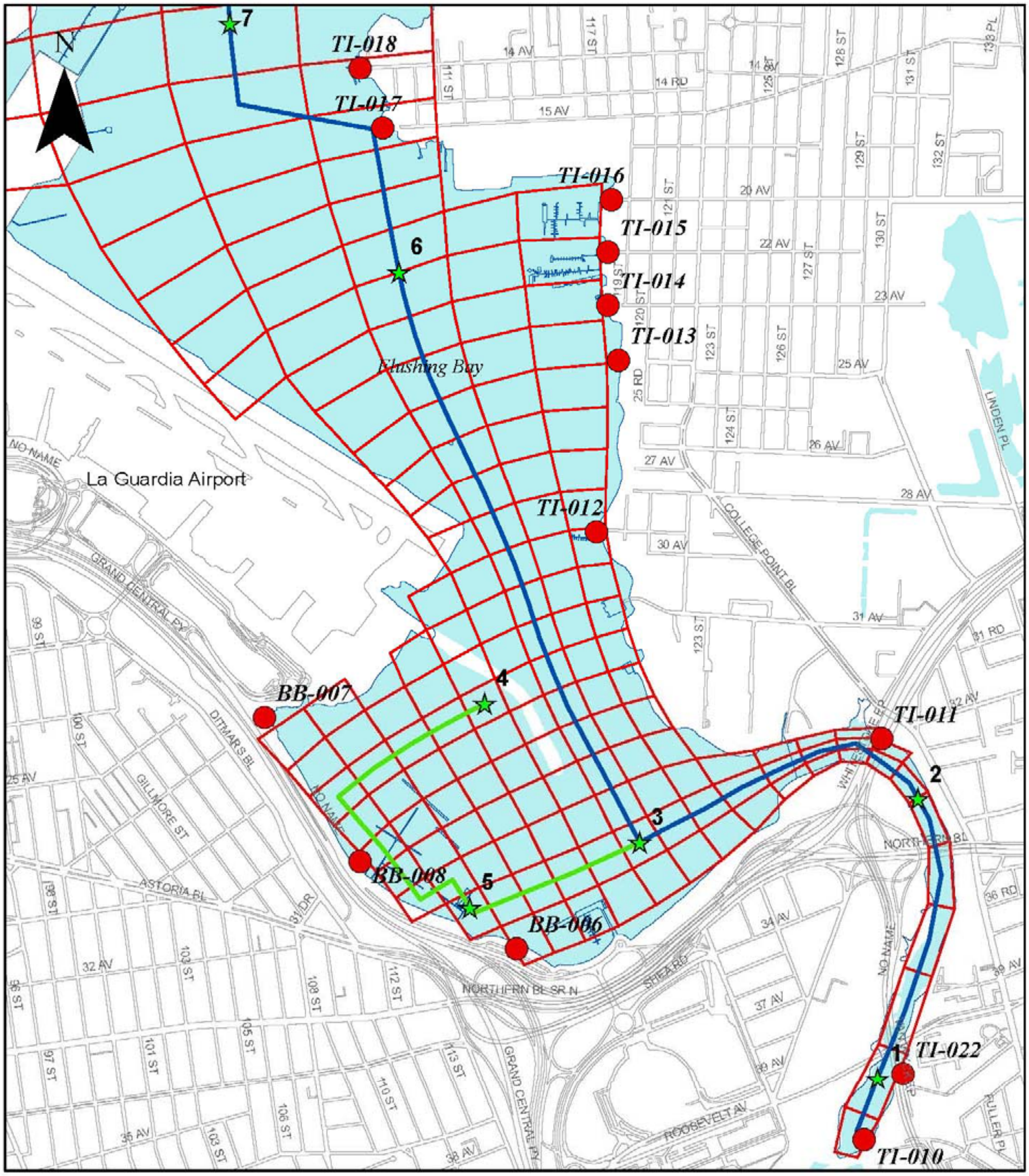
Name	2.2 Default	Value used in 2.2 Modeling
Alpha (surf) OR Alpha F (diff) [-]	0.50000	0.50000
Beta [-]	0.95000	0.95000
Surface pressure [kPa]	101.32500	101.32500
Fractional effective saturation depth (Fed) [-]	0.32500	0.32500
Supply gas CO2 content [vol. %]	0.03500	0.03500
Supply gas O2 [vol. %]	20.95000	20.95000
Off-gas CO2 [vol. %]	2.00000	2.00000
Off-gas O2 [vol. %]	18.80000	18.80000
Off-gas H2 [vol. %]	0.0	0.0
Off-gas NH3 [vol. %]	0.0	0.0
Surface turbulence factor [-]	0.25000	0.25000
Set point controller gain []	1.00000	1.00000

Settling:
Modified Vesilind

Name	2.2 Default	Value used in 2.2 Modeling
Maximum Vesilind settling velocity (Vo) [ft/min]	0.3873	0.3873
Vesilind hindered zone settling parameter (K) [L/g]	0.3700	0.3700
Clarification switching function [mg/L]	100.0000	100.0000
Specified TSS conc.for height calc. [mg/L]	2500.0000	2500.0000
Maximum compactability constant [mg/L]	15000.0000	15000.0000

APPENDIX E

Supplemental Water Quality Data



Outfall
Locations
Creek Transect Axis
Bay Transect Axis
ERTM Model Grid

1 inch equals 1,500 feet

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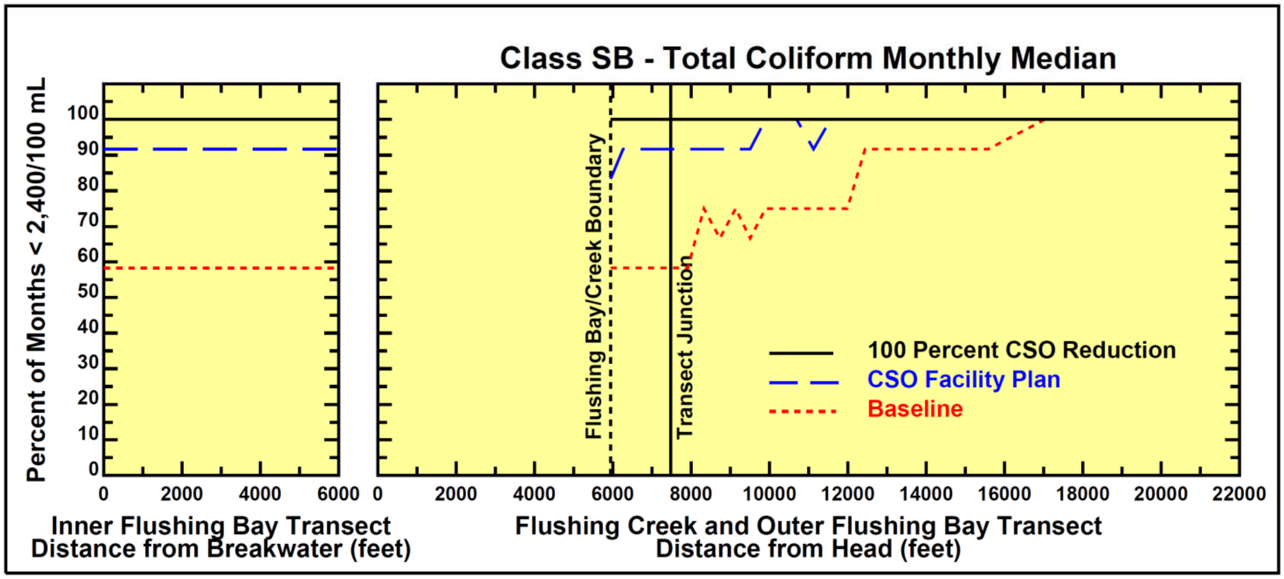
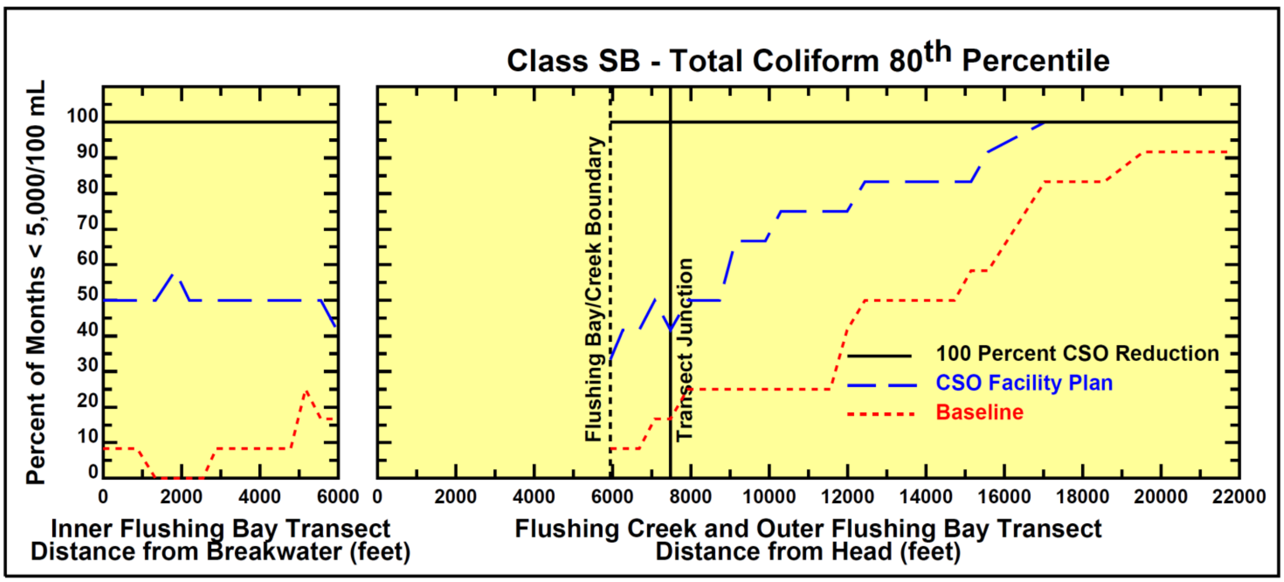
Standard Attainment Locations





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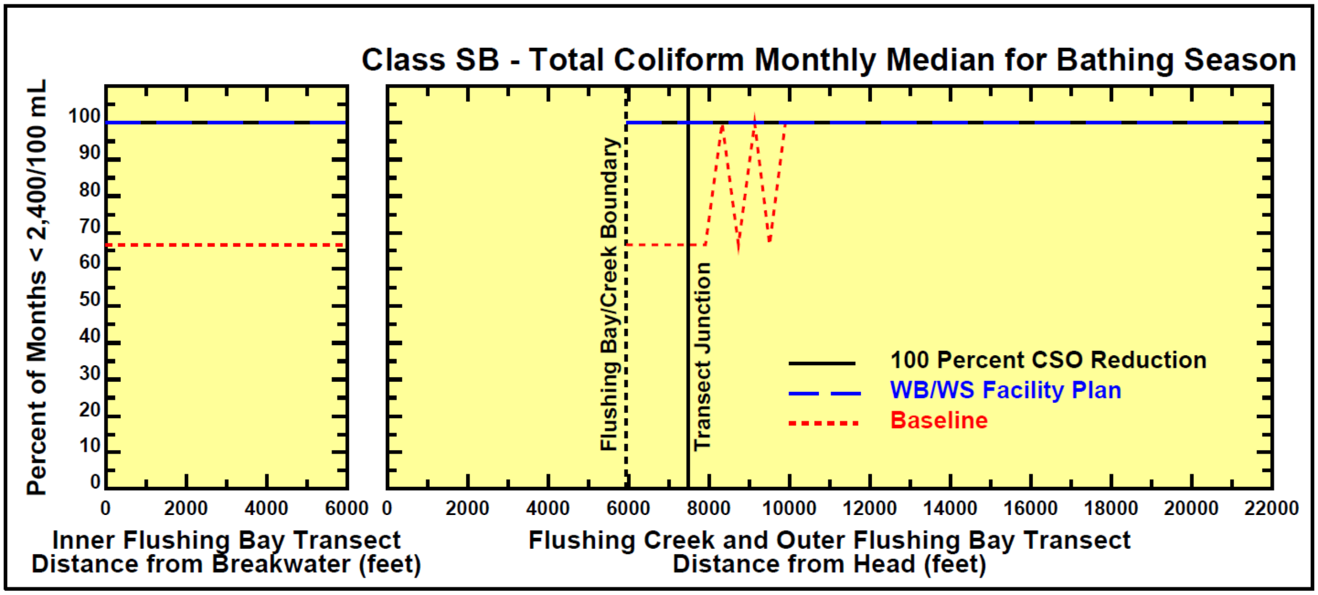
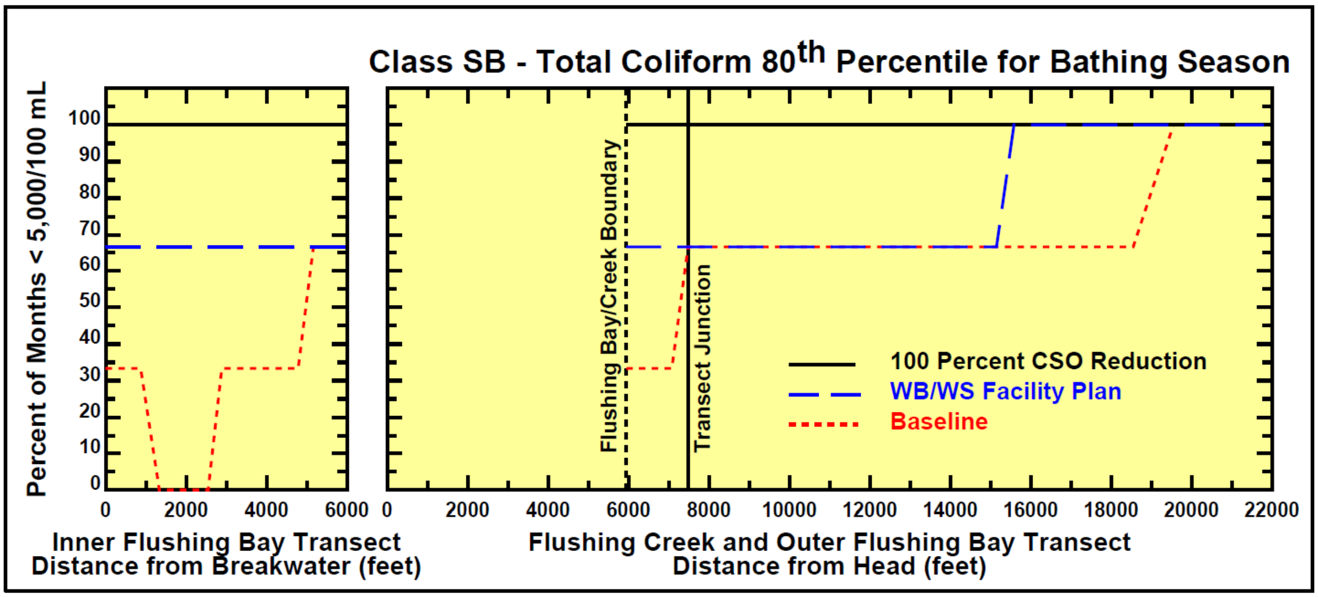
Annual Attainability of SB Total Coliform Criteria

FIGURE E-2





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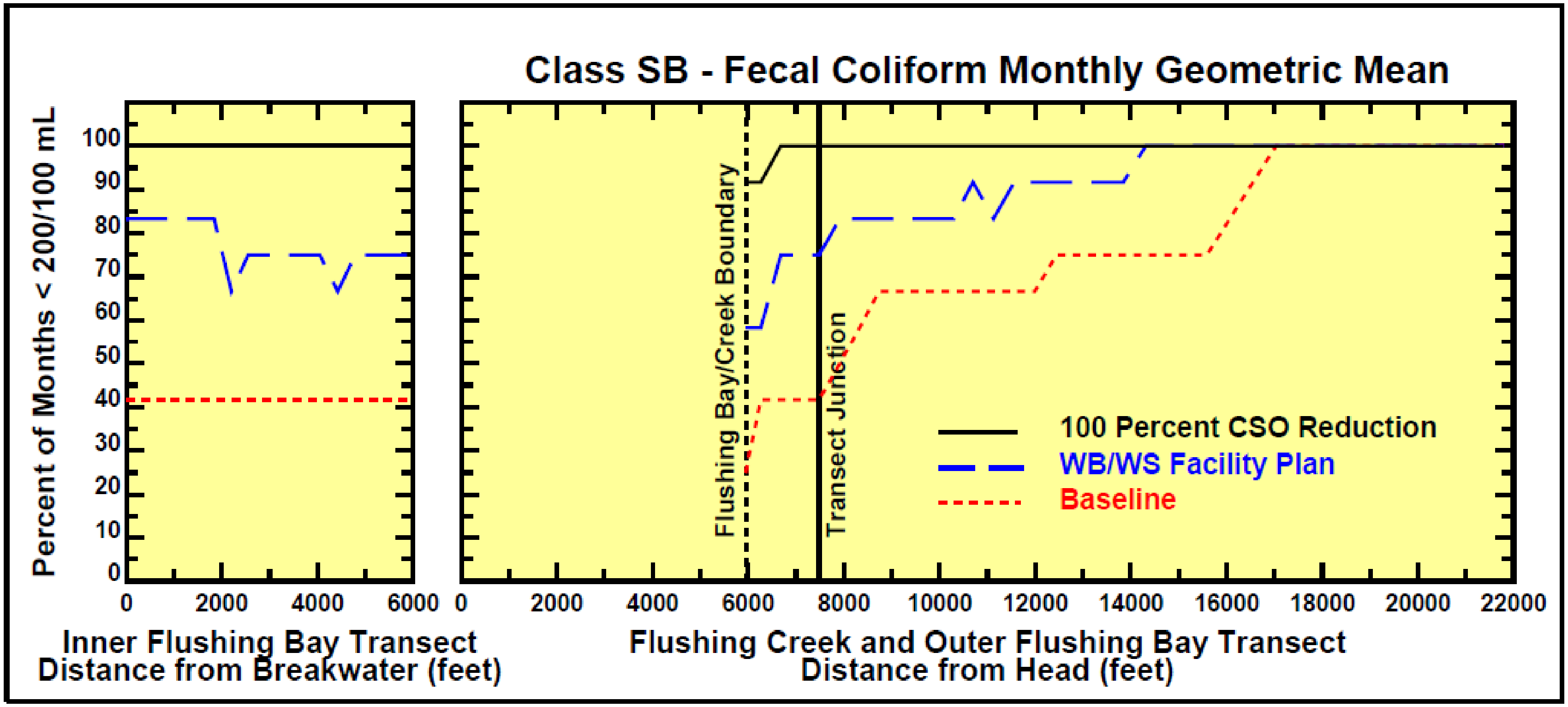
Recreation Season Attainability of SB/SC Total Coliform Criteria

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE E-3



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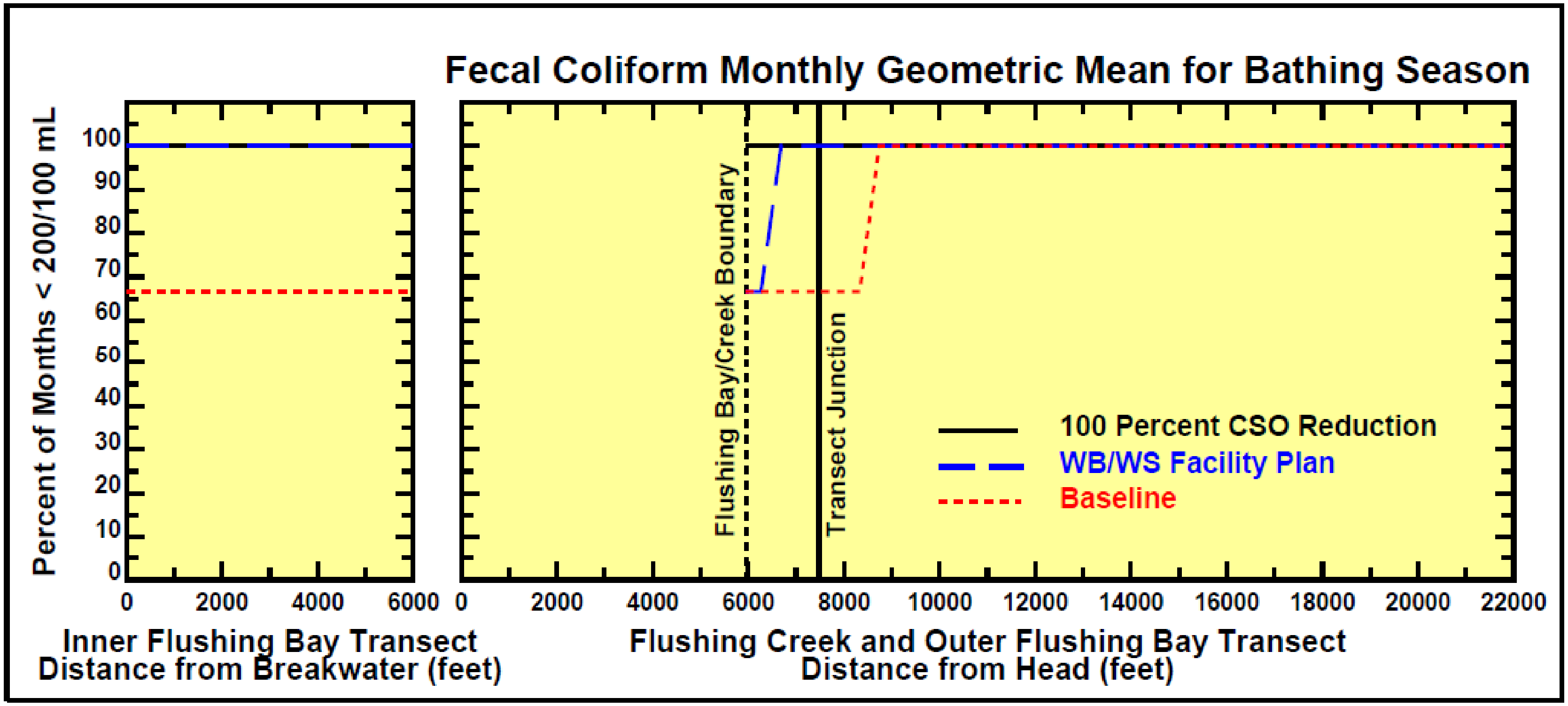
Flushing Bay Waterbody/Watershed Facility Plan

Annual Attainability of SB/SC Fecal Coliform Criteria

FIGURE E-4



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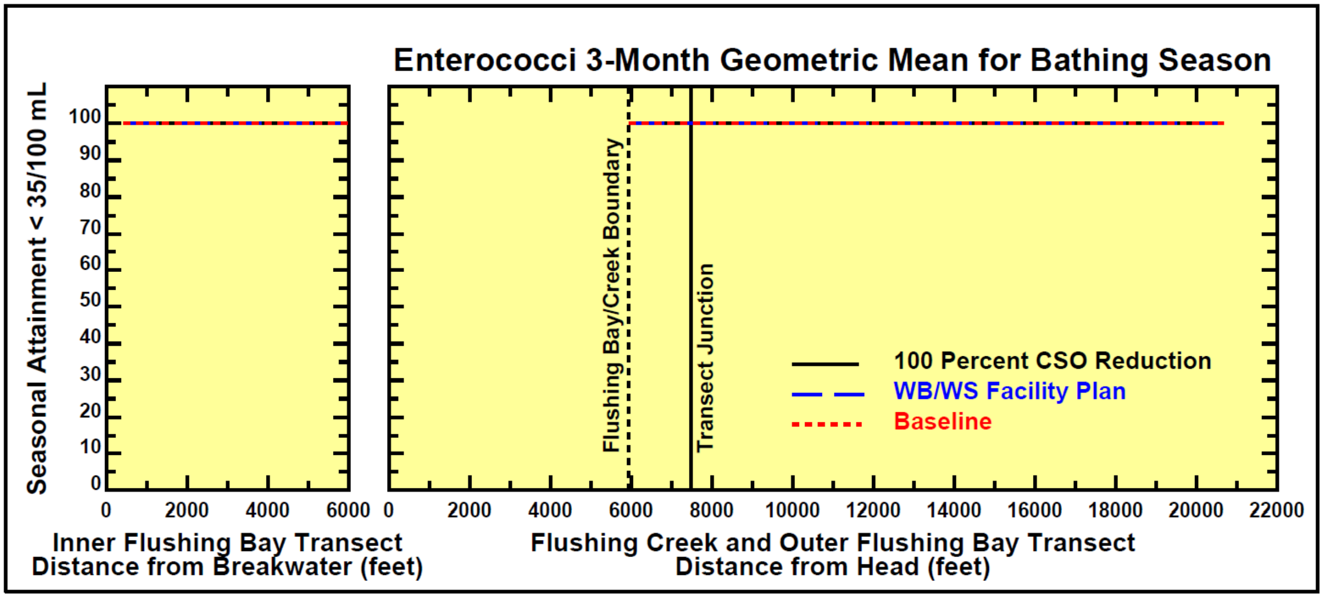
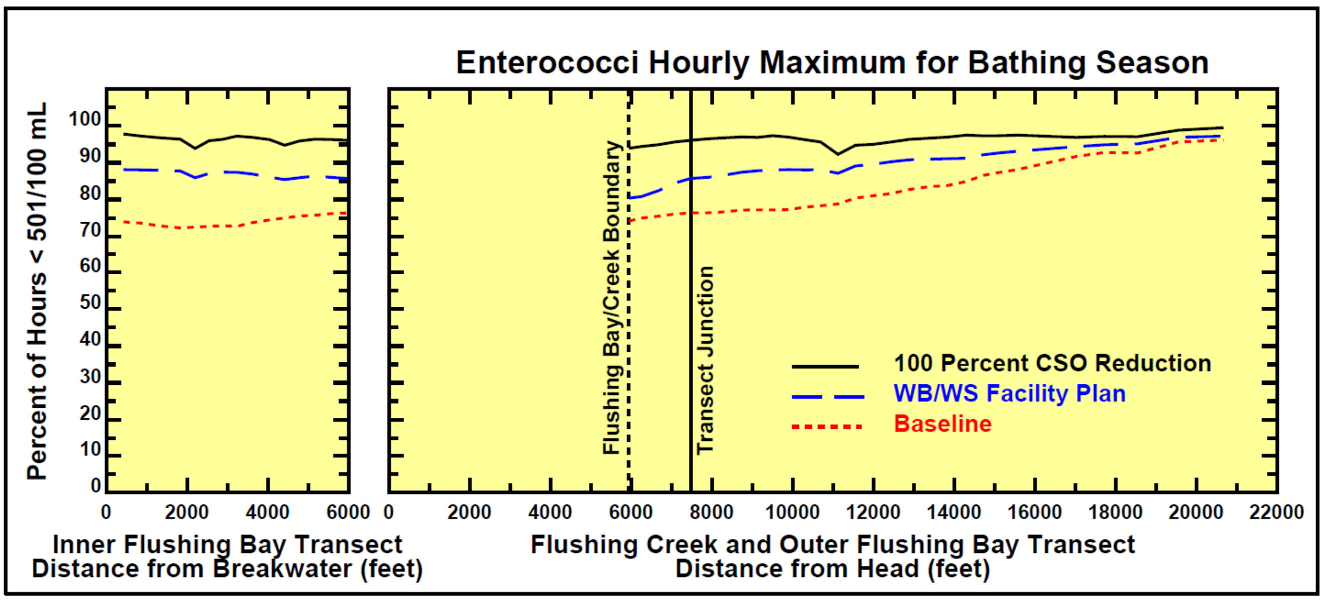
Recreation Season Attainability of SB/SC Fecal Coliform Criteria





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Recreation Season Attainability of Enterococci Criteria

Flushing Bay Waterbody/Watershed Facility Plan

FIGURE E-6