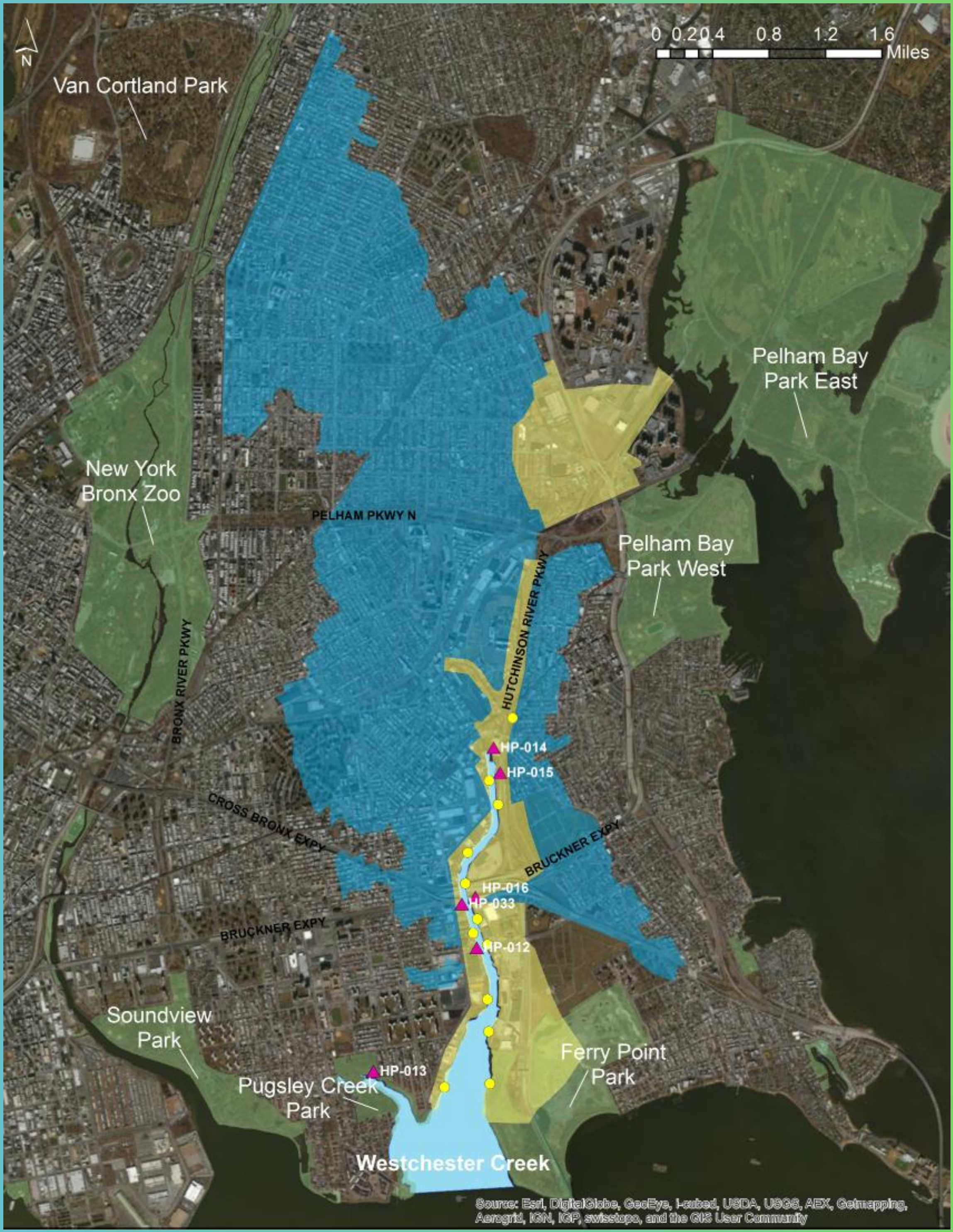
New York City Department of Environmental Protection

Capital Project No. WP-169
Long Term Control Plan II

Combined Sewer Overflow Long Term Control Plan for Westchester Creek



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

Prepared by: AECOM USA, Inc.

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EXECUTIVE SUMMARY

This Executive Summary is organized as follows:

- Background — An overview of the regulations, approach and existing waterbody information.
- Findings — A summary of the key findings of the water quality data analyses, the water quality modeling simulations and the alternatives analysis.
- Recommendations — A listing of recommendations that are consistent with the Federal CSO Control Policy and the Clean Water Act (CWA). In addition, recommendations regarding suggested site-specific targets for the Westchester Creek waterbody are provided. The site-specific targets are expected to advance the waterbody toward the Primary Contact WQ Criteria.

BACKGROUND

This Long Term Control Plan (LTCP) for Westchester Creek was prepared pursuant to the Combined Sewer Overflow (CSO) Order on Consent (DEC Case No. CO2-20110512-25), dated March 8, 2012 (2012 Order on Consent). The 2012 Order on Consent is a modification of the 2005 CSO Order on Consent (DEC Case No. CO2-20000107-8). Under the 2012 Order on Consent, the New York City Department of Environmental Protection (DEP) is required to submit 11 waterbody-specific LTCPs to the New York State Department of Environmental Conservation (DEC) by December 2017. The Westchester Creek LTCP is the second of the LTCPs under the 2012 Order on Consent to be completed.

The goal of each LTCP, as described in the LTCP Goal Statement in the 2012 Order on Consent, is to identify, with public input, appropriate CSO controls necessary to achieve waterbody-specific water quality standards (WQS) consistent with the Federal CSO Control Policy and related guidance. In addition, the Goal Statement provides: *"Where existing water quality standards do not meet the Section 101(a)(2) goals of the Clean Water Act, or where the proposed alternative set forth in the LTCP will not achieve existing water quality standards or the Section 101(a)(2) goals, the LTCP will include a Use Attainability Analysis examining whether applicable waterbody classifications, criteria, or standards should be adjusted by the State."* DEP conducted water quality assessments where the data is represented by % attainment with pathogen targets and associated recovery times. For this LTCP, in accordance with guidance from DEC, 95 percent attainment of applicable water quality criteria constitutes compliance with the existing water quality standards or the Section 101(a)(2) goals[1] conditioned on verification through rigorous post construction monitoring (PCM). The PCM will be reviewed for the Citywide LTCP and the percent attainment targets will be reviewed and, based upon the PCM results, possibly modified.

[1] This LTCP is designed to meet the existing WQS that have been promulgated by DEC. To the extent that this LTCP provides, analyzes, or selects alternatives that may lead to achievement of targets beyond what are required under existing WQS, DEP provides these analyses and/or commitments in order to improve water quality beyond the requirements of the CSO Control Policy and other applicable law. DEP reserves all rights with respect to any administrative and/or rulemaking process that DEC may engage in to revise WQS.

Regulatory Requirements

The waters of the City of New York are subject to Federal and New York State laws and regulations. Particularly relevant to this LTCP is the U.S. Environmental Protection Agency (EPA) CSO Control Policy, which provides guidance on the development and implementation of LTCPs, and the setting of WQS. In New York State (NYS), CWA regulatory and permitting authority has been delegated to the DEC.

DEC has designated Westchester Creek as a Class I waterbody, defined as "suitable for fish, shellfish and wildlife propagation and survival." The best usages of Class I waters are "secondary contact recreation and fishing" (6 NYCRR 701.13).

DEC has recently advised DEP that it plans to adopt the 30-day rolling GM for enterococci of 30 cfu/100mL, with a not to exceed the 90th percentile statistical threshold value (STV) of 110 cfu/100mL, which is the EPA Recommended Recreational Water Quality Criteria (2012 EPA RWQC). The analyses in this LTCP were performed prior to this recent communication, and thus used the 30-day rolling GM for enterococci of 35 cfu/100mL with a corresponding STV of 130 cfu/100mL. Sufficient time was not available to update all of the LTCP; as directed by DEC, DEP will conduct this analysis and provide the results of such analysis to DEC when it is available. The criteria used in this LTCP are similar to the criteria the DEC plans to adopt. It is not expected that the recommendations herein will be altered by the new criteria when adopted.

This LTCP used the bacteria criteria shown in Table ES-1 to evaluate the proposed alternatives.

Table ES- 1. Classifications and Standards Applied

Analysis	Numerical Criteria Applied
Existing WQ Criteria	I (Fecal Monthly GM – 2000 cfu/100 mL)
Primary Contact WQ Criteria*	SC (Fecal Monthly GM – 200 cfu/100 mL)
Future Primary Contact WQ Criteria**	(Entero rolling 30-d GM – 35 cfu/100 mL + STV – 130 cfu/100 mL)

Note: GM = Geometric Mean; STV = 90th Percentile Statistical Threshold Value.

*This water quality standard is not currently assigned to Westchester Creek. For such standard to take effect, DEC must first adopt the standard in accordance with rulemaking and environmental review requirements.

**This Future Standard has not yet been proposed by DEC. For such standard to take effect, DEC must first adopt the standard in accordance with rulemaking and environmental review requirements.

The criteria assessed in this LTCP include the applicable existing standards (Class I – secondary contact recreation for Westchester Creek). Also assessed in this LTCP is what attainment would be if DEC were to re-classify Westchester Creek to a Class SC - limited primary contact recreation. The best usage of

Class SC waters is fishing. The SC classification further states that water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use of the waterbody for these purposes. It should be also noted that enterococci criteria do not apply to tributaries such as Westchester Creek under the BEACH Act of 2000, therefore, Westchester Creek water quality assessments for Class SC considered the fecal coliform criteria only (Table ES-1). As described above, the 2012 EPA RWQC recommended certain changes to the bacterial water quality criteria for primary contact. DEC has indicated that NYS will seek to adopt those more stringent standards for both primary and secondary contact waterbodies. As such, this LTCP includes attainment analysis both for existing standards and for the proposed 2012 EPA RWQC that is referred to as the Future Primary Contact WQ Criteria. Table ES-1 summarizes the Existing WQ Criteria, Primary Contact WQ Criteria and Future Primary Contact WQ Criteria applied in this LTCP.

Through analyses described in this LTCP, DEP has determined that the Future Primary Contact WQ Criteria for bacteria would be more challenging to meet, with the STV value essentially impossible to meet.

Westchester Creek Watershed

Westchester Creek watershed characteristics and the CSO and stormwater outfalls are as shown in Figure ES-1. Westchester Creek is a tributary of the Upper East River and is located in the eastern section of the Bronx. The Westchester Creek LTCP Study Area comprises both Westchester Creek and Pugsley Creek and their highly urbanized watersheds. Bounded on the east by the Hutchinson River watershed and on the west by the Bronx River watershed, the Westchester Creek watershed contains numerous parks and open spaces, particularly along the lower portions of the waterbody. However, industrial, manufacturing, transportation and utility uses exist along the western shore and the middle reaches of the eastern shore. The natural watershed of Westchester and Pugsley Creeks consists of approximately 3,600 acres based on interpretation of the local topography. The majority of the Westchester Creek watershed is served by the Hunts Point (HP) Waste Water Treatment Plant (WWTP). Sanitary flows and a portion of combined sanitary and stormwater flows are conveyed to the HP WWTP for treatment. Flows that exceed the capacity of the conveyance and treatment system are discharged into the waterbodies via permitted CSO outfalls. Limited portions of the drainage area along the shorelines discharge their runoff directly to Westchester Creek.

The CSO regulators that discharge to Westchester Creek serve an area of approximately 4,271 acres; the total drainage to Westchester Creek is 4,952 acres. The remaining tributary area (681 acres) includes approximately equal areas of direct runoff and stormwater service areas.

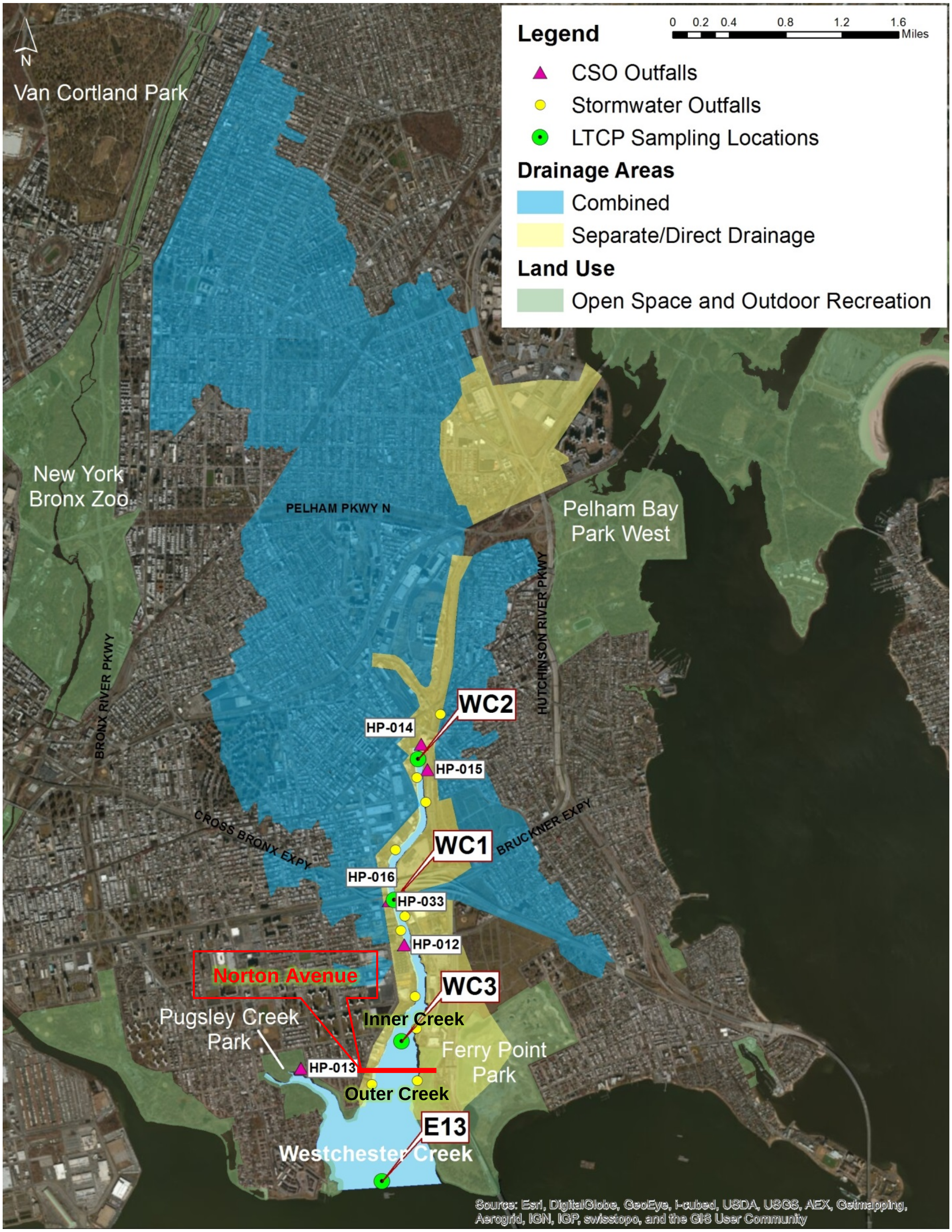


Figure ES-1. Watershed Characteristics and Sampling Locations

Green Infrastructure

Based upon Westchester Creek's characteristics, DEP has determined that the watershed is a CSO tributary that will receive GI improvements.. The Westchester Creek watershed has a total combined sewer impervious area of 3,480 acres out of a total of drainage area of 4,952 acres. DEP projects the following application rates by 2030:

- 348 acres (10 percent) to be managed using green infrastructure right-of-way-bioswales (ROWBs);
- 122 acres (3.5 percent) to be managed in onsite private properties in Westchester Creek through new development and compliance with the Stormwater Performance Standard; and
- 17 acres (0.5 percent) to be managed in onsite public properties.

This acreage represents 14 percent of the total combined sewer impervious area in the watershed.

DEP conservatively estimated new development trends based on Department of Buildings (DOB) building permit data from 2000 to 2011 and has projected that data for the 2012-2030 period to account for compliance with the stormwater performance standard.

Findings

Analysis of water quality in Westchester Creek was based on data collected from December 2013 to April 2014 during the development of the Westchester Creek LTCP. Figure ES-2 presents fecal coliform bacteria data collected at Stations WC2, WC1, WC3 and E13, in Westchester Creek. The data in Figure ES-3 represents the period of December 2013 through April 2014. As the improvements from the 2011 WWFP have yet to be implemented in the Westchester Creek drainage area at the time of the LTCP sampling, the results represent pre-WWFP or pre-baseline conditions.

The data indicate that the bacteria concentrations at the head end of Westchester Creek (Station WC2) are elevated within the data period with GMs for enterococci at approximately 50 cfu/100mL and fecal coliform bacteria near 150 cfu/100mL. The 75th percentile excursions above these values reach nearly 100 cfu/100mL for enterococci and exceed 200 cfu/100mL for fecal coliform bacteria. Single wet weather sample excursions reach 30,000 cfu/100mL for enterococci and 50,000 cfu/100mL for fecal coliform.

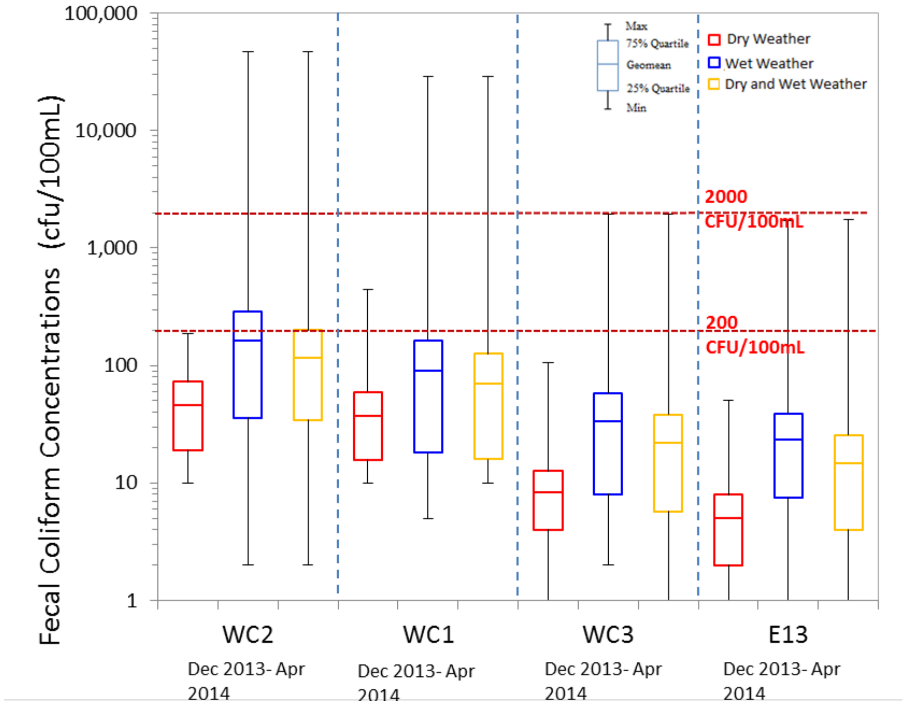


Figure ES-2. Fecal Coliform Data – Westchester Creek

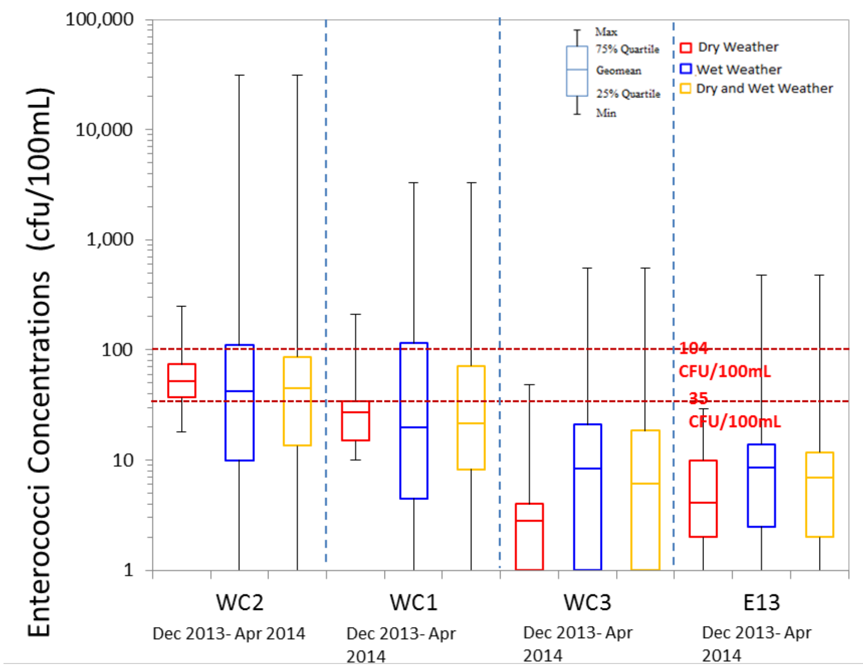


Figure ES-3. Enterococci Data – Westchester Creek

As noted in these graphics, dry weather fecal coliform concentrations are lower than those for wet weather conditions. Enterococci concentrations measured in dry weather approximated the wet weather concentrations at most locations. The general trend for both fecal coliform and enterococci bacteria is for the highest values to be at the head end of the creek, and decreasing downstream towards the East River.

Baseline Conditions, 100 Percent CSO Control and Performance Gap

Analyses utilizing computer models were conducted as part of this LTCP to assess the attainment with existing Class I, Primary Contact WQ Criteria (Class SC) and Future Primary Contact WQ Criteria. The analyses focused on two primary objectives:

1. Determine the future baseline levels of compliance with water quality criteria with all sources being discharged at existing levels to the waterbody. These sources would primarily be direct drainage runoff, stormwater and CSO. This analysis is presented for Existing WQ criteria, Primary Contact WQ Criteria (Class SC) and Future Primary Contact WQ Criteria.

2. Determine attainment levels with 100 percent of CSO controlled or no discharge of CSO to the waterbody, keeping the remaining non-CSO sources. This analysis is presented for the standards and bacteria criteria shown in Table ES-1.

DEP assessed water quality using the East River Tributary Model (ERTM), a water quality model that was created and calibrated during the development of the WWFP in 2009. Model outputs for fecal and enterococci bacteria as well as Dissolved Oxygen (DO) were compared with various monitored data sets during calibration in order to improve the accuracy and robustness of the models to adopt them for LTCP evaluations. The water quality model was then used to calculate ambient pathogen concentrations within the waterbody for a set of baseline conditions.

Baseline conditions were established in accordance with the guidance provided by DEC to represent future conditions. These included the following assumptions: the design year was established as 2040; Hunts Point Wastewater Treatment Plant (WWTP) would receive peak flows at 2xDDWF; grey infrastructure would include those elements recommended in the 2011 WWFP; and waterbody-specific GI application rates would be based on the best available information. In the case of Westchester Creek, GI was assumed to have 14 percent coverage.

The water quality assessments were conducted using continuous water quality simulations – a one-year (2008 rainfall) simulation for bacteria and DO assessment to support alternatives evaluation, and a 10-year (2002 to 2011 rainfall) simulation for bacteria for attainment analysis for developed alternatives. The gaps between calculated baseline bacteria as well as DO were then compared to the applicable pathogen and DO criteria to quantify the level of non-attainment.

The analysis showed an Inner and Outer Area is required. A summary of the baseline attainment results for the Inner Area and Outer Area are presented in Table ES-2. The projected level of attainment following 100 percent control of the CSO discharges is the same as for existing conditions.

Table ES- 2. Baseline Compliance with Bacteria Water Quality Criteria

Location		Meets Existing WQ Criteria (Class I)	Meets Primary Contact WQ Criteria (Class SC)	Meets Future Primary Contact WQ Criteria
Westchester Creek	Inner Area (Represented by stations WC2, WC1, WC3)	YES	NO	NO
	Outer Area Represented by station E13)	YES	YES	YES(1)

Note: YES indicates attainment is calculated to occur ≥ 95 percent of time.
NO indicates attainment is calculated to be less ≤ 95 percent of time.
(1) Calculated to comply 96 percent of the time with GM but STV values if adopted would not be attained.

Table ES-2 shows that Westchester Creek meets the Existing WQ Criteria. Levels of attainment are less for the Primary Contact WQ Criteria (Class SC) in Westchester Creek and Future Primary Contact WQ Criteria.

Further, even with 100 percent control of all CSOs the projected attainment with the recreational season enterococci criteria only increases marginally for the same 10-year period. Even less attainment occurs when the 2012 EPA RWQC enterococci STV value 90th upper percentile limits are applied. A more detailed discussion of the attainment modeling results is in Section 8.

In summary, the baseline modeling showed that Westchester Creek exhibits a high level of attainment with the existing WQ criteria. The attainment levels with the Primary Contact WQ Criteria (Class SC) and the Future Primary Contact WQ Criteria are lower. The enterococci STV value 90th percentile limit cannot be met in the Inner Area.

Public Outreach

DEP followed a comprehensive public participation plan in ensuring engagement of interested stakeholders in the LTCP process. Stakeholders included both citywide and regional groups, a number of who offered comments at two public meetings held for this LTCP. DEP will continue to gather public feedback on waterbody uses and will provide the public UAA-related information at the third Westchester Creek Public Meeting. The third meeting will present the final recommended plan to the public after DEC review of the LTCP.

At the second of two public meetings conducted to date, there was a high degree of public support for DEP's findings that additional grey infrastructure based-CSO controls were not warranted, due to the water quality improvements achieved from implementation of the 2011 WWFP recommendations. No support was expressed for additional CSO controls or improved use for Westchester Creek during the public participation meetings.

Evaluation of Alternatives

A multi-step process was used to evaluate control measures and CSO control alternatives. The evaluation process considered factors related to environmental benefits; community and societal impacts; and implementation and O&M considerations. Following the comments from two detailed technical workshops, the retained alternatives were subjected to cost performance and cost attainment evaluations where economic factors were introduced. Table ES-3 contains the six retained alternatives.

Table ES-3. Summary of Retained Alternatives

Alternative	Description
1. Throgs Neck PS Force Main (FM) Extension	Extend FM to Hunts Point WWTP, maintain capacity at 37.5 MGD, and modify pumps to account for additional head loss. Maintaining current capacity at 37.5 MGD and extending the force main directly to the Hunts Point WWTP.
2. 24.5 MG Storage Tunnel	40-ft. dia., 2,600 LF tunnel deemed to be the most viable technology for capturing outfall HP-014 volume. Includes 24.5 MGD dewatering PS.
3. 43 MG Storage Tunnel	40-ft. dia., 4,500 LF tunnel deemed to be the most viable technology for capturing CSO from outfalls HP-014, HP-015, HP-016 and HP-033. Includes 43 MGD dewatering PS.
4. 50 MG Storage Tunnel	26-ft. dia., 12,600 LF tunnel deemed to be the most viable technology for capturing CSO from outfalls HP-014, HP-015, HP-016, HP-033, HP-012 and HP-013. Includes 50 MGD dewatering PS.
5. Floatables Control	Targeting HP-011 at the East River to address the increased AAOV resulting from the planned WWFP recommendations; evaluation deferred to the Bronx River LTCP..
6. Bronx River Siphon Enhancement	Targeting HP-011 at the East River to address the increased AAOV resulting from the planned WWFP recommendations; evaluation deferred to the Bronx River LTCP

CSO Reductions, WQ Impact with the Selected Alternative

A summary of the results of the final step of the evaluation process for enterococci and fecal coliform are illustrated by Figure ES-4 and ES-5, which is a cost-performance curve for the various alternatives regarding enterococci and fecal coliform loading reductions. The best-fit curve in the figure does not clearly show a knee-of-the-curve (KOTC).

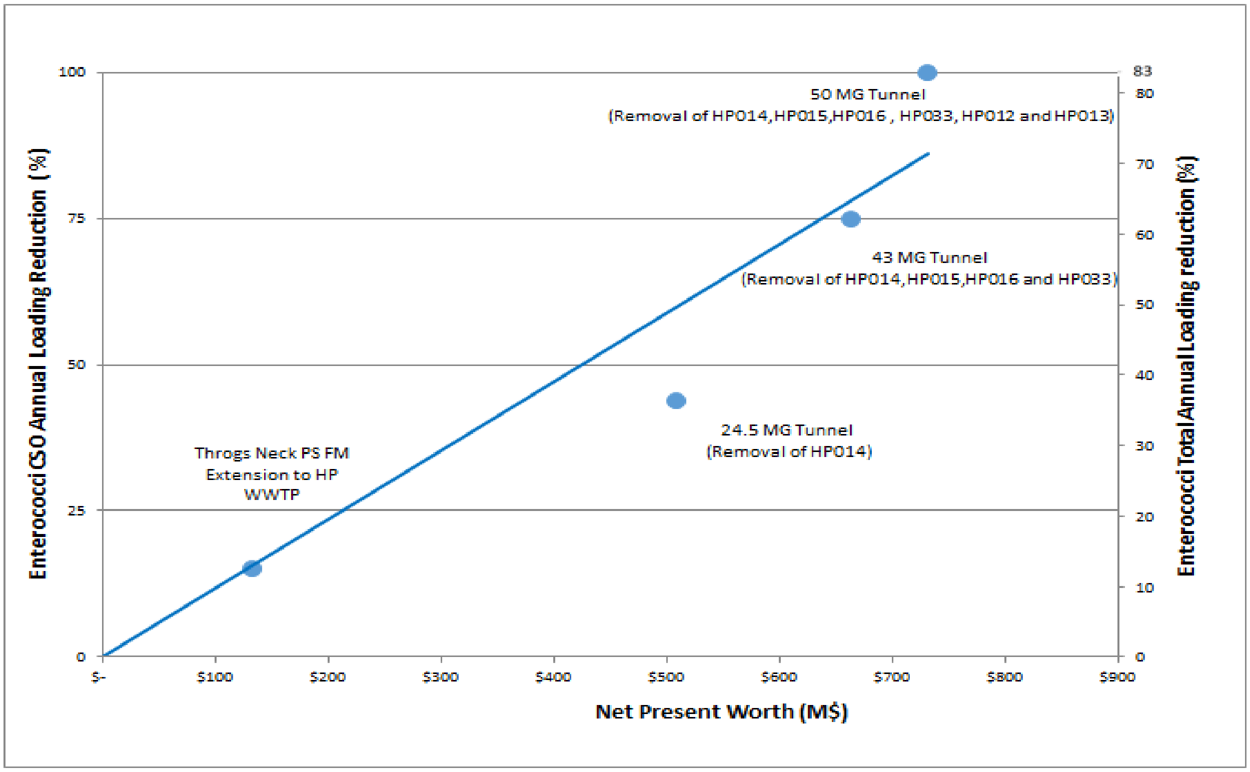


Figure ES-4. Cost vs. Enterococci Loading Reduction (2008 Rainfall)

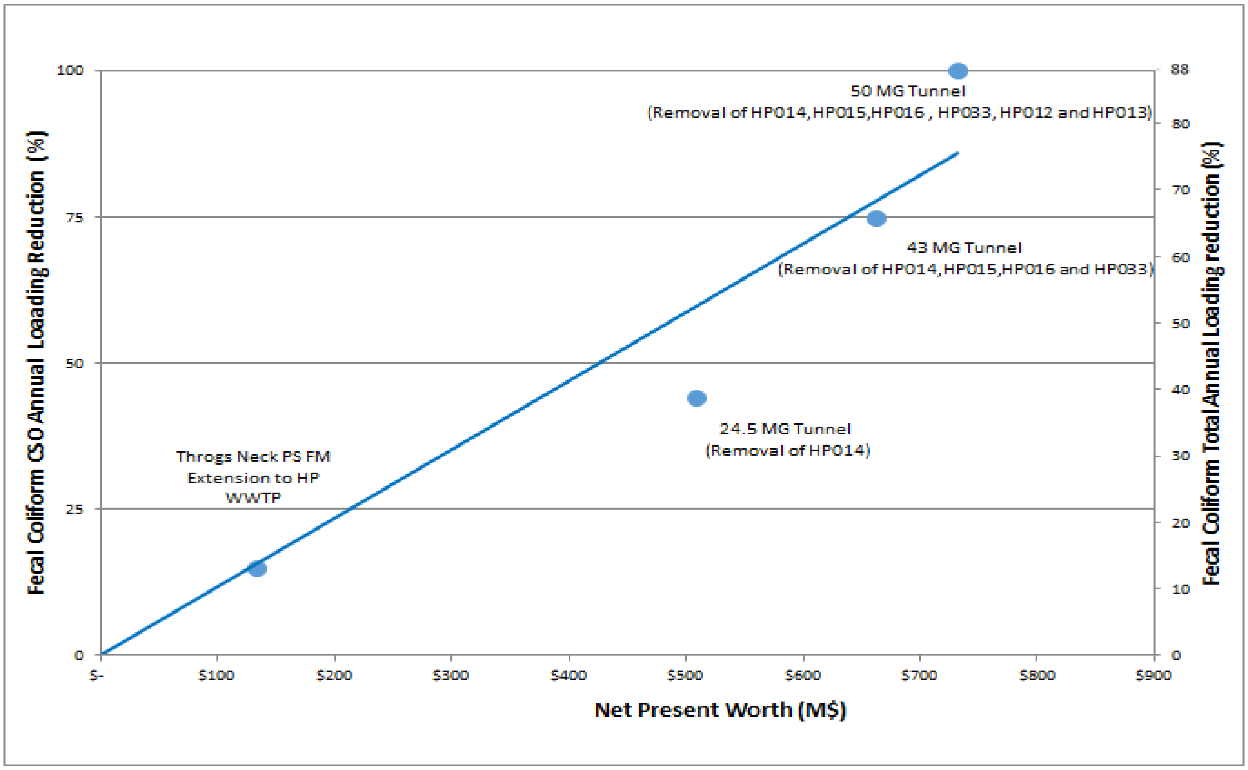


Figure ES-5. Cost vs. Fecal Coliform Loading Reduction (2008 Rainfall)

The cost-attainment curves that are presented in Section 8.5 did not show meaningful improvement in WQS attainment for any of the alternatives, including that with 100 percent CSO control.

RECOMMENDATIONS

Long Term CSO Control Plan Implementation, UAA and Summary of Recommendations

DEP will implement the plan elements identified in this section after approval of the LTCP by DEC. This Long Term Control Plan recommends the continued implementation of WWFP recommendations and has identified potential site specific water quality targets for the water body beyond the currently applicable water quality standards, based on the predicted performance of the selected CSO controls. The potential site specific targets allow Westchester Creek to advance towards the Primary Contact WQ Criteria (Class SC). DEP will work to achieve the site specific targets. They are based on a review of ten years of water quality model simulations. Post construction monitoring data will be collected to assess and compared to the targets.

The potential site specific water quality targets are based on a review of ten years of water quality model simulations and should be met the majority of the time.

The LTCP analyses and recommendations for Westchester Creek LTCP are summarized below for the following items:

1. Water Quality Modeling Results
2. Identified UAA Site specific Targets
3. Summary of Recommendations

Water Quality Modeling Results

The water quality modeling results for Westchester Creek are shown in Table ES-4 for the recommended alternative. These results provide the calculated annual attainment of the fecal coliform and enterococci bacteria concentrations for the plan. The results show, for the different calculated levels of attainment, when concentrations would be at or lower than the Existing WQ Criteria, Primary Contact WQ Criteria (Class SC) and Future Primary Contact WQ Criteria with 2012 EPA RWQC.

The recommended plan achieves annual attainment of the existing fecal coliform criteria. For the Primary Contact WQ Criteria (Class SC), Westchester Creek is projected to achieve a high level of attainment with the fecal coliform criterion. However, for the inner area closer to the head of the creek, attainment of this criterion remains below what is considered to achieve the corresponding water quality standards or the Section 101(a)(2) goals . With the recommended plan, compliance with the Future Primary Contact WQ Criteria with 2012 EPA RWQC remains low in Westchester Creek.

Table ES-4. Calculated 10-year Bacteria Attainment for Recommended Plan (Baseline Conditions) – Recreational Season (May 1st – October 31st)

Station	Existing WQ Criteria(Class I)		Primary Contact WQ Criteria (Class SC)		Future Primary Contact WQ Criteria	
	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
WC2	Fecal ≤2,000	100	Fecal ≤200	88	Enterococci ≤35	64
					STV≤130	4
WC1	Fecal ≤2,000	100	Fecal ≤200	93	Enterococci ≤35	77
					STV≤130	16
WC3	Fecal ≤2,000	100	Fecal ≤200	95	Enterococci ≤35	87
					STV≤130	24
E11	Fecal ≤2,000	100	Fecal ≤200	100	Enterococci ≤35	96
					STV≤130	52

Attainment of the STV upper 90th percentile values contained in the future Primary Contact WQ Criteria is difficult if not impossible to achieve. Maximum enterococci concentrations will far exceed the EPA recommended Future Contact WQ Criteria STV concentration of 130 cfu/100 mL. Calculated 90th percentile concentrations are greater than the proposed value of 130 cfu/100 mL on an annual basis with some portions of the creek able to attain 130 in the recreational season. As noted earlier, recent input from DEC is that the agency plans to promulgate the 30/110 cfu/100mL rolling GM and STV respectively. The analyses performed for this LTCP are based on the 35/130 cfu/100mL numerical criteria. Additional information on the STV water quality criteria is presented in Section 8 and the UAA.

Potential UAA Site Specific Targets

Since the recommended LTCP projects will not result in full compliance in Westchester Creek with the Primary Contact WQ Criteria (Class SC), DEP has prepared a UAA for Westchester Creek that identifies potential site specific incremental targets with advisories. Application of these targets will reduce the bacteria loads to Westchester Creek and will advance Westchester Creek towards the Primary Contact WQ Criteria, Class SC.

These site specific targets are based on water quality model simulations that account for CSO and stormwater sources. Under these conditions, the bacteria water quality indicators should be less than the identified targets the majority of the time.

The recommended recreational season site-specific targets are summarized in Table ES-5 in comparison to the existing and Primary Contact WQ Criteria. This table also provides a summary of the calculated bacteria criteria attainment. As noted in this table, based upon projections, the plan results in a high level of attainment.. Table ES-5 also presents an Inner and Outer Area. The Inner Area is from Norton Avenue north and the Outer Area is from Norton Avenue South as shown in Figure ES-1.

Table ES-5. Summary of Recommended Recreational Season Bacteria Water Quality Targets

Location	Existing WQ Criteria (Class	Primary Contact WQ Criteria (Class SC)	Site Specific Targets (cfu/100mL)	Attainment with Incremental Targets (%)
Inner Area (WC2, WC1, WC3)	Fecal Coliform(1) ≤ 2000	Fecal Coliform(1) ≤ 200	Fecal Coliform ≤ 600	97
			Enterococci ≤ 300(2)	97
Outer Area (E11)	Fecal Coliform(1) ≤ 2000	Fecal Coliform(1) ≤ 200	Fecal Coliform ≤ 200	99
			Enterococci ≤35(2)	96

Notes: (1) Monthly GM.
(2) 30-day rolling average GM during recreation season (May 1 to October 31).

DEP has performed an analysis to determine the amount of time following the end of rainfall required for the outer portion of Westchester Creek to recover and return to concentrations less than 1,000 cfu/100 mL fecal coliform and 130 cfu/100mL enterococci. The analyses consisted of examining the water quality model calculated for outer Westchester Creek pathogen concentrations for recreation periods (May 1st to October 31st) abstracted from 10-years of model simulations. The time to return to 1,000 or 130 was then calculated for each storm with the various size categories and the median time after the end of rainfall was then calculated for each rainfall category.

The results of these analyses are summarized in Table ES-6 for the outer portion of Westchester Creek. As noted the duration of time within which pathogen concentrations are expected to be higher than New York State Department of Health (DOH) considers safe for primary contact varies with location and with rainfall event size. Generally, a value of around 24 hours would be typical for the outer portion of Westchester Creek (E13) for storms with rainfall volumes of less than 1-inch.

Table ES-6. Time to Recover at Station E13

Rain Event Size (in)	Station	Time to Recover (hours)	
		Fecal Coliform Threshold (1000 cfu/100mL)	Enterococci Threshold (130 cfu/100mL)
<0.1	E13	-	-
0.1-0.4	E13	-	-
0.4-0.8	E13	-	-
0.8-1.0	E13	3	16
1.0-1.5	E13	3	24
>1.5	E13	19	37

Summary of Recommendations

Water quality in Westchester Creek will be improved with the actions presented in this LTCP. Attainment with the pathogen standards will increase due to implementation of the WWFP and GI projects; however, the overall water quality will only marginally improve.

The actions items identified with the Westchester Creek LTCP are:

1. The LTCP includes a UAA that identifies feasible site-specific WQ targets based on the projected performance of the selected CSO controls. A post construction monitoring program will be initiated after the WWFP improvements are operational. Based upon the results of such monitoring, the site-specific WQ targets may need to be reviewed.

2. DEP will establish with the NYC Department of Health and Mental Hygiene through public notification a 24-hour wet weather advisory during the Recreational Season (May 1 to October 31), during which swimming and bathing would not be recommended in the outer Westchester Creek. The LTCP includes a recovery time analysis that can be used to establish the 24-hour wet weather advisory for public notification.

3. DEP will continue to implement the WWFP recommendations: Pugsley Creek parallel sewer and regulator modifications at CSO-29 and CSO-29A.

4. DEP will continue to implement the Green Infrastructure program.

5. DEP will include in the Bronx River LTCP an analysis to control floatables at the HP-011 at the East River to address the increased CSO volume resulting from the planned WWFP recommendations.

6. DEP will investigate as part of the Bronx River LTCP a new siphon targeting HP-011 at the East River. This analysis will investigate the AAOV resulting from the planned WWFP recommendations with goal of increasing CSO flow to the Hunts Point WWTP.

In summary, this LTCP is expected to reduce the human contributed CSO bacteria and pathogens discharged to Westchester Creek from CSOs. The overall water quality attainment in Westchester Creek is anticipated to marginally improve due to the nature of the pathogen standards and due to the stormwater and direct drainage contributions. The action items above are expected to provide improvement beyond the existing water quality standards.

DEP is committed to improving water quality in this waterbody, which will be advanced by the improvements and recommendations presented in this plan. These identified actions have been balanced with input from the public and awareness of the cost to the citizens of New York City.

1.0 INTRODUCTION

This Long Term Control Plan (LTCP) for Westchester Creek was prepared pursuant to the Combined Sewer Overflow (CSO) Order on Consent (DEC Case No. CO2-20110512-25), dated March 8, 2012 (2012 Order on Consent). The 2012 Order on Consent is a modification of the 2005 CSO Order on Consent (DEC Case No. CO2-20000107-8). Under the 2012 Order on Consent, the New York City Department of Environmental Protection (DEP) is required to submit 11 waterbody-specific LTCPs to the New York State Department of Environmental Conservation (DEC) by December 2017. The Westchester Creek LTCP is the second of the LTCPs under the 2012 Order on Consent to be completed.

1.1 Goal Statement

The following is the LTCP Introductory Goal Statement, which appears as Appendix C in the 2012 Order on Consent. It is generic in nature, so that waterbody-specific LTCPs will take into account, as appropriate, the fact that certain waterbodies or waterbody segments may be affected by the City's concentrated urban environment, human intervention and current waterbody uses, among other factors. DEP will identify appropriate water quality outcomes based on site-specific evaluations in the drainage basin-specific LTCP, consistent with the requirements of the Federal CSO Control Policy and the Clean Water Act (CWA).

> *The New York City Department of Environmental Protection submits this Long Term Control Plan (LTCP) in furtherance of the water quality goals of the Federal Clean Water Act and the State Environmental Conservation Law. We recognize the importance of working with our local, State, and federal partners to improve water quality within all City-wide drainage basins and remain committed to this goal.*
>
> *After undertaking a robust public process, the enclosed LTCP contains water quality improvement projects, consisting of both grey and green infrastructure, which will build upon the implementation of the U. S. Environmental Protection Agency's (EPA) Nine Minimum Controls and the existing Waterbody/Watershed Facility Plan projects. As per EPA's CSO Control Policy, communities with combined sewer systems are expected to develop and implement LTCPs that provide for attainment of water quality standards and compliance with other Clean Water Act requirements. The goal of this LTCP is to identify appropriate CSO controls necessary to achieve waterbody-specific water quality standards consistent with EPA's 1994 CSO Policy and subsequent guidance. Where existing water quality standards do not meet the Section 101(a)(2)* goals[1] *of the Clean Water Act, or where the proposed alternative set forth in the LTCP will not achieve existing water quality standards or the Section 101(a)(2) goals, the LTCP will include a Use Attainability Analysis examining whether applicable waterbody classifications, criteria, or standards should be adjusted by the State. The Use Attainability Analysis will assess the*

[1] This LTCP is designed to meet the existing WQS that have been promulgated by DEC. To the extent that this LTCP provides, analyzes, or selects alternatives that may lead to achievement of targets beyond what are required under existing WQS, DEP provides these analyses and/or commitments in order to improve water quality beyond the requirements of the CSO Control Policy and other applicable law. DEP reserves its rights to participate in any administrative and/or rulemaking process that DEC may engage in to revise WQS, including, if it so desires, to oppose revised WQS that DEC may propose and reserves its right to challenge such revised WQS.

waterbody's highest attainable use, which the State will consider in adjusting water quality standards, classifications, or criteria and developing waterbody-specific criteria. Any alternative selected by a LTCP will be developed with public input to meet the goals listed above.

On January 14, 2005, the NYC Department of Environmental protection and the NYS Department of Environmental Conservation entered into a Memorandum of Understanding (MOU), which is a companion document to the 2005 CSO order also executed by the parties and the City of New York. The MOU outlines a framework for coordinating CSO long-term planning with water quality standards reviews. We remain committed to this process outlined in the MOU and understand that approval of this LTCP is contingent upon our State and federal partners' satisfaction with the progress made in achieving water quality standards, reducing CSO impacts, and meeting our obligations under the CSO Orders on Consent.

This Goal Statement has guided the development of the Westchester Creek LTCP and UAA.

1.2 Regulatory Requirements (Federal, State, Local)

The waters of the City of New York are subject to Federal and New York State regulation. The following sections provide an overview of the regulatory issues relevant to long term CSO planning. Detailed discussions of regulatory requirements are provided in the June 2011 Westchester Creek Waterbody Watershed Facility Plan (WWFP) (DEP, 2011).

1.2.a Federal Regulatory Requirements

The CWA established the regulatory framework to control surface water pollution, and gave EPA the authority to implement pollution control programs. The CWA established the National Pollutant Discharge Elimination System (NPDES) permit program. NPDES regulates point sources discharging 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, the NPDES permit program is administered by the DEC, and is thus a State Pollution Discharge Elimination System (SPDES) program. New York City has had an approved SPDES program since 1975. Section 303(d) of the CWA and 40 CFR §130.7 (2001) requires states to identify water bodies that do not meet water quality standards and are not supporting their designated uses. These waters are placed on the Section 303(d) List of Water Quality Limited Segments (also known as the list of impaired water bodies). The List identifies the pollutant or stressor causing impairment and establishes a schedule for developing a control plan to address the impairment. Placement on this list can lead to the development of a Total Maximum Daily Load (TMDL) for each waterbody and associated pollutant/stressor on the list. Pollution controls based on the TMDL serve as a means to attain and maintain water quality standards for the impaired water body. Westchester Creek was included on the Part 3c 2004 list of impaired waterbodies – Waterbodies for which TMDL Development May be Deferred (Pending Implementation/Evaluation of Other Restoration Measures) due to low dissolved oxygen (DO) concentrations by urban sources, stormwater runoff, and CSO discharges. Westchester Creek was retained in this section of the 2010 303(d) List. However, as shown in Table 1-1, Westchester Creek, which is included under the CSO Order, has been delisted from the 2012 303(d) list (revised February 2013) as a Category 4b waterbody for which required control measures other than a TMDL (i.e., order on consent) are expected to restore uses.

Table 1-1. 2012 DEC 303(d) Impaired Waters Listed and Delisted (with Source of Impairment)

Waterbody	Pathogens	DO/Oxygen Demand	Floatables
Westchester Creek		Urban, Storm, CSOs	CSOs, Urban/Storm

1.2.b Federal CSO Control Policy

The 1994 EPA CSO Control Policy provides guidance to permittees and NPDES permitting authorities on the development and implementation of a LTCP, in accordance with the provisions of the CWA. The CSO policy was first established in 1994 and codified as part of the CWA in 2000.

1.2.c New York State Policies and Regulations

The State of New York has established Water Quality Standards (WQS) for all navigable waters within its jurisdiction. Westchester Creek is classified as a Class I waterbody. A Class I waterbody is defined as “suitable for fish, shellfish and wildlife propagation and survival”. The best usages of Class I waters are “secondary contact recreation and fishing” (6 NYCRR 701.13) Interstate Environmental Commission (IEC).

The States of New York, New Jersey and Connecticut are signatories 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, Westchester Creek. The IEC has recently been incorporated into and is now part of the New England Interstate Water Pollution Control Commission (NEIWPCC), a similar multi-state compact of which New York is a member. The IEC is now a district of NEIWPCC. Westchester Creek is classified as Type A under the IEC system. Details of the IEC Classifications are presented in Section 2.2.

1.2.d Administrative Consent Order

The City and DEC have entered into Orders on Consent to address CSO issues, including the 2005 CSO Order on Consent, which was issued to bring all DEP CSO-related matters into compliance with the provisions of the CWA and the New York State Environmental Conservation Law (ECL), and requires implementation of the LTCPs. The 2005 Order on Consent required DEP 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 the 1994 EPA CSO Control Policy. The 2005 Order on Consent was modified as of April 14, 2008, to change certain construction milestone dates. In addition, DEP and DEC entered into a separate memorandum of Understanding (MOU) to facilitate WQS reviews in accordance with the EPA CSO Control Policy. The last modification to the 2005 Order that occurred prior to 2012 was in 2009, which addressed the completion of the Flushing Creek CSO Retention Facility.

In March 2012, DEP and DEC amended the 2005 Order to provide for incorporation of Green Infrastructure (GI) into the LTCP process as proposed under the City’s Green Infrastructure Plan, and to update certain project plans and milestone dates. In doing so, some of the grey infrastructure projects planned earlier were eliminated from the Order.

1.3 LTCP Planning Approach

The LTCP planning approach includes several phases, including a characterization phase – an assessment of current waterbody and watershed characteristics, system operation and management practices, the status of current green and grey infrastructure projects, and an assessment of current system performance. DEP gathers the majority of this information from field observations, historical records and analysis of studies and reports. The next phase is the identification and analysis of alternatives to reduce the frequency of wet weather discharges and improve water quality. DEP expects that alternatives will include a combination of green and grey infrastructure elements and will be carefully evaluated using both the collection system and receiving water models. Following the analysis of alternatives, DEP will develop a recommended plan along with an implementation schedule and strategy. If the proposed alternative will not achieve existing WQS or the Section 101(a)(2) goals of CWA, the LTCP will include a UAA examining whether Applicable waterbody classifications, criteria, or standards should be adjusted by the State.

1.3.a Integrate Current CSO Controls from Waterbody/Watershed Facility Plans (Facility Plans)

This LTCP builds upon prior efforts by capturing the findings and recommendations from the previous facility planning documents for this watershed and integrating the findings into the LTCP.

DEP submitted a draft Waterbody/Watershed Facility Plan report in June 2007 for Westchester Creek. Comments from DEC were received on January 10, 2010. In June 2011, DEP issued the revised Westchester Creek WWFP which was subsequently revised February 2012. The WWFP was approved by DEC on May 4, 2012. The WWFP, which was prepared pursuant to the 2005 Order on Consent, includes an analysis and presentation of operational and structure modifications targeting the reduction of CSOs and improve the overall performance of the collection and treatment system within the watershed.

1.3.b Coordination with DEC

As part of the LTCP process, DEP attempted to work closely with DEC to share ideas, track progress, and work toward developing strategies and solutions to address wet weather challenges in the New York Harbor Complex.

Representatives from DEP and DEC technical staff met to discuss this LTCP during its development. Separately, on a quarterly basis, DEC, DEP and outside technical consultants convene for a larger progress meeting that typically includes technical staff as well as representatives from the DEP and DEC's legal departments and department chiefs who oversee the execution of projects covered by the Order.

1.3.c Watershed Planning

DEP prepared its CSO WWFPs before the emergence of green infrastructure (GI) as an established method for reducing stormwater runoff; consequently the WWFPs did not include a full analysis of GI alternatives for controlling CSOs. In comments on DEP's CSO WWFPs, community and environmental groups voiced widespread support for GI and urged that DEP place greater reliance upon that sustainable strategy. Including GI in the LTCPs is consistent with the 2012 Order and recent EPA guidance. To the extent that GI installations are feasible in any given area, the use of GI will lead to the achievement of better water quality and sustainability benefits than using solely grey technologies. A sustainable approach includes the management of stormwater at its source, through the creation of vegetated areas and other GI, bluebelts and greenstreets, green parking lots, green roofs, and other technologies discussed in detail in Section 5.0 of this report.

1.3.d Public Participation Efforts

A concerted effort was made during the Westchester Creek LTCP Planning process to involve all relevant and appropriate stakeholders and keep public and stakeholders informed about the project. A public outreach participation plan was developed and implemented throughout the process which is posted and continuously updated on DEP's LTCP program website (www.nyc.gov/dep/ltcp). Specific objectives of this initiative included the following:

- Develop and implement an approach that would reach all interested stakeholders;
- Integrate the public outreach efforts with all other aspects of the planning process; and
- Take advantage of other on-going public efforts being conducted by DEP and other City agencies as part of other related programs.

The public participation efforts for this Westchester Creek LTCP are summarized in Section 7.0 in more detail.

2.0 WATERSHED/WATERBODY CHARACTERISTICS

This section of the LTCP summarizes the major characteristics of the Westchester Creek watershed and waterbody, building upon earlier documents that present a characterization of the area. These include the WWFP for Westchester Creek (DEP, 2011, Revised Feb 2012).

2.1 Watershed Characteristics

This subsection contains a summary of the watershed characteristics as they relate to the sewer system configuration, performance, and impacts to the adjacent waterbodies as well as the modeled representation of the collection system used for analyzing system performance and CSO control alternatives.

2.1.a Description of Watershed

Westchester Creek is a tributary of the Upper East River and is located in the eastern section of the Bronx. The Westchester Creek LTCP Study Area comprises both Westchester Creek and Pugsley Creek and their highly urbanized watersheds. Bound on the east by the Hutchinson River watershed and on the west by the Bronx River watershed, the Westchester Creek watershed contains numerous parks and open spaces, particularly along the lower portions of the waterbody, including Ferry Point Park, Clason's Point Park, Castle Hill Park and Pugsley Creek Park. St. Raymond's Cemetery comprises a large portion of the eastern watershed as well. Although open spaces are significant, the land use in the watershed is predominantly residential. The land immediately adjacent to the creek is generally a mix of open space and residential and industrial uses. However, industrial, manufacturing, transportation and utility uses exist along the western shore and the middle reaches of the eastern shore.

The natural watershed of Westchester and Pugsley Creeks consists of approximately 3,600 acres based on interpretation of the local topography. Construction of engineered collection systems, urban development and other alterations to the watershed and runoff pathways have resulted in approximately 5,000 acres of drainage area tributary to Westchester and Pugsley Creeks. Ferry Point Park, the largest section of open space within the assessment area, occupies the eastern shoreline from the mouth of Westchester Creek up to approximately one-mile upstream.

Pugsley Creek is bound by two parks, Pugsley Creek and Castle Hill. Pugsley Creek Park surrounds the creek along the western and northern shorelines, whereas Castle Hill Park lies at the tip of Castle Hill Point on the eastern side of the mouth of Pugsley Creek. The area surrounding the creek is almost entirely residential with limited commercial zones.

The urbanization of Westchester Creek and Pugsley Creek has led to the creation of combined sewer systems (CSSs) and to an increase in the impervious area of the formerly natural direct drainage areas. The majority of the Westchester Creek watershed is served by the Hunts Point (HP) Wastewater Treatment Plant (WWTP). Sanitary flows and a portion of combined sanitary and stormwater flows are conveyed to the HP WWTP for treatment. Flows that exceed the capacity of the conveyance and treatment system are discharged into the waterbodies via permitted CSO outfalls. Limited portions of the drainage area along the shorelines discharge their runoff directly to Westchester Creek. Figure 2-1 depicts the Westchester Creek Study Area and its location relative to the Hunts Point WWTP (HP WWTP).

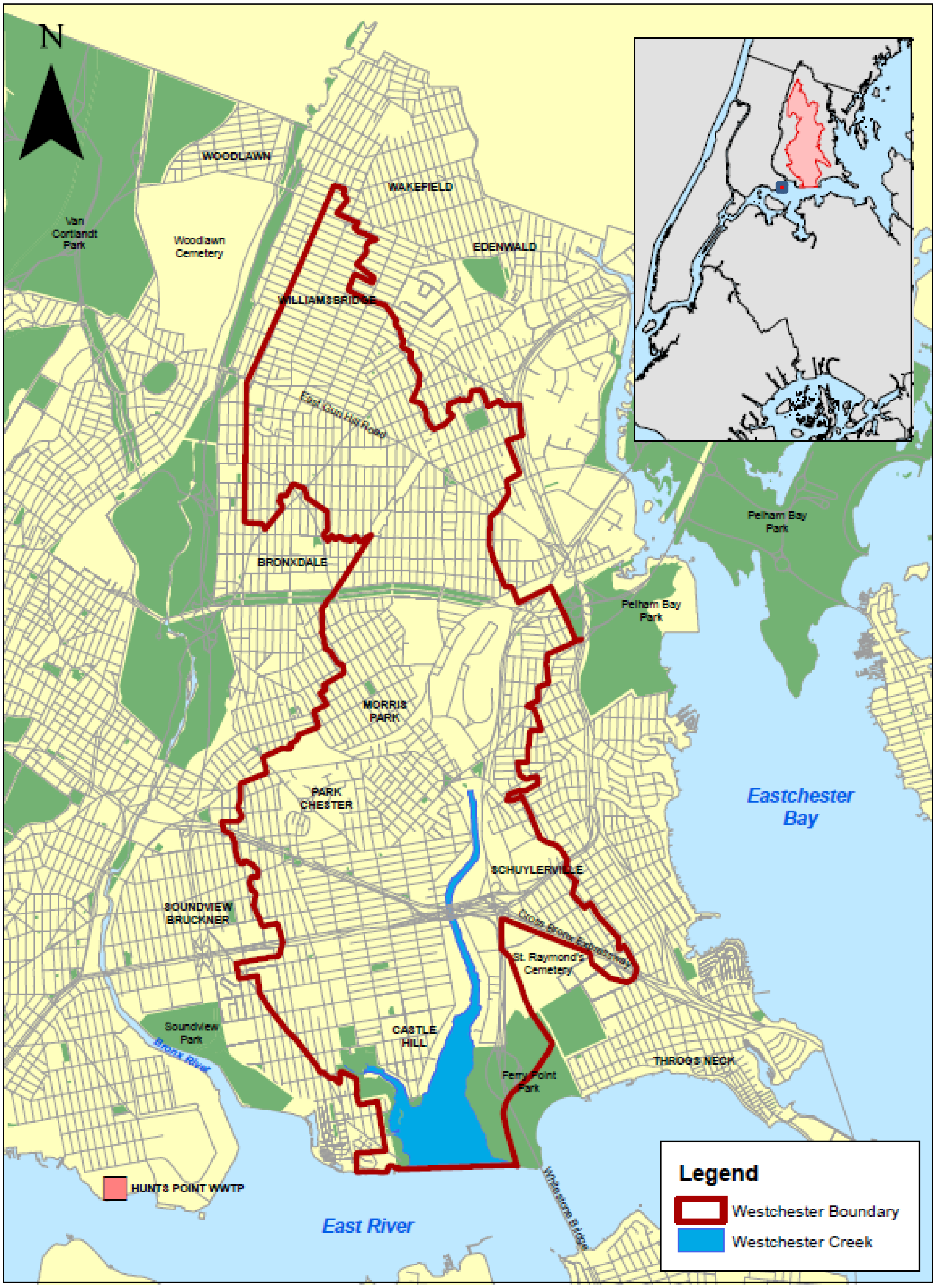


Figure 2-1. Westchester Creek Study Area and HP WWTP

As a residential community within New York City, several large and notable transportation corridors cross the watershed, providing access between dense commercial and manufacturing areas and residential areas, as depicted in Figure 2-2. A major interstate highway system interchange spans over Westchester Creek including the Cross Bronx Expressway (Interstate 95), the Bruckner Expressway (Interstate 278), the Whitestone Expressway (Interstate 678) and the Hutchinson River Parkway. The Parkway runs parallel to the eastern shore of Westchester Creek. The Unionport Bridge carries Bruckner Boulevard across Westchester Creek within this interchange. Businesses in the area rely heavily on local access to the Bruckner Expressway and Cross Bronx Expressway. These transportation corridors also limit access to portions of the waterbodies and need to be taken into consideration when developing CSO control solutions.

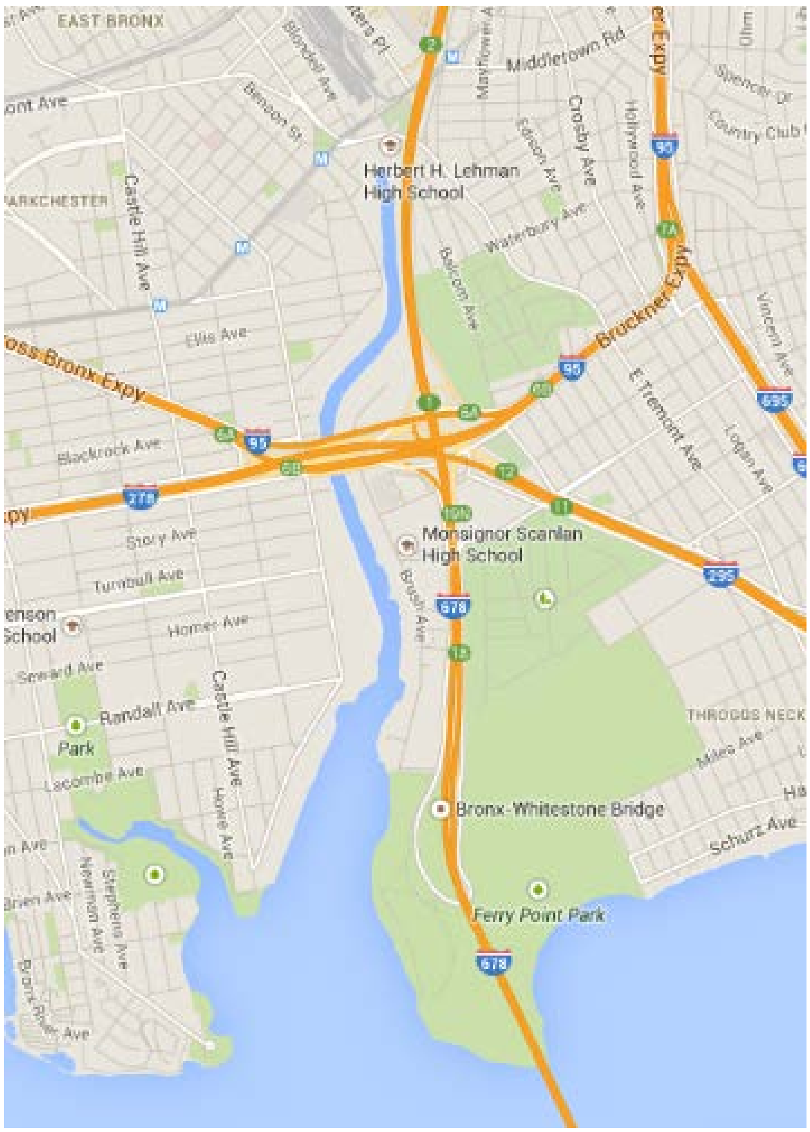


Figure 2-2. Major Transportation Features

2.1.a.1 Existing and Future Land use and Zoning

Current zoning for the watershed is shown in Figure 2-3. Zoning immediately adjacent to Westchester Creek is dominated by manufacturing districts. Zoning adjacent to Pugsley Creek is comprised primarily of park properties and residential districts. The majority of the western shore of Westchester Creek is zoned manufacturing, from the head near its confluence with Pugsley Creek. Areas to the north and northwest of Westchester Creek are primarily M1 zones, and the southern reaches contain M1, M2 and M3 zoning. The eastern shore of Westchester Creek is zoned M1 from the Bruckner Expressway southward to Ferry Point Park. The generalized land use of the watershed is shown in Figure 2-4.

The land within a ¼-mile radius of the Westchester Creek waterbody is primarily residential, except for the manufacturing zoning concentrated on the shores of Westchester Creek, and limited commercial districts concentrated along neighborhood thoroughfare within the residential zoning, as illustrated in Figure 2-5. Residential zoning includes R3, R4, R5, R6, and R7 districts, permitting a broad range of housing types, as well as community facilities and open uses which serve the residents of these districts. The entire western portion of the area within a ¼-mile radius of Westchester Creek is zoned as R4. Most of the communities to the east are zoned R5, with some R4 and R3 areas mixed. The area northeast of the head of Westchester Creek is zoned R5, R6 and R7.

The relative distribution of land uses in the watershed and riparian area (within a ¼-mile radius is summarized in Table 2-1.

Table 2-1. Westchester Creek Land Use Summary by Category[(1)]

Land Use Category	Watershed %	Riparian Area (1/4 mile) %	Shoreline %
Open Space	15	44	69
Residential	55	20	2
Commercial	7	8	7
Industrial	4	12	11
Mixed Use [(2)]	18	15	10

(1) Totals may not add to 100 percent due to rounding.
(2) Public facilities and institutional, commercial, manufacturing, transportation and vacant.

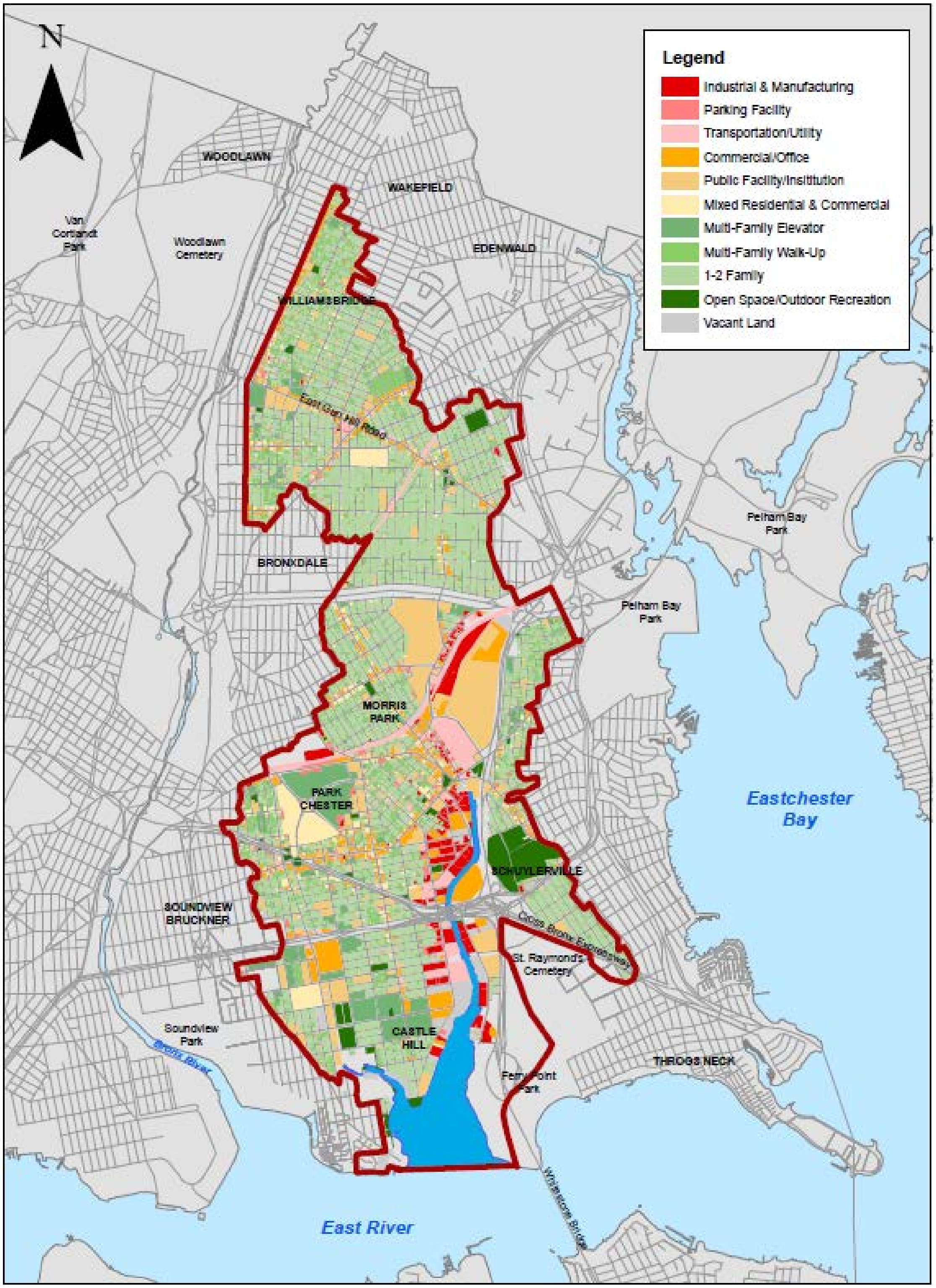


Figure 2-3. Zoning Within Westchester Creek Watershed

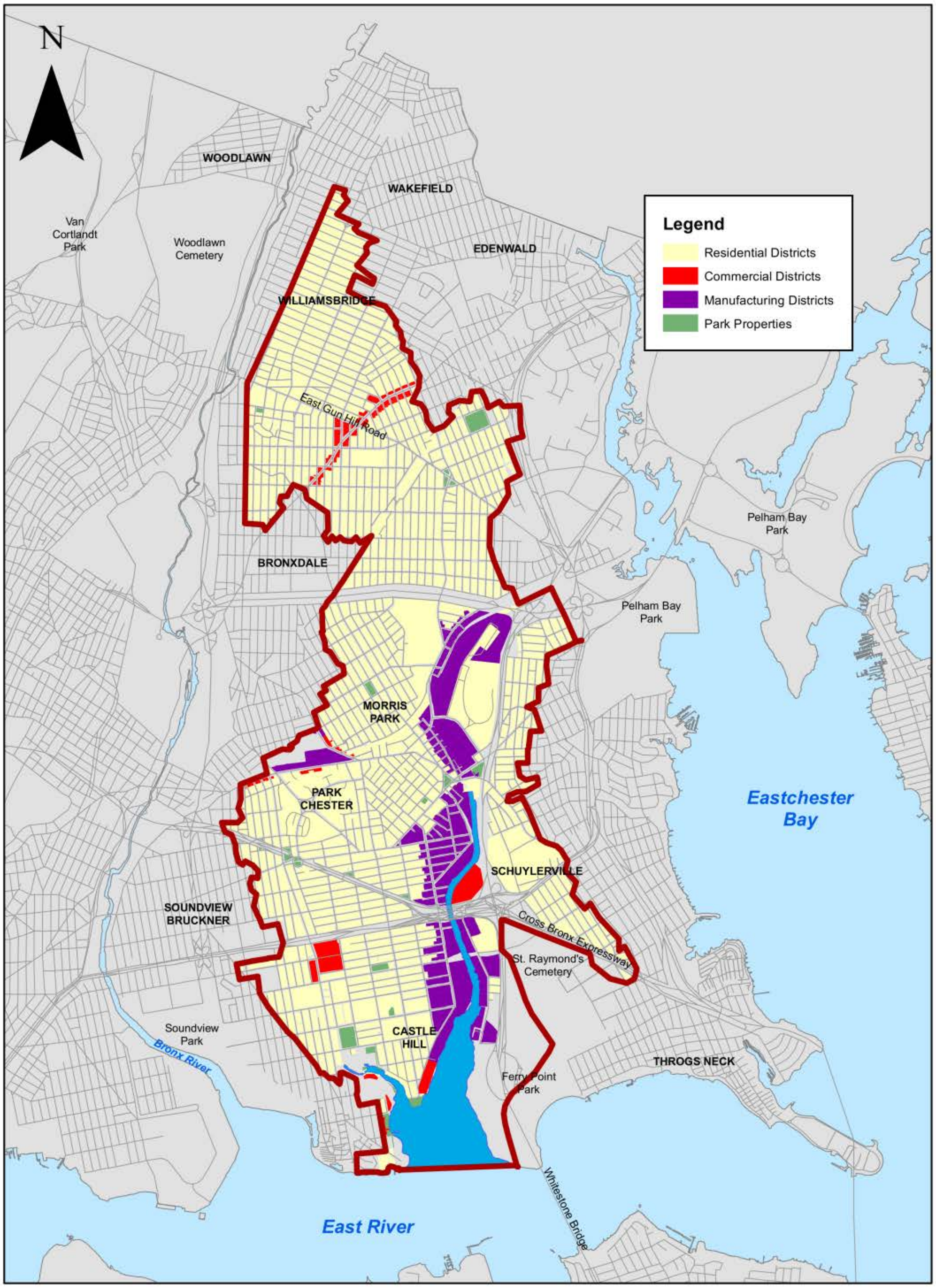


Figure 2-4. Westchester Creek Generalized Land Use

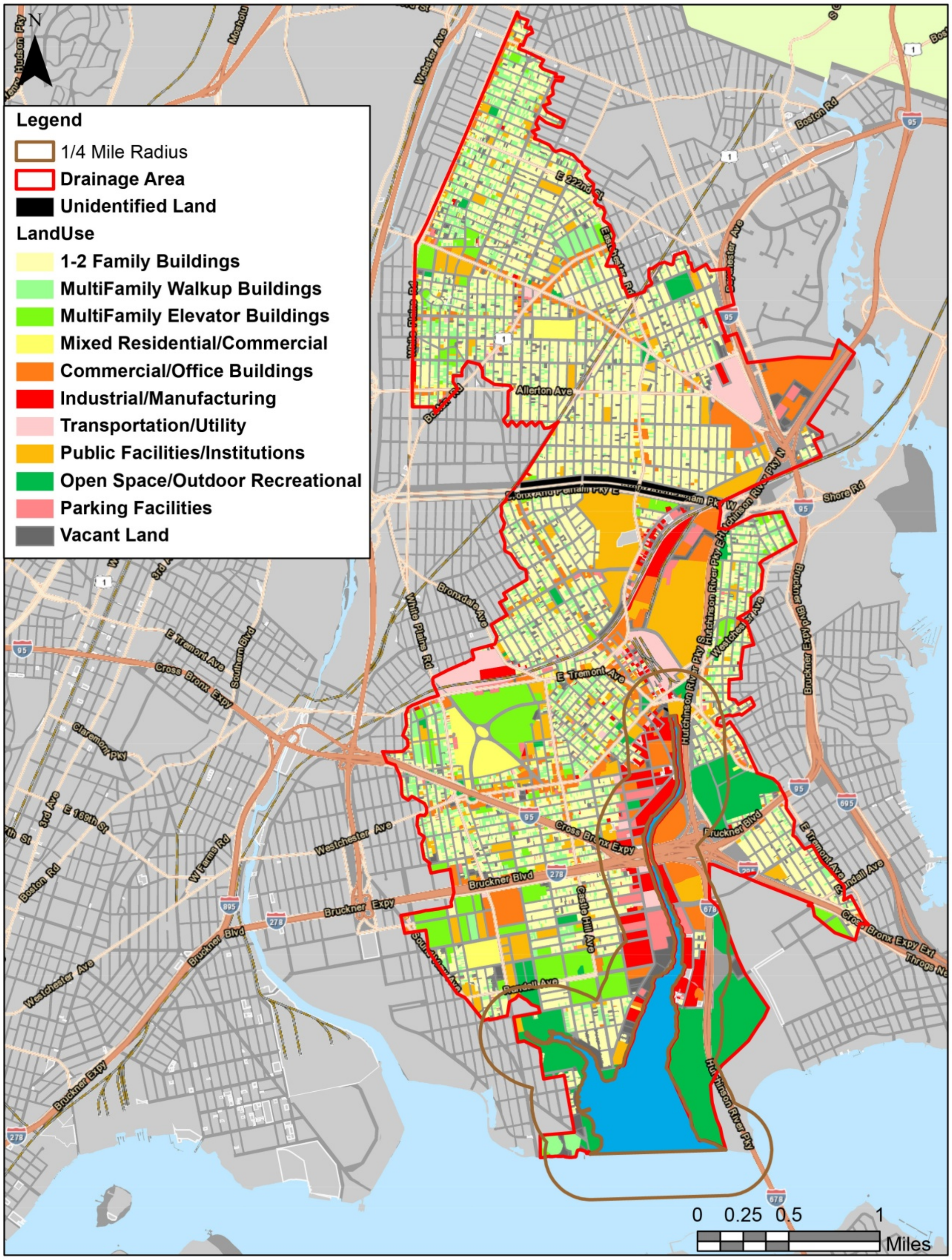


Figure 2-5. ¼ Mile Land Use in Westchester Creek & Pugsley Creek

2.1.a.2 Permitted Discharges

There are several permitted stormwater discharge points. These are discussed in more detail in Section 2.1.c.

2.1.a.3 Impervious Cover Analysis

Impervious surfaces within a watershed are those characterized by an artificial surface, such as concrete, asphalt, rock, or rooftop. Rainfall occurring on an impervious surface will experience a small initial loss through ponding and seasonal evaporation on that surface, with the remaining rainfall volume becoming overland runoff that directly flows into the sewer system and/or separate stormwater system. The impervious surface is important when characterizing a watershed and CSS performance, as well as construction of hydraulic models used to simulate the performance of the CSS.

A representation of the impervious cover was made in the 13 NYC WWTPs combined area drainage models developed in 2007 to support the several WWFPs that were submitted to DEC in 2009. However, as described below, efforts to update the model and the impervious surface representation have been recently completed.

As the City started to focus attention on the use of GI to manage street runoff by either slowing it down prior to entering the combined sewer network, or preventing it from entering the network entirely, it became clear that a more detailed evaluation of the impervious cover would be beneficial. In addition, the City realized that it would be important to distinguish between impervious surfaces that directly introduce runoff [Directly Connected Impervious Areas, or DCIA] to the sewer system from those impervious surfaces that may not contribute runoff directly to the sewers. For example, a rooftop with roof drains directly connected to the combined sewers (as required by the NYC Plumbing Code) would be an impervious surface that is directly connected. However, a sidewalk or pervious surface adjacent to a parkland may not contribute runoff to the CSS and as such would not be considered to be directly connected.

In 2009 and 2010, DEP invested in the development of high quality satellite measurements of impervious surfaces required to conduct the analyses that improved the differentiation between pervious and impervious surfaces, as well as the different types of impervious surfaces. The data and the approach used are described in detail in the InfoWorks (IW) Citywide Model Recalibration Report (DEP, 2012a).

The result of this effort yielded an updated model representation of the areas that contribute runoff to the CSS. This improved set of data aided in model recalibration, and provided the DEP with a better idea where GI can be deployed to reduce the runoff contributions from impervious surfaces that contribute flow to the collection system.

2.1.a.4 Population Growth and Projected Flows

The DEP Bureau of Environmental Planning and Analysis (BEPA) routinely develop water consumption and dry weather wastewater flow projections for DEP planning purposes. Water and wastewater demand projections were developed by BEPA in 2012; an average per capita water demand of 75 gallons per capita per day was determined to be representative of future uses. The year 2040 was established as the planning horizon, and populations for that time were developed by the DCP and the New York Transportation Metropolitan Council.

The 2040 population projection figures were then used with the dry weather per capita sewage flows to establish the dry weather sewage flows contained in the IW model for the HP WWTP sewershed. This was accomplished by using GIS tools to proportion the 2040 populations locally from the 2010 census information for each landside subcatchment, tributary to each CSO. Per capita dry weather sanitary sewage flows for these landside model subcatchments were established as the ratio of two factors: the year per capita dry weather sanitary sewage flow, and 2040 estimated population for the landside model subcatchment within the HP WWTP service area.

2.1.a.5 Update Landside Modeling

The Westchester Creek watershed is part of the overall HP WWTP system model (HP model). Several modifications to the collection system have occurred since the model was calibrated in 2007. Given that the HP model has been used for analyses associated with the annual reporting requirements of the SPDES permit BMPs, many of these changes have already been incorporated into the model. Major changes to the modeled representation of the collection system that have been made since the 2007 update include:

- Updated representation of HP-009 (R-13) via survey
- Updated hydrology upstream of HP-009 based on CSO Pilot Monitoring Program
- Removal of demonstration inflatable dams (Metcalf, Lafayette)
- Updated hydrology in Hutchinson River drainage area
- Updated stormwater piping in Hutchinson River drainage area
- CSO 28 baffle removed, weir raised 8 inches
- Additional details included for HP-011 and HP-013 outfall piping
- Westchester County portion of model upstream of Hutchinson River updated
- Updated CSO 29 and 29A improvements per "Engineering Design Services for Westchester Creek CSO Modifications"
- Updated Pugsley improvements per "Basis of Design Report for Pugsley Creek Relief Sewer"

In addition to changes made to the modeled representation of the collection system configuration, several other changes have been made to the model, including:

- ***Runoff generation methodology***, including the identification of pervious and impervious surfaces. As described in Section 2.1.a.3 above, the impervious surfaces were also categorized into DCIAs and impervious runoff surfaces that do not contribute runoff to the collection system.
- ***GIS Aligned Model Networks.*** Historical IW models were constructed using record drawings, maps, plans, and studies. Over the last decade, the DEP Bureau of Water and Sewer Operations (BWSO) has been developing a GIS system that will provide the most up-to-date information available on the existing sewers, regulators, outfalls, and pump stations. As part of

the update and model recalibration, data from the GIS repository for interceptor sewers were used. The models will continue to evolve and be updated as more information becomes available from this source and any other field information.

- ***Interceptor Sediment Cleaning Data.*** DEP recently completed a citywide interceptor sediment inspection and cleaning program. From April 2009 to May 2011, approximately 136 miles of the City's interceptor sewers were inspected. Data on the average and maximum sediment in the inspected interceptors were available for use in the model as part of the update and recalibration process. Multiple sediment depths available from sonar inspections were spatially averaged to represent depths for individual interceptor segments included in the model, for sections not yet cleaned.

- ***Evapotranspiration Data.*** Evapotranspiration (ET) is a meteorological input to the hydrology module of the IW model that represents the rate at which depression storage (surface ponding) is depleted and available for use for additional surface ponding during subsequent rainfall events. In previous versions of the model, an average rate of 0.1 inches/hour (in/hr) was used for the model calibration, while no evaporation rate was used as a conservative measure during alternatives analyses. During the update of the model, hourly ET estimates obtained from four National Oceanic and Atmospheric Administration (NOAA) climate stations [John F. Kennedy (JFK), Newark (EWR), Central Park (NYC), and LaGuardia (LGA)] for an 11-year period were reviewed. These data were used to calculate monthly average ETs, which were then used in the updated model. The monthly variations enabled the model simulation to account for seasonal variations in ET rates, which are typically higher in the summer months.

- ***Tidal Boundary Conditions at CSO Outfalls.*** Tidal stage can affect CSO discharges when tidal backwater in a CSO outfall reduces the ability of that outfall to relieve excess flow. Model updates took into account this variable boundary condition at CSO outfalls that were influenced by tides. Water elevation based on the tides was developed using a customized interpolation tool that assisted in the computation of meteorologically-adjusted astronomical tides at each CSO outfall in the New York Harbor complex.

- ***Dry Weather Sanitary Sewage Flows.*** Dry weather sewage flows were developed as discussed in Section 2.1.a.4 above. Hourly dry weather flow (DWF) data for 2011 were used to develop the hourly diurnal variation patterns at each plant. Based on the calibration period, the appropriate dry weather flows for 2005 or 2006 or another calendar year was used.

- ***Precipitation.*** A review of the rainfall records for model simulations was undertaken as part of this exercise, as discussed in Section 2.1.b below.

In 2012, thirteen of the City's IW landside models underwent recalibration in addition to the updates and enhancements listed above. This effort and calibration results are included in the IW Citywide Recalibration Report (DEP, June 2012) required by the 2012 Order on Consent. Following this report, DEP submitted to DEC a Hydraulic Analysis report in December 2012. The general approach followed was to recalibrate the model in a stepwise fashion beginning with the hydrology module (runoff). The following summarizes the overall approach to model update and recalibration:

- ***Site scale calibration (Hydrology)***. The first step was to focus on the hydrologic component of the model, which had been modified since 2007. Using updated satellite data. Flow monitoring data were collected in upland areas of the collection systems, remote from (and thus largely unaffected by) tidal influences and in-system flow regulation, for use in understanding the runoff characteristics of the impervious surfaces. Data were collected in two phases – Phase 1 in the Fall of 2009, and Phase 2 in the Fall of 2010. These areas ranged from 15 to 400 acres in spatial extent. A range of areas with different land use mixes was selected to support the development of standardized set of coefficients that can be applied to other unmonitored areas of the City. The primary purpose of this element of the recalibration was to adjust pervious and impervious area runoff coefficients to provide the best fit of the runoff observed at the upland flow monitors.

- ***Area-wide recalibration (Hydrology and Hydraulics).*** The next step in the process was to focus on larger areas of the modeled systems where historical flow metering data were available, and which were neither impacted by tidal backwater conditions nor subjected to flow regulation. Where necessary, runoff coefficients were further adjusted to provide reasonable simulation of flow measurements made at the downstream end of these larger areas. The calibration process then moved downstream further into the collection system, where flow data were available in portions of the conveyance system where tidal backwater conditions could exist, as well as potential backwater conditions from throttling at the WWTPs. The flow measured in these downstream locations would further be impacted by regulation at in-system control points (regulator, internal reliefs, etc.). During this step in the recalibration, minimal changes were made to runoff coefficients.

The result of this effort is a model with better representation of the collection system and its tributary area for the HP WWTP basin. This updated model is used for the alternatives analysis as part of this LTCP. A comprehensive discussion of the recalibration effort can be found in the IW Citywide Recalibration Report (December 2012).

2.1.b Review and Confirm Adequacy of Design Rainfall Year

DEP has been consistently applying the 1988 annual precipitation characteristics to the landside IW models to develop pollutant loads from combined and separately sewered drainage areas. To date, 1988 has been considered to be representative of long-term average conditions, and therefore, has been used for analyzing facilities where "typical" rather than extreme conditions serve as the basis of design, in accordance with EPA CSO Control Policy of using an "average annual basis" for analyses. The selection of 1988 as the average condition was re-considered, however, in light of the increasing concerns over climate change, with the potential for more extreme and possibly more frequent storm events. Recent landside modeling analyses in the City have used the 2008 precipitation pattern to drive the runoff-conveyance processes, along with the 2008 tide observations; DEP believes 2008 to be more representative than 1988 conditions as it also includes some extreme storms.

While the 2011 Westchester Creek WWFP were based on 1988 rainfall conditions, future baseline conditions runs are now being performed using 2008 as the typical precipitation year. A comparison of these rainfall years, which led to the selection of 2008 as the typical year, is provided in Table 2-2.

Table 2-2. Comparison of Rainfall Years to Support Evaluation of Alternatives

Parameter	WWFP JFK 1988	Present Day Average 1969-2010	Present Best Fit JFK 2008
Annual Rainfall (in)	40.7	45.5	46.3
July Rainfall (in)	6.7	4.3	3.3
November Rainfall (in)	6.3	3.7	3.3
Number of Very Wet Days (>2.0 in)	3	2.4	3
Average Peak Storm Intensity (in/hr)	0.15	0.15	0.15

2.1.c Description of Sewer System

The watershed tributary to Westchester Creek includes combined and separated sewer service areas within the HP WWTP collection system. The HP WWTP is located in the southwestern portion of the collection system. The orientation of the Upper East River tributaries are generally north-south such that flow from the Hutchinson River watershed and the Throgs Neck PS must pass through the Westchester Creek drainage basin to be treated at the Hunts Point WWTP. There are 15 PSs located in the HP WWTP drainage area. Of these, 12 handle combined sewage and the other three are stormwater only.

The CSO regulators that discharge to Westchester Creek serve an area of approximately 4,271 acres; the total drainage to Westchester Creek is 4,952 acres. The remaining tributary area (681 acres) includes approximately equal areas of direct runoff and stormwater service areas. Each portion of the drainage area is discussed below. Figure 2-6 presents a schematic of the sewer system as well as the sewershed tributary to the study area.

2.1.c.1 Overview of Drainage Area and Sewer System

Westchester Creek and Pugsley Creek are served by the HP WWTP. The facility is located at 1270 Ryawa Avenue in the Hunts Point section of the Bronx on a 45-acre site adjacent to the Upper East River between Halleck Street and Manida Street. The HP WWTP serves an area of 16,664 acres in the east side of the Bronx, including the communities of City Island, Throgs Neck, Edgewater Park, Schuylerville, Country Club, Pelham Bay, Westchester Square, Clason Point, Castle Hill, Union Port, Soundview, Parkchester, Van Nest, Co-op City, Morris Park, Pelham Parkway, Pelham Gardens, Baychester, Olinville, Williamsbridge, Edenwald, Eastchester, Hunts Point, Woodlawn, Wakefield, East Tremont, West Farms, and Longwood. The total sewer length, including sanitary, combined, and interceptor sewers, that feeds into the HP WWTP is 424 miles. Figure 2-6 shows the Westchester Creek watershed and the key components of the HP WWTP collection system. As depicted in the figure, the HP WWTP service area spans across the Bronx River and Hutchinson River watersheds, in addition to that of Westchester Creek.

The HP 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 HP WWTP has a design dry weather flow (DDWF) capacity of 200 million gallons per day (MGD), and is designed to receive a maximum flow of 400 MGD (2xDDWF) with up to 260 MGD receiving secondary treatment, (1.3 times DDWF to protect the BNR control processes). Flows over 260 MGD receive primary treatment and disinfection.

There are no non-sewered areas in the Westchester Creek drainage area.

Figure 2-6. Sewer System Schematic, Sewershed Tributary to Westchester Creek Study Area

AECOM

Hunts Point Stormwater Outfalls

The HP WWTP service area includes several permitted MS4 outfalls. Those that are tributary to Westchester and Pugsley Creeks are summarized in Table 2-3.

Table 2-3. Hunts Point WWTP Stormwater Discharges to Westchester Creek and Pugsley Creek

Stormwater Outfall	Outfall Location	Drainage Area (ac)
HP-054	Pugsley Creek park	46
HP-602	Lafayette Avenue, Westchester Creek	30
HP-623	Clason's Point	47
HP-625	Castle Hill Point	2
HP-635	Yznaga Place, Westchester Creek	93
HP-839	Head end of Westchester Creek	123
	Total	340

Westchester Creek and Pugsley Creek CSOs

The CSS tributary to Westchester and Pugsley Creeks is relieved during wet weather events via seven regulators that discharge through six outfalls distributed along the shoreline of the waterbodies. The outfalls are permitted by DEC under the HP WWTP SPDES permit (NY-0026191). The CSO outfalls include HP-014, HP-016, HP-015, HP-033, HP-012 and HP-013. The majority of these regulating structures overflow to Westchester Creek along the western shoreline from a double barrel combined sewer that generally follows Zerega Avenue to Castle Hill Point before it turns westward past the head of Pugsley Creek. The Throgs Neck portion of the service area is conveyed towards the HP WWTP via the 37.5 MGD Throgs Neck PS located on the western shore of Westchester Creek. Overflow relief for this PS is provided at the upstream end by regulator R-04 and by CSO-23A on the discharge side. The Throgs Neck PS does not have a wet weather bypass. Flow in excess of the PS capacity backs up through the collection system and out to Westchester Creek as a CSO discharge at Outfall HP-016 via Regulator R-04.

Wet weather flows in the CSS, with incidental sanitary and stormwater contributions as summarized above result 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.

The location of stormwater and CSO outfalls are shown in Figure 2-7.

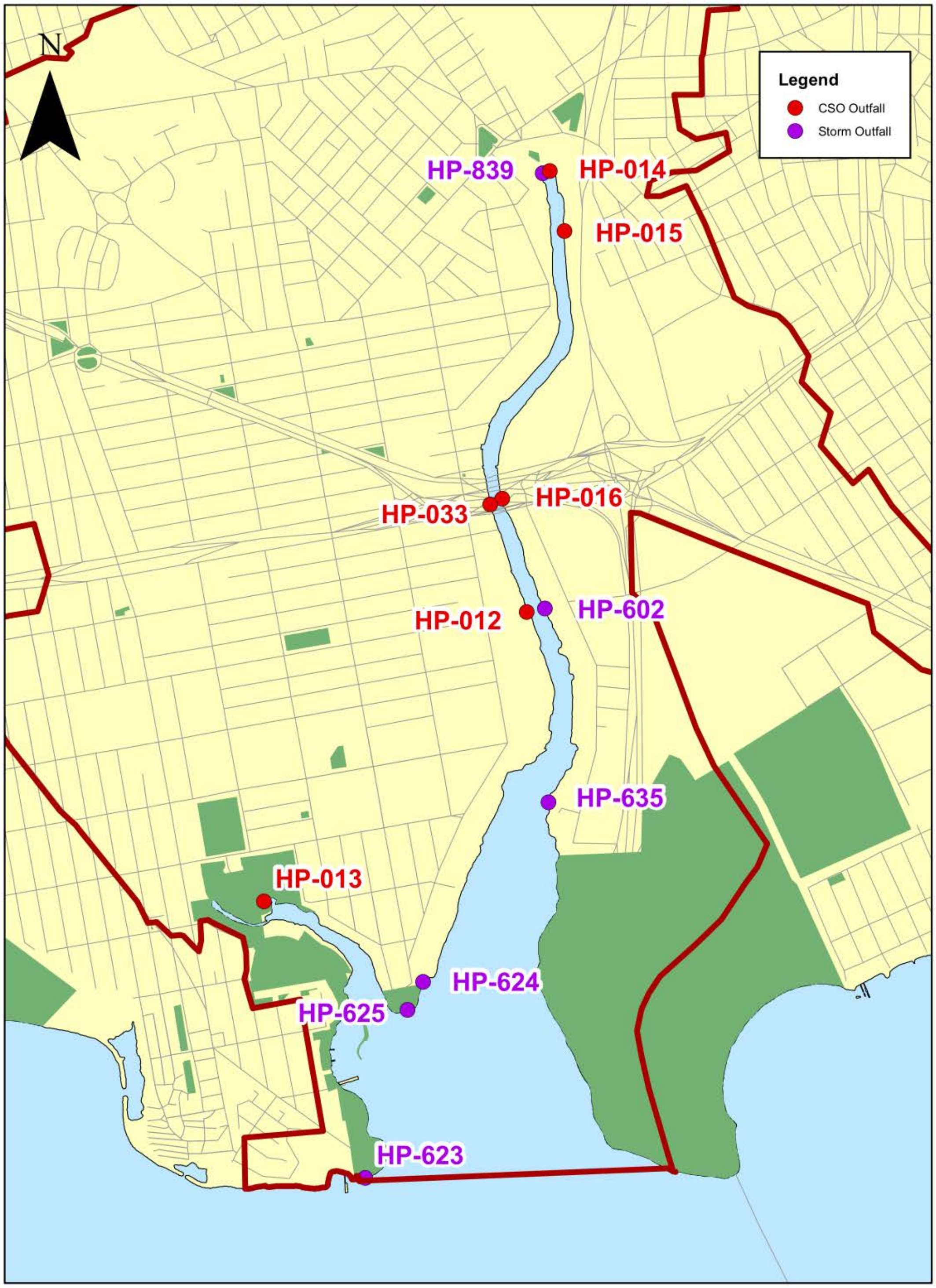


Figure 2-7. Westchester Creek CSO and Stormwater Discharge Locations

2.1.c.2 Stormwater and Wastewater Characteristics

Pollutant loadings for the sources identified and discussed in Section 2.1.c.1 were assessed for their impacts to water quality in Westchester Creek. The pollutant concentrations found in wastewater, combined sewage, and stormwater can vary based on a number of factors, including flow rate, runoff contribution, and the matrix of the waste discharged to the system from domestic and non-domestic customers. Since the matrix of these waste streams can vary, it can be challenging to identify a single concentration of pollutants to use for analyzing the impact of discharges from these systems to the waterbody.

HP WWTP Stormwater Outfalls: Stormwater overflow concentrations are assigned an Event Mean Concentrations (EMC) for inclusion in the water quality model calibration and LTCP baseline analyses. Historical information and data collected from sampling events were used to guide the selection of concentrations of BOD, TSS, total coliform, fecal coliform, and enterococci to use in calculating pollutant loadings from the various sources. Table 2-4 shows EMC stormwater concentrations for NYC stormwater discharges to Westchester Creek from the HP WWTP service area. Previously collected citywide sampling data from Inner Harbor Facility Planning Study (DEP, 1994) was combined with data for the EPA Harbor Estuary Program (HydroQual, 2005a) to develop these stormwater concentrations. The IW sewer system model (Section 2.1.a.5) is used to generate the flows from NYC storm sewer outfalls and concentrations noted in Table 2-4 are associated with the flows used to develop pollutant loadings.

HP and Westchester Creek CSOs: CSO pollutant concentrations can be extremely variable and are a function of many factors. Generally, CSO concentrations are a function of local sanitary sewage and runoff entering the combined sewers. For the modeling analyses, CSO concentrations were calculated based on a mass balance of HP WWTP sanitary sewage concentrations and EMC stormwater runoff concentrations during each hour of each storm event. Influent dry-weather samples at the NYC WWTPs were used to model sanitary concentrations (DEP process control records; HydroQual, 2005b). These sanitary sewage influent concentrations are summarized in Table 2-4. The concentrations of the stormwater entering the CSS were taken as those values shown in Table 2-4. The IW model is run in the water quality mode and traces the amount of sanitary sewage and the amount of stormwater at each location within the model. When there is a CSO discharge, its pollutant concentrations will have the calculated mix of sanitary sewage and storm runoff pollutants for each hour of overflow.

CSO concentrations were collected in 2014 to provide site specific information that would validate the mass balance approach noted above. The CSO overflow bacteria concentrations were characterized by direct measurements from three storm events in 2014 for outfalls HP-014 and HP-016. These concentrations are shown in Figure 2-8, a cumulative frequency distribution graphic. Both individual sample points are shown as well as the trend line that best fits the data distribution. Measured fecal coliform concentrations are log-normally distributed as is typical for this type of data and values range from 38,000 to 661,000 MPN/100mL. Similarly, enterococci concentrations are also log normally distributed and range from 13,500 to 170,000 MPN/100mL. These observed concentrations are well within the range that DEP would expect from combined sewage which is reflective of a mixture of the higher sanitary pathogens with the lower stormwater runoff pathogens. However, a comparison of Figure 2-8 and Table 2-4 suggests that the assumed stormwater and sanitary pathogen concentrations used in the model yield calculated CSO discharge concentrations that are higher than those actually observed in 2014. This is discussed in greater detail in Section 6.2, but is largely attributable to the sanitary concentration being higher in the past. Therefore, the assumed sanitary and stormwater concentrations used may be considered conservative estimates of the CSO loadings.

Table 2-4. Sanitary and Stormwater Discharge Concentrations, HP WWTP

Constituent	Sanitary Concentration	Stormwater Concentration
$CBOD_5$ (mg/L) [(1)]	105	15
TSS (mg/L) [(1)]	110	15
Total Coliform Bacteria (MPN/100mL) [(2,3)]	$25x10^6$	150,000
Fecal Coliform Bacteria (MPN/100mL) [(2,3)]	$4x10^6$	120,000
Enterococci (MPN/100mL) [(2,3)]	$1x10^6$	50,000

(1) 2011, 2012, 2013 DEP Process Control HP WWTP operational records
(2) Hydroqual Memo to DEP, 2005a.
(3) Bacterial concentrations expressed as "most probable number" (MPN) of cells per 100 mL.

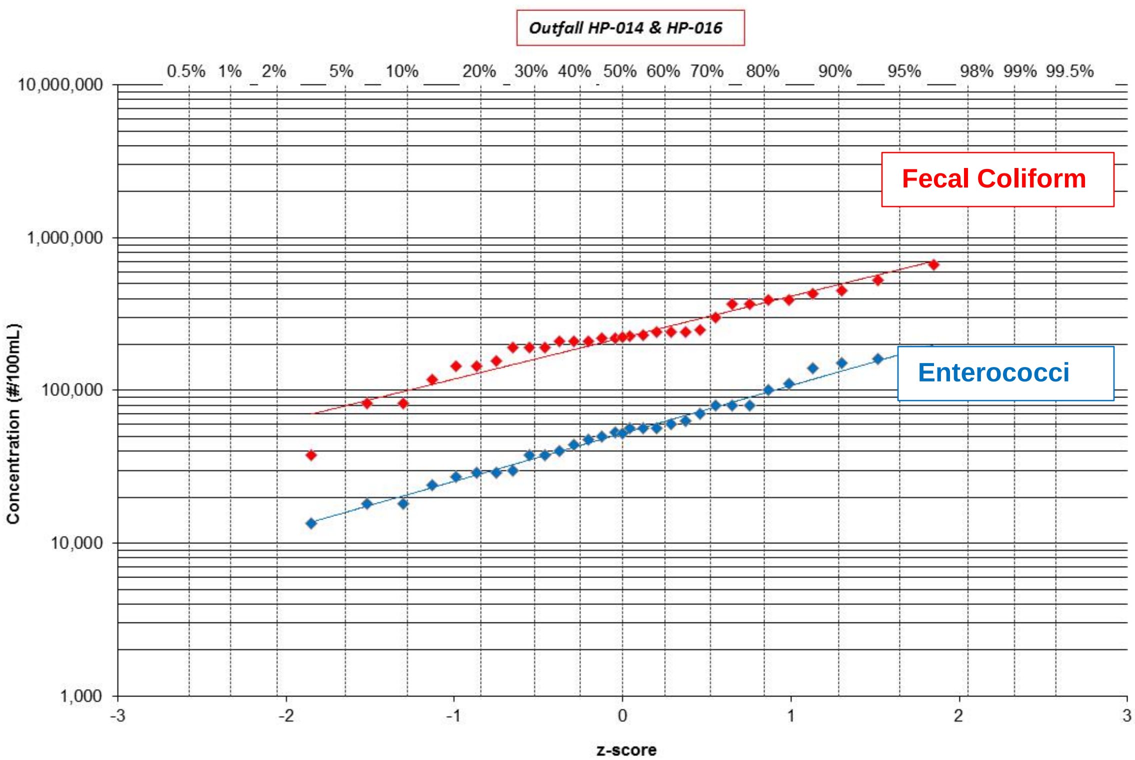


Figure 2-8. HP CSO Bacteria 2014 Sampling Data

Direct Drainage: Some of the HP service area is considered direct drainage area, as shown in Figure 2-5, where stormwater drains directly to receiving waters without entering the CSS. Generally, these are shoreline areas adjacent to waterbodies, and were delineated based on topography and the resultant direction of stormwater overland sheet flow. These areas can be parks, industrial areas or other areas. They generally, however, tend not to be residential areas. Pathogen concentrations assigned to this overland runoff were defined as being different than typical MS4 stormwater runoff which would be more typical of runoff from residential areas. Stormwater from residential areas generally has higher concentrations of pathogens associated with it than does stormwater from these lower use areas. For this analysis, direct drainage pathogens were assigned as a fecal coliform concentration of 4,000 cfu/100mL and an enterococci concentration of 6,000 cfu/100mL. These values were developed as being typical and representative of the range of concentrations found in the following sources:

- NYS Stormwater Manual – Concentrations selected as typical of non-residential land uses
- National Stormwater Quality Data Base (2004) – Concentrations associated with commercial, mixed commercial, industrial, mixed industrial and open space land uses.
- NYC stormwater – Lowest 15^{th} percentile values as representing cleaner MS4 stormwater.

Other Sources: There are no sources that discharge pathogens to Westchester Creek that DEP is aware of other than CSOs, MS4 stormwater and direct drainage.

Illicit Sources: DEP is not aware of any sources of illicit discharges to Westchester Creek. Dry weather samples collected in the creek in 2014 did not exhibit characteristic elevated pathogen concentrations that occur when illicit sanitary discharges are present.

2.1.c.3 Hydraulic Analysis of Sewer System

A citywide hydraulic analysis was completed in December 2012, to provide further insight into the hydraulic capacities of key system components and system responses to various wet weather conditions. The IW model was updated in the Westchester Creek drainage area after this effort was completed. Thus, the model results reported in this sub-section, while relevant for their intended use to document overall system-wide performance beyond the Westchester Creek watershed, may differ slightly from volumes reported in the remainder of this LTCP. The hydraulic analyses can be divided into the following major components:

- Annual simulations to estimate the number of annual hours that the WWTP is predicted to receive and treat up to 2xDDWFfor rainfall years 2008, and with projected 2040 DWFs; and
- Estimation of peak conduit/pipe flow rates that would result from a significant single event with projected 2040 DWFs.

Detailed presentations of the data were contained in the December 2012 Hydraulic Analysis Report submitted to DEC. The objective of each evaluation and the specific approach undertaken are briefly described in the following paragraphs.

Annual Hours at 2xDDWF for 2008 with Projected 2040 DWFs

Model simulations were conducted to estimate the annual number of hours that the HP WWTP would be expected to treat 2xDDWF for the 2008 precipitation year, which contained a total precipitation of 46.26 inches, as measured at JFK Airport. These simulations were conducted using projected 2040 DWFs for two model input conditions – the re-calibrated model conditions as described in the December 2012 IW Citywide Recalibration Report. For these simulations, the primary input conditions applied were as follows:

- Projected 2040 DWF conditions.
- 2008 tides and precipitation data.
- WWTP at 2xDDWF capacity of 415 MGD.
- No sediment in the combined sewers (i.e., clean conditions).
- Sediment in interceptors representing the sediment conditions after the inspection and cleaning program completed in 2011 and 2012.
- No green infrastructure.

For the HP service area, the simulation of the 2008 annual rainfall year resulted in a prediction that the HP WWTP would operate at or over its 2xDDWF capacity 59 hours throughout the year.

Estimation of Peak Conduit/Pipe Flow Rates

Model output tables containing information on several pipe characteristics were prepared, coupled with calculation of the theoretical, non-surcharged, full-pipe flow capacity of each sewer included in the model. To test the conveyance system response under what would be considered a large storm event condition, a single-event storm that was estimated to approximate a five-year return period (in terms of peak hourly intensity as well as total depth) was selected from the historical record.

The selected single event was simulated in the model for WWFP conditions implemented. The maximum flow rates and maximum depths predicted by the model for each sewer segment in the model were retrieved and aligned with the other pipe characteristics. Columns in the tabulations were added to indicate whether the maximum flow predicted for each conduit exceeded the non-surcharged, full-pipe flow, along with a calculation of the maximum depth in the sewer as a percentage of the pipe full height. It was suspected that potentially, several of the sewer segments could be flowing full, even though the maximum flow may not have reached the theoretical maximum full-pipe flow rate for reasons such as downstream tidal backwater, interceptor surcharge or other capacity-limiting reasons. The resulting data were then scanned to identify the likelihood of such capacity-limiting conditions, and also provide insight into potential areas of available capacity, even under large storm event conditions. Key observations/ findings of this analysis are described below.

- Capacity exceedances for each sewer segment were evaluated in two ways for both interceptors and combined sewers:
  - Full flow exceedances, where the maximum predicted flow rate exceeded the full-pipe non-surcharged flow rate. This could be indicative of a conveyance limitation.
  - Full depth exceedances, where the maximum depth was greater than the height of the sewer segment. This could be indicative of either a conveyance limitation or a backwater condition.
- About 94 percent (by length) of the interceptors were predicted to flow at full depth or higher. Between 53 and 55 percent (by length) of the combined sewers were also predicted to flow at full depth, and 76 percent of the combined sewers flowed at least 75 percent full.

- The results for the system condition with WWFP improvements showed that the overall peak plant inflow and HGL near the plant improved slightly, in comparison to the non-WWFP conditions in the HP WWTP service area.

- About 76 percent of the combined sewers (by length) reached a depth of at least 75 percent under the WWFP simulations. This indicates that limited additional potential exists for in-line storage capability in the HP system.

2.1.c.4 Identification of Sewer System Bottlenecks, Areas Prone to Flooding and History of Sewer Backups

There are no known system bottlenecks and areas prone to flooding in the Westchester Creek watershed. DEP conducts regular sewer inspections and cleaning as reported in the BMP annual reports. Figure 2-9 shows the sewers inspected and cleaned throughout 2013 in the Bronx, which encompasses the entire watershed of Westchester Creek.

DEP recently conducted a sediment accumulation analysis to quantify levels of sediments in the combined sewer systems. For this analysis, the normal approximation to the hypergeometric distribution was used to randomly select a sample subset of sewers representative of the modeled systems as a whole, with a confidence level commensurate to that of the IW watershed models. Field crews investigated each location, and estimated sediment depth using a rod and tape. Field crews also verified sewer pipe sizes shown on maps, and noted physical conditions of the sewers. The data were then used to estimate the sediment levels as a percentage of overall sewer area. The aggregate mean for the entire City was approximately 1.25 percent, with a standard deviation of 2.02 percent.

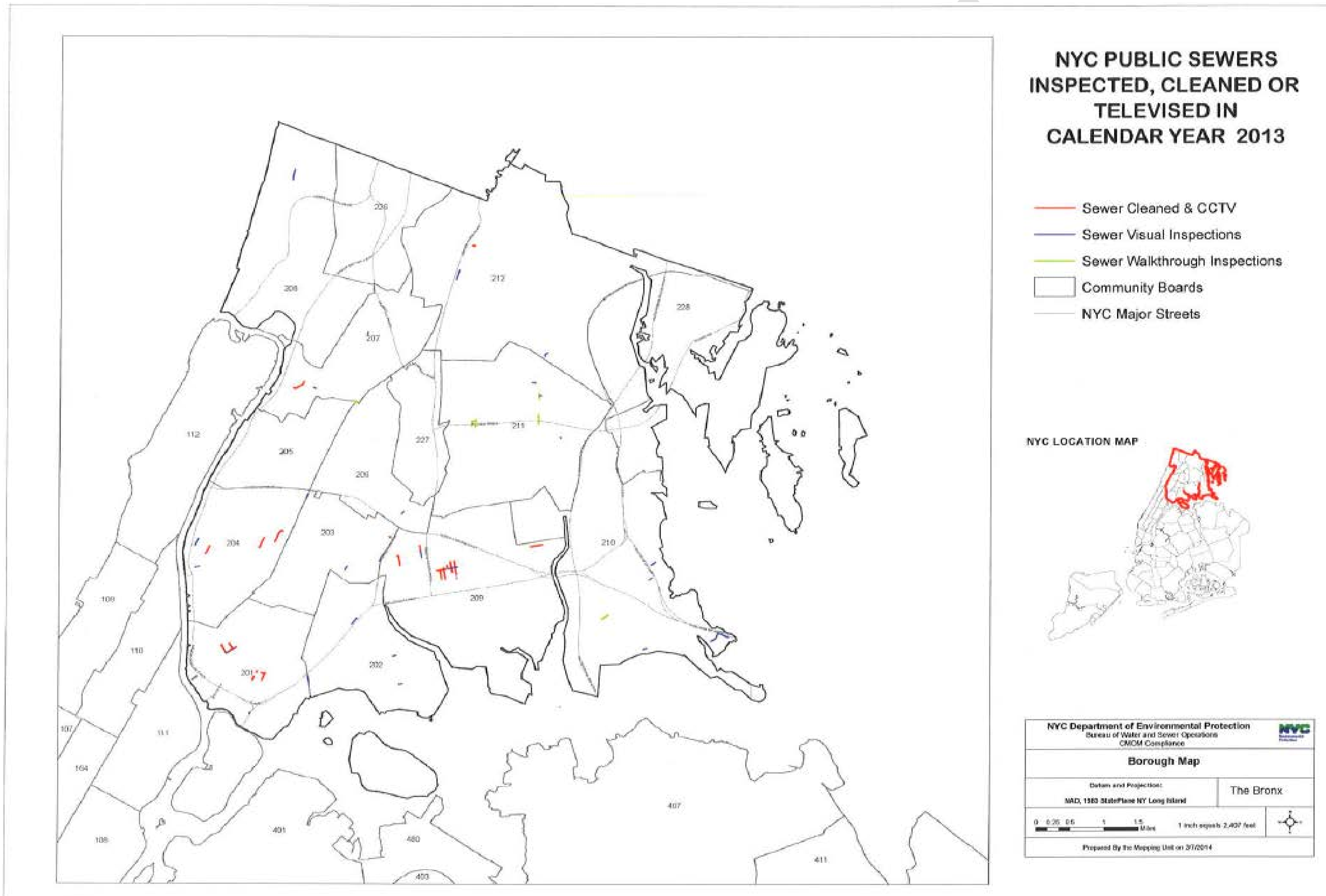


Figure 2-9. Sewers Inspected and Cleaned Throughout 2013

2.1.c.5 Findings from Interceptor Inspections

In the last decade, DEP has implemented technologies and procedures to enhance its use of proactive sewer maintenance practices. DEP has many programs and staff devoted to sewer maintenance, inspection and analysis. GIS and Computerized Maintenance and Management System CMMS systems provide DEP with expanded data tracking and mapping capabilities, and can facilitate identification of trends to allow provision of better service to its customers. As referenced above, reactive and proactive system inspections result in maintenance including cleaning and repair as necessary. According to the 2013 Best Management Practices (BMP) report, no intercepting sewers were inspected or sediment removed in the HP WWTP service area throughout this specific year.

2.1.c.6 Status of Receiving Wastewater Treatment Plants (WWTPs)

The Westchester Creek watershed is entirely served by the HP WWTP. The Plant is undergoing rehabilitation to enhance nitrogen removal, and other miscellaneous improvements to existing facilities.

2.2 Waterbody Characteristics

This section of the report describes the features and attributes of Westchester Creek. Characterizing the features of this waterbody is important for assessing the impact of wet weather loadings as well as to define approaches and solutions that mitigate the impact of CSO discharges.

2.2.a Description of Waterbody

Westchester Creek is a narrow, highly channelized, navigable waterway extending approximately 2½ miles from its confluence with the Upper East River. The creek is approximately 165 feet wide at its head and widens to about 300 feet within about a mile upstream of the confluence with the Upper East River. Near the confluence, Pugsley Creek assigns characteristics of an open bay area to the downstream end of Westchester Creek. Pugsley Creek enters this bay from the northwest, extending about ½-mile from its head to the tip of Castle Hill Point. Neither creek receives any natural freshwater flow. The present day physical and water quality characteristics of Westchester Creek and Pugsley Creek, as well as existing uses are described as follows.

2.2.a.1 Current Waterbody Classification(s) and Water Quality Standards

New York State Policies and Regulations

In accordance with the provisions of the CWA, the NYS has established WQS for all navigable waters within its jurisdiction. NYS, through DEC, developed a system of waterbody classifications based on designated uses that includes five saline classifications for marine waters. DEC considers the Class SA and Class SB classifications to fulfill the CWA. Class SC supports aquatic life and recreation, but the primary and secondary recreational uses of the waterbody are limited due to other factors. Class I supports the aquatic life protection as well as secondary contact recreation. SD waters shall be suitable only for fish, shellfish and wildlife survival because natural or man-made conditions limit the attainment of higher standards. DEC has classified Westchester Creek as Class I, with secondary contact as its primary usage.

Numerical criteria corresponding to these waterbody classifications are as shown in Table 2-5. DEP conducted water quality assessments where the data is represented by percent attainment with pathogen targets. For this LTCP, in accordance with guidance from DEC, 95 percent attainment of applicable water quality criteria constitutes compliance with the existing WQS or the Section 101(a) (2) goals.

Dissolved oxygen (DO) is the numerical criterion that DEC uses to establish whether a waterbody supports aquatic life uses. Total and fecal coliform bacteria concentrations are the numerical criteria that DEC uses to establish whether a waterbody supports recreational uses. In addition to numerical criteria, NYS has narrative criteria to protect aesthetics in all waters within its jurisdiction, regardless of classification (see Section 1.2.c.). As indicated in Table 2-6, these narrative criteria apply to all five classes of marine waters.

Table 2-5. New York State Numerical Surface WQS (Saline)

Class	Usage	Dissolved Oxygen (mg/L)	Total Coliform (MPN/100mL)	Fecal Coliform (MPN/100mL)	Enterococci (MPN/100mL)
SA	Shellfishing for market purposes, primary and secondary contact recreation, fishing. Suitable for fish, shellfish and wildlife propagation and survival.	≥ 4.8(1) ≥3.0(2)	≤ 70(3)	N/A	-------
SB	Primary and secondary contact recreation and fishing. Suitable for fish, shellfish and wildlife propagation and survival.	≥4.8(1) ≥3.0(2)	≤ 2,400(4) ≤ 5,000(5)	≤ 200(6)	≤ 35
SC	Limited primary and secondary contact recreation, fishing. Suitable for fish, shellfish and wildlife propagation and survival.	≥4.8(1) ≥3.0(2)	≤ 2,400(4) ≤ 5,000(5)	≤ 200(6)	N/A
I	Secondary contact recreation and fishing. Suitable for fish, shellfish and wildlife propagation and survival.	≥ 4.0	≤ 10,000(6)	≤ 2,000(6)	N/A
SD	Fishing. Suitable for fish, shellfish and wildlife survival. Waters with natural or man-made conditions limiting attainment of higher standards.	≥ 3.0	N/A	N/A	N/A

Chronic criterion based on daily average. The DO concentration may fall below 4.8 mg/L for a limited number of days, as defined by the formula:

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

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.,

Class	Usage	Dissolved Oxygen (mg/L)	Total Coliform (MPN/100mL)	Fecal Coliform (MPN/100mL)	Enterococci (MPN/100mL)
$$\sum_{i=1}^{n} \frac{t_i(actual)}{t_i(allowed)} < 1.0$$ (2) Acute criterion (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 80th percentile of five or more samples. (6) Monthly geometric mean of five or more samples.					

Note that the enterococci criterion of 35 cfu/100 mL listed in Table 2-5, although not promulgated by DEC, is now an enforceable standard in New York State as EPA established January 1, 2005, as the date upon which the criteria must be adopted for all coastal recreational waters. According to the DEC interpretation of the BEACH Act of 2000, the criterion applies on a 30-day moving GM basis during recreational season (May 1st to October 31st). Furthermore this criterion is not applicable to the tributaries of the Long Island Sound and the East River tributaries and therefore would not apply to Westchester Creek under current water quality classifications.

Currently, DEC is conducting its federally-mandated "triennial review" of the NYS WQS, in which States are required to review their water quality standards every three years. DEC is in the pre-public proposal phase of this rule, and staff is considering a wide range of revisions/additions to water quality standards regulations. DEC has indicated that in accordance with the 2012 EPA recreational water quality criteria, the enterococci criterion will be under formal rulemaking within NYS and as such will become a formal standard sometime in the future.

Table 2-6. New York State Narrative WQS

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.

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 IEC includes all tidal waters of greater New York City. Westchester Creek is interstate water and is regulated by IEC as Class B-1 waters. Numerical criteria for IEC-regulated waterbodies are shown in Table 2-7, while narrative criteria are shown in Table 2-8.

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. IEC effluent quality regulations do not apply to CSOs if the CSS is being operated with reasonable care, maintenance, and efficiency. Although IEC regulations are intended to be consistent with the respective state WQS, the three-tiered IEC system and the five New York State marine classifications in New York Harbor do not provide for an exact spatial correspondence.

Table 2-7. IEC Numeric WQS

Class	Usage	DO (mg/L)	Waterbodies
A	All forms of primary and secondary contact recreation, fish propagation, and shellfish harvesting in designated areas	≥ 5.0	East River, east of the Whitestone Br.; Hudson River north of confluence with the Harlem River; Raritan River. east of the Victory Bridge 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.	≥ 4.0	Hudson River, south of confluence with Harlem River; upper New York Harbor; East River from the Battery to the Whitestone Bridge; Harlem River; Arthur Kill between Raritan Bay and Outerbridge Crossing.
B-2	Passage of anadromous fish, maintenance of fish life	≥ 3.0	Arthur Kill north of Outerbridge Crossing; Newark Bay; Kill Van Kull

Table 2-8. IEC 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.

EPA Policies and Regulations

For designated bathing beach areas, the EPA criteria require that an enterococci reference level of 104 cfu/100 mL to be used by agencies for announcing bathing advisories or beach closings in response to pollution events. For non-designated beach areas of primary contact recreation, which are used infrequently for primary contact, the EPA criteria require that an enterococci reference level of 501 cfu/100 mL be considered indicative of pollution events.

These reference levels, according to the EPA documents, are not criteria, 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 are to be used for announcing beach advisories or beach closings in response to pollution events.

EPA released its Recreational Water Quality Criteria (RWQC) recommendations in December 2012 that are designed to protect human health in coastal and non-coastal waters designed for primary recreation use. These recommendations were based on a comprehensive review of research and science that evaluated the link between illness and fecal contamination in recreational waters. The recommendations are intended as guidance to states, territories, and authorized tribes in developing or updating WQS to protect swimmers from exposure to bacteria found in water with fecal contamination. As there are no bathing beaches located in Westchester Creek, these criteria do not apply. However, the BEACH Act of 2000 directs coastal states to adopt and submit to EPA revised recreational WQS for bathing waters by December 2015.

The 2012 RWQC offers two sets of numeric concentration thresholds, as listed in Table 2-9, and includes limits for both the GM (30-day) and a statistical threshold value (STV). The STV is a new limit, and is intended to be a value that should not be exceeded by more than 10 percent of the samples taken.

Table 2-9. 2012 RWQC Recommendations

Criteria Elements	Recommendation 1 (estimated illness Rate 36/1,000)		Recommendation 2 (estimated illness Rate 32/1,000)	
Indicator	**GM (cfu/100 mL)**	**STV (cfu/100 mL)**	**GM (cfu/100 mL)**	**STV (cfu/100 mL)**
Enterococci (marine and fresh)	35	130	30	110
E. coli (fresh)	126	410	100	320

It is not known at this time how DEC will implement the 2012 EPA RWQC. Recent input from DEC has stated that Recommendation 2 will be used to update water quality criteria. The LTCP analyses were based on the enterococci numerical criteria associated with Recommendation 1.

2.2.a.2 Physical Waterbody Characteristics

Located in the eastern section of the Bronx, New York, Westchester Creek generally extends south of Westchester Avenue in the Bronx and parallels Hutchinson River Parkway until Westchester Creek and Pugsley Creek merge with the Upper East River. Both are tributary to the Upper East River, although neither creek carries freshwater flow. Both will be addressed by this LTCP.

The waterbody can collectively be divided into three distinct reaches that have physically different characteristics: Westchester Creek, Pugsley Creek, and an embayment area at the confluence of the two creeks with the Upper East River.

Westchester Creek is a narrow, highly channelized, navigable waterway extending in a north-south orientation approximately 2½ miles from its head to the confluence with the Upper East River. The Creek is approximately 165 feet wide at its head, and widens to about 300 feet within about a mile of the Upper East River, where its confluence with Pugsley Creek forms an open bay area. Pugsley Creek is approximately ½ mile long and enters this bay from the northeast. Land around Pugsley Creek watershed is residential. However, the majority of the shoreline is parkland. In contrast, the navigable Westchester Creek is surrounded primarily by industrial land uses. The mouth of the waterbody is approximately 3,000 feet wide.

Shoreline Physical Characterization

Most of the shoreline of Westchester Creek has been altered, by construction of either bulkheads or rip-rap armoring as illustrated in Figure 2-10. The western shoreline is mostly natural along the southern reaches, but extensively bulkheaded and armored from the Unionport Bridge northward with few breaks. Areas of rip-rap are located along publicly accessible areas of castle Hill Point, Clason's Point, and along Ferry Point Park, as well as along many of the privately owned industrial properties.

Piers are only located in Pugsley Creek along the western shore and are associated with private family residences, and do not appear to be in operation based on their condition. The eastern shoreline is mostly natural with patches of rip-rap armoring and bulkheads concentrated in the middle reaches of its length. The multiple barrel CSO outfall located at the head of Westchester Creek has concrete bulkheads and wingwalls. Other CSO and stormwater outfalls can be found along the waterbody.

Shoreline Slope

Westchester Creek is historically significant for supporting commerce in the eastern area of the Bronx. With the increase in ship sizes over the years and sedimentation of the Creek, regular maintenance dredging of a navigable channel in Westchester Creek has been performed by the U.S. Army Corps of Engineers (USACE). The last previously conducted dredging project by the USACE for navigational purposes was implemented in 1977.

The navigational dredging has substantially altered the natural slopes and depths of the waterbody. This change in the natural slope may be the cause of changes in sediment accretion and removal dynamics. The dredging may also have partially limited the potential for the establishment of submerged aquatic vegetation beds as well as other benthic and epibenthic processes.

Waterbody Sediment Surficial Geology/Substrata

Based on past field investigations, the stream bed of Westchester Creek is predominantly composed of silt and clay. The waterbody bottom is generally covered with a layer of very wet, very soft, dark brown silt, often with a trace of sand and some occasional gravel. Cores collected during the summer of 2005 indicated the presence of material containing amounts of organic matter and a low percentage of solids on top of the natural bottom sediments. This material is often attributed to historical discharges of CSO and stormwater.

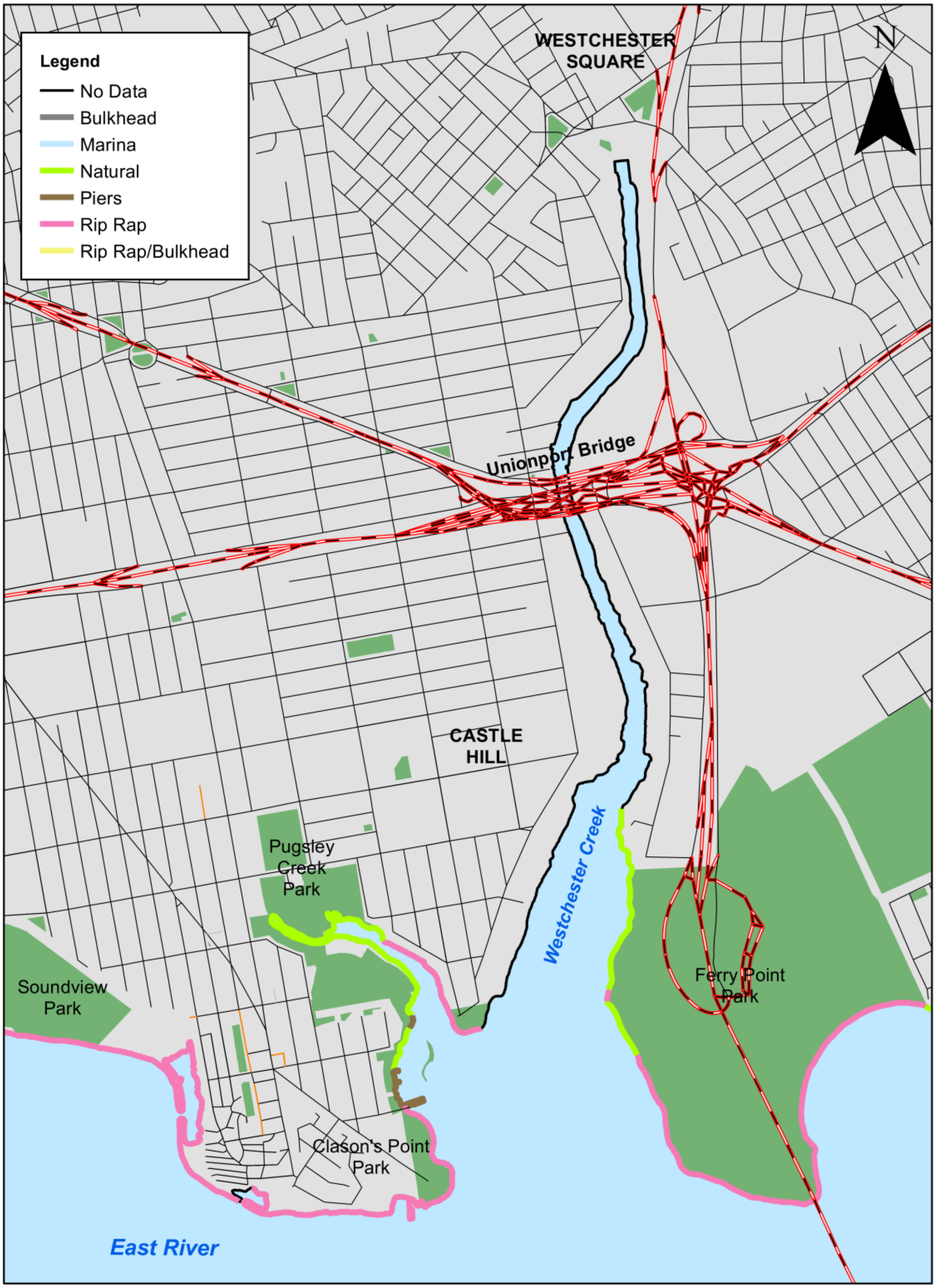


Figure 2-10. Shoreline Physical Conditions

Waterbody Type

Westchester Creek is classified as a saline tributary to the Upper East River and Long Island Sound according to Title 6 of the New York State Code of Rules and Regulations (NYCRR). Although considered tributary to the Upper East River, the creek has very limited natural freshwater flow. All natural flows previously tributary to Westchester Creek have been captured by engineered collection systems in response to population growth and urban development. As a result, most wetlands in Westchester Creek were filled in.

Because of the limited natural freshwater inflows and the narrow typical cross-section of the waterbody, Westchester Creek hydrodynamics are predominantly controlled by tidal flows. Exposed mudflats are a characteristic of the downstream end of the creek, including Pugsley Creek.

Tidal/Estuarine Systems Biological Systems

Intertidal/Estuarine Wetlands

The marshes at the head of Westchester Creek were completely filled by 1961 and the Bronx State Hospital was constructed in this area (DEP, 2003a). Aerial photographs from a survey conducted by DEC in 1974, a review of the US Fish and Wildlife Service National Wetland Inventory (NWI) wetland maps, as well as results of field investigations, documented the presence of intertidal and high marsh areas along both shores of Westchester Creek. Distribution is fragmented and the total area of these areas is less than 15 acres. The small wetland area located at the head of Pugsley Creek is estuarine, intertidal, emergent, persistent, irregularly flooded wetlands (E2EM1P). The larger wetland area in Pugsley Creek is estuarine, intertidal, flat, regularly flooded wetlands (E2FLN). The area along the western shore near the mid-reach of Westchester Creek is also an E2FLN wetland. Applicable NWI classification codes are shown in Table 2-10.

Table 2-10. Applicable NWI Classification Codes

NWI Classification	Description
E2EM1P	Estuarine, inter-tidal, emergent-persistent, irregular
E2FLN	Estuarine, inter-tidal, flat, regular

Aquatic and Terrestrial Communities

Westchester Creek supports aquatic communities which are similar to those found throughout the New York Harbor and other urban tributaries. These aquatic communities contain typical estuarine species whose composition has been highly modified by physical changes to the original watershed, shoreline, and inherent impacts to water and sediment quality. These changes represent constraints to Westchester Creek, impacting its full potential to support a diverse aquatic life community.

In Westchester Creek, pier piles and bulkheads provide the majority of underwater substrates capable of supporting epibenthic communities. From epibenthic studies (in 2000 and 2001) it was found that 26 taxa were identified (June 2011, Westchester Creek WWFP - DEP, 2011). The major groups found were barnacles, tunicates, hydroids, annelid and crabs. Some gastropods, sponges and shrimp were found. Fish (tautog and guppies) were also present.

In the middle section of Westchester Creek, barnacles were the dominant organism although tunicate (*Molgula manhattensis*) were also found. Near the mouth of Westchester Creek, *Balanus eburneus* were the dominant organisms followed by *Molgula manhattensis* and *Botryllus schlosseri*. The mouth of the Creek had more hydroids and barnacles and an additional tunicate species present. Individual species of bryozoans, nudibranchs and algae were present in the mouth of Westchester Creek but not in the middle section. However, in the middle of the Creek, more mud crabs were present than in the mouth. More mud snails, shrimp and fish were present in the middle portion of the Creek but are not present near the mouth of the Creek.

Freshwater Systems Biological Systems

No New York State regulated freshwater wetlands exist in the watershed of Westchester Creek, i.e., freshwater wetlands greater than 12.4 contiguous acres.

2.2.a.3 Current Public Access and Uses

There are no public beaches on or near Westchester Creek. The New York City Department of Parks and Recreation (NYCDPR) has no plans for promoting swimming in the waterbody in the near future. The physical characteristics of Westchester Creek preclude bathing without substantial physical modifications to this waterbody and associated watershed.

Westchester Creek is accessible from various parks along the southern shorelines, including Castle Hill Park and Ferry Point Park. Elsewhere, public access is extremely limited due to the private ownership of land along the shorelines, the presence of highway rights-of-way, fencing and other obstacles. Public spaces adjacent to the waterbody, such as the YMCA playground on Castle Hill Point and the Lehman High School athletic field at the head end of Westchester Creek, are fenced in and do not encourage water usage. In addition, very few of the privately owned properties adjacent to the waterbody would allow such use.

Access to the shoreline of Pugsley Creek is possible at several locations by walkways, parkland, boat ramps and NYCDPR concessions. However, such access is concentrated along the lower reaches of the Creek. As an example, Castle Hill Park includes pathways and stairs along the shore. Access to the western shoreline is possible from Clasons Point Park. The upper reaches are publicly inaccessible due to fencing. Shoreline recreational fishing does occur along the accessible areas in the southern portion of the waterbody.

2.2.a.4 Identification of Sensitive Areas

Federal CSO Policy requires that the LTCPs give the highest priority to controlling overflows to sensitive areas. 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 primary contact recreation
- Waters with threatened or endangered species and their habitat
- Additional areas determined by the Permitting Authority (i.e., DEC).

General Assessment of Sensitive Areas

An analysis of the waters of the Westchester Creek and Pugsley Creek with respect to the CSO Policy was conducted and is summarized in Table 2-11.

Table 2-11. Sensitive Areas in Westchester Creek

Designation	Present
Outstanding National Resource Waters	No
National Marine Sanctuaries	No
Threatened or Endangered Species	No
Primary Contact Recreation	No
Public Water Supply Intake	No
Public Water Supply Protected Areas	No
Shellfish Bed	No
Areas determined by DEC	No

There are no sensitive areas in the Westchester Creek assessment area, based on the following information:

- There are no ONRW waters, National Marine Sanctuaries, or public water supplies in or near the waters of New York Harbor;
- There are no designated shellfishing areas within Westchester Creek or the upper East River;
- There are no bathing beaches in or near Westchester Creek. Public bathing beaches are explicitly prohibited by local law in the upper East River and its tributaries;
- There are no threatened or endangered marine animal species or corresponding designated habitat in Westchester Creek according to responses to Freedom of Information Act (FOIA) letter requests to the New York Natural Heritage Program, the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service (USFWS); and
- None of the items specifically listed by DEC are within or adjacent to the Westchester Creek study area.

2.2.a.5 Tidal Flow and Background Harbor Conditions and Water Quality

DEP has been collecting New York Harbor water quality data since 1909. These data are utilized by regulators, scientists, educators, and citizens to assess impacts, trends, and improvements in the water quality of New York Harbor.

The Harbor Survey Monitoring Program (HSM) has been the responsibility of DEP's Marine Sciences Section (MSS) for the past 27 years. Initially, surveys were performed in response to public complaints about quality of life near polluted waterways. The initial effort has grown into a survey that consists of 72 stations distributed throughout the open waters of the harbor and smaller tributaries within the City. The number of water quality parameters measured has also increased from five in 1909 to over 20 at present.

Harbor water quality has improved dramatically since the initial surveys. Infrastructure improvements and the capture and treatment of virtually all dry-weather sewage are the primary reasons for this improvement. During the last decade, water quality in NY Harbor has improved to the point that the waters are now utilized for recreation and commerce throughout the year. Still, impacted areas remain within the Harbor. The LTCP process has begun to focus on those areas within the Harbor that remain impacted; it will examine 10 waterbodies and their drainage basins, and develop a comprehensive plan for each waterbody.

The HSM program focuses on enterococci and fecal coliform bacteria, DO, chlorophyll 'a', and Secchi transparency as the water quality parameters of concern. Data are presented in four sections, each delineating a geographic region within the Harbor. Westchester Creek is located within the Upper East River – Western Long Island Sound (UER-WLIS) section. This area contains nine open water monitoring stations and five tributary sites. Figure 2-11 shows the location of Stations monitored in the Upper East River in the vicinity of Westchester Creek as part of the HSM program. As noted, none of the HSM program stations are located within Westchester Creek and the closest stations that are still routinely monitored near the mouth of Westchester Creek are stations E7 and E14, located east and west of the creek by a mile or so. As part of the LTCP Post Construction Monitoring (PCM), DEP intends to institute sampling in Westchester Creek in 2018 to align with the construction of WWFP recommended facilities.

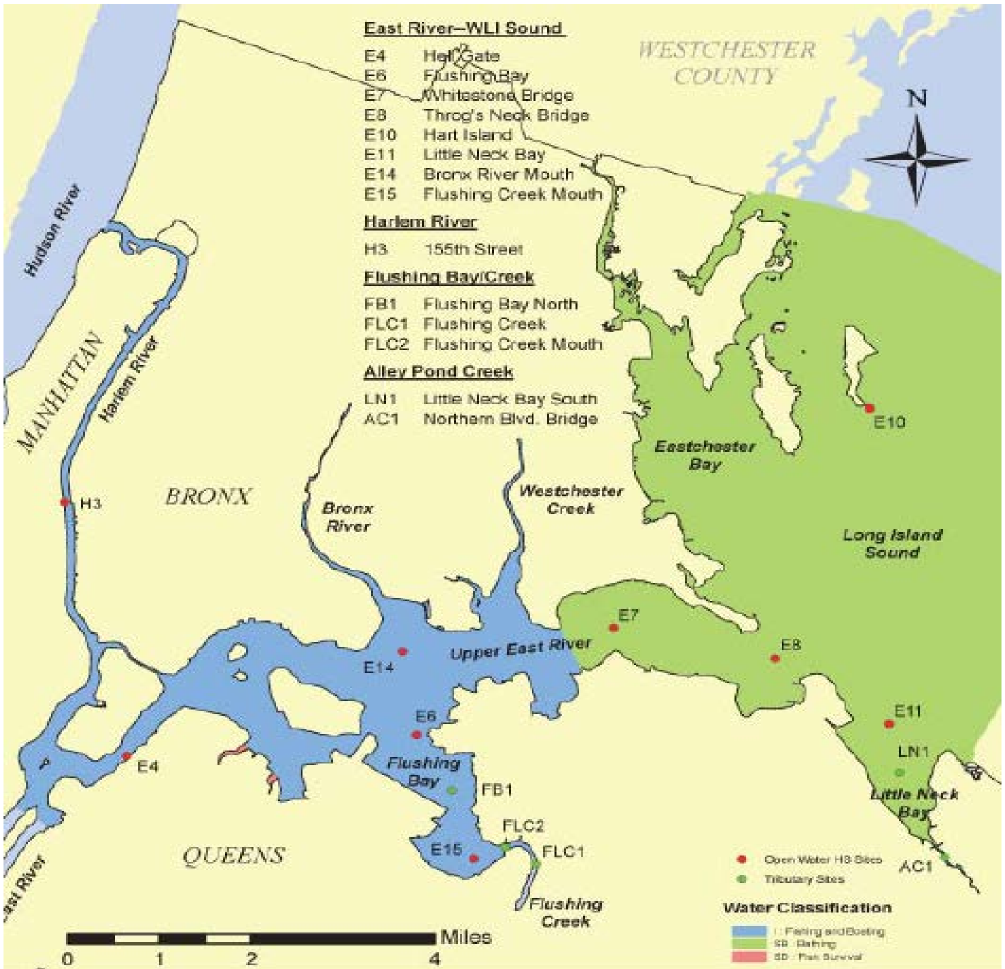


Figure 2-11. DEP Harbor Survey Monitoring Locations UER-WLIS Region

The following sections provide an overview of the bacteria quality and DO levels of the Westchester Creek based on data collected by DEP as part of the HSM Program and as part of this LTCP. Additional information from the HSM program can be found at the following location.

http://www.nyc.gov/html/dep/html/harborwater/harborwater_quality_survey.shtml

2.2.a.6 Compilation and Analysis of Existing Water Quality Data

DEP Harbor Survey Data

Recent data collected within Westchester Creek are available from sampling conducted by the DEP's HSM program for 2013 and early 2014. The HSM program does not routinely sample locations within Westchester Creek. In anticipation of collecting water quality data to update monitoring that was performed in 2005, the HSM implemented a routine sampling program that was initiated in December 2013 through the end of March 2014. Samples were collected from stations WC2, WC1, WC3 and E13 (Figure 2-12) to characterize the water quality of the waterbody.

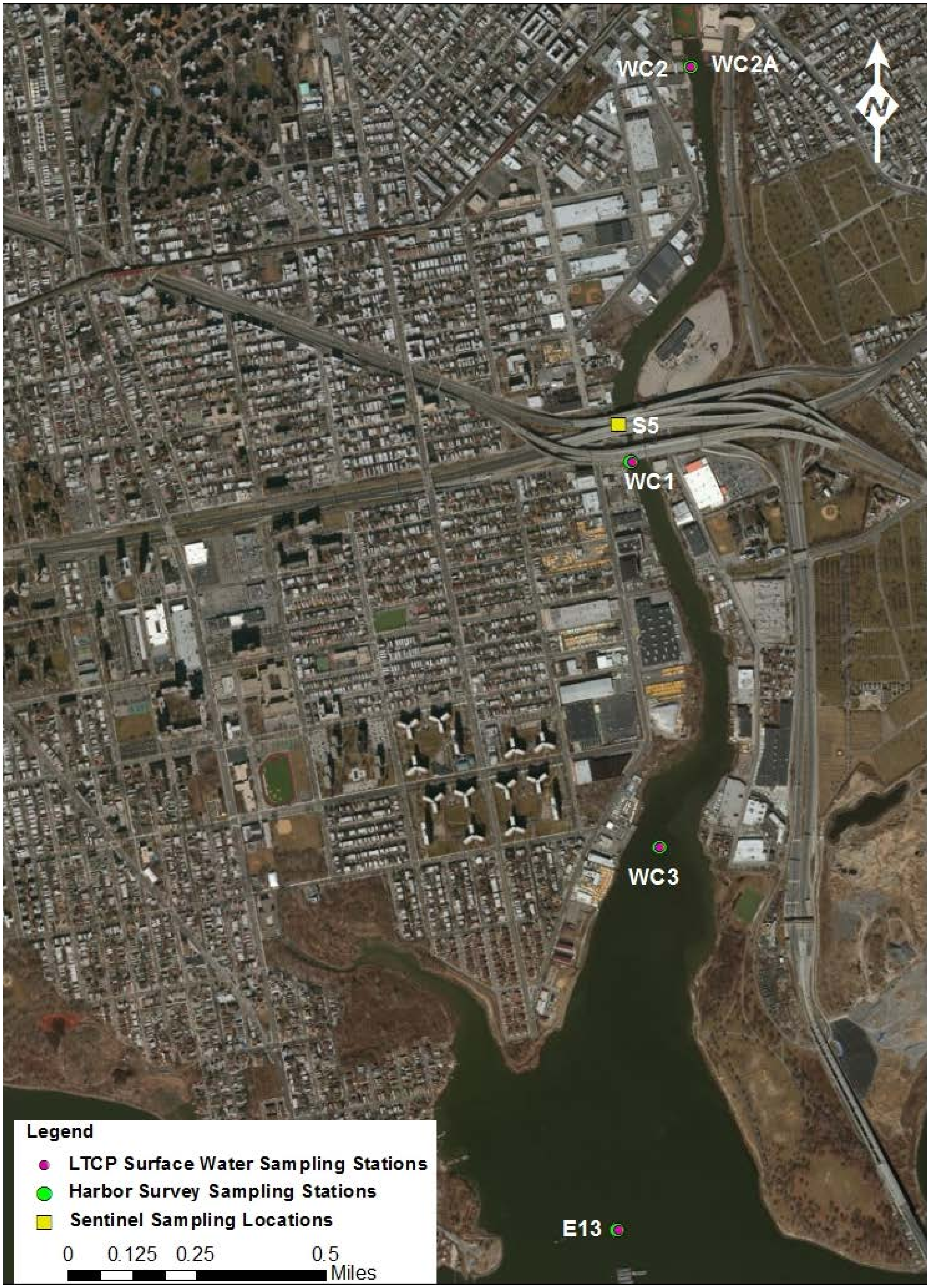


Figure 2-12. Location of Westchester Creek Water Quality Sampling Stations

Westchester Creek LTCP Sampling

To supplement the water quality sampling information that is available from DEP, a sampling program was conducted during the development of this LTCP. This program targeted the development of a better understanding of the temporal variability of the water quality trends within Westchester Creek. Samples were collected at the same locations as those sampled by DEP. However, the LTCP sampling program targeted both dry and wet weather in April 2014. The emphasis of the sampling program was on bacteria indicators although data were developed for other water quality indicators such as DO. Sampling stations matched the DEP HSM program locations but were designated Stations WC2, WC1, WC3, and E13, as depicted in Figure 2-12.

Sentinel Monitoring Program

The DEP also conducts routine sampling at 71 locations in City waters in dry weather to inform the agency of potential illicit discharges to their MS4 storm sewers. If elevated pathogen levels are detected during the quarterly dry weather sampling, DEP deploys its internal staff to track down and eliminate the sources of pollutants. The Sentinel Monitoring Program sampling station (S5) in Westchester Creek is located at the same location as the HSM and LTCP monitoring Station WC1.

Data Discussion

Figures 2-13 and 2-14 present a number of statistical parameters of the DEP Harbor Survey, LTCP and Sentinel Monitoring data sets over the same period (December 2013 through April 2014). Shown on these figures are the site GMs over the noted period, along with data ranges (minimum to maximum and 25th percentile to 75th percentile). For reference purposes, the relevant water quality criteria are also shown.

Figure 2-13 presents fecal coliform bacteria data collected at Stations WC2, WC1, WC3 and E13, in Westchester Creek, along with the monthly GM water quality criteria for reference. Figure 2-14 presents enterococci data for the same stations, along with the monthly GM and SSM reference level.. As the improvements from the 2011 WWFP have yet to be implemented in the Westchester Creek drainage area at the time of the LTCP sampling, the results represent pre-WWFP or pre-baseline conditions.

The data indicate that the bacteria concentrations at the head end of Westchester Creek (Station WC2) are elevated within the data period with GMs for enterococci at approximately 50 cfu/100mL and fecal coliform bacteria near 150 cfu/100mL. The 75th percentile excursions above these values reach nearly 100 cfu/100mL for enterococci and exceed 200 cfu/100mL for fecal coliform bacteria. Single wet weather sample excursions reach 30,000 cfu/100mL for enterococci and 50,000 cfu/100mL for fecal coliform.

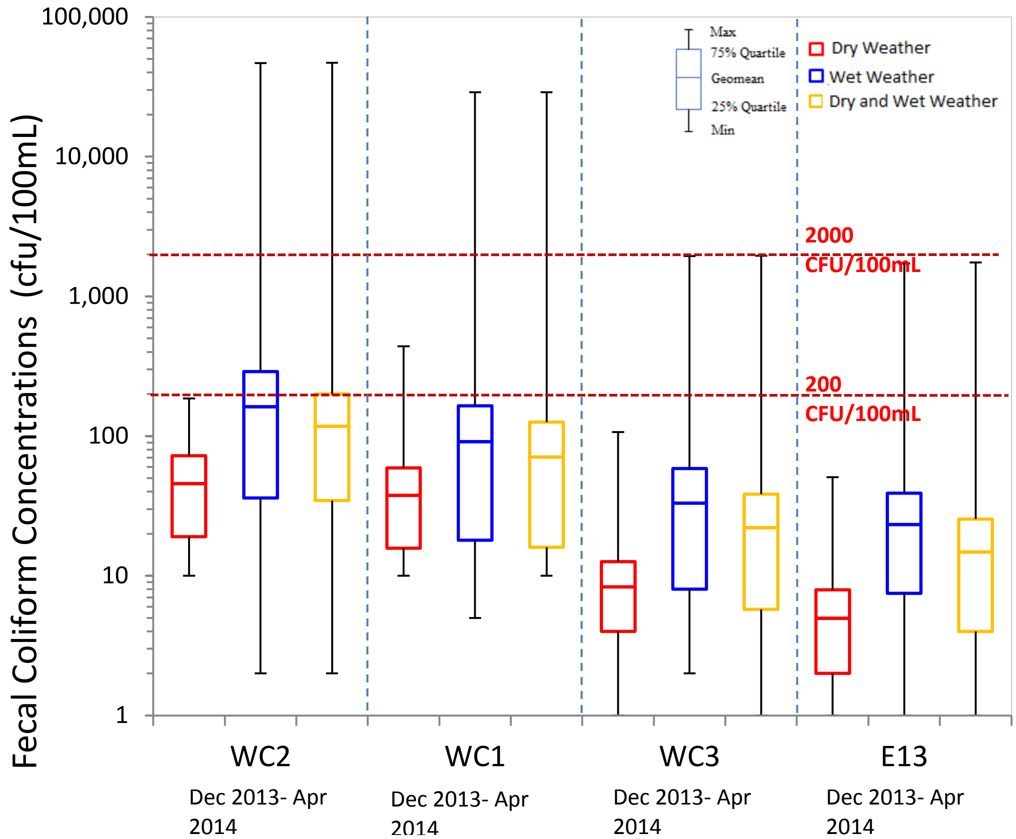


Figure 2-13. Fecal Coliform Data from HSM, LTCP, and Sentinel Monitoring Programs – Westchester Creek, December 2013 – April 2014

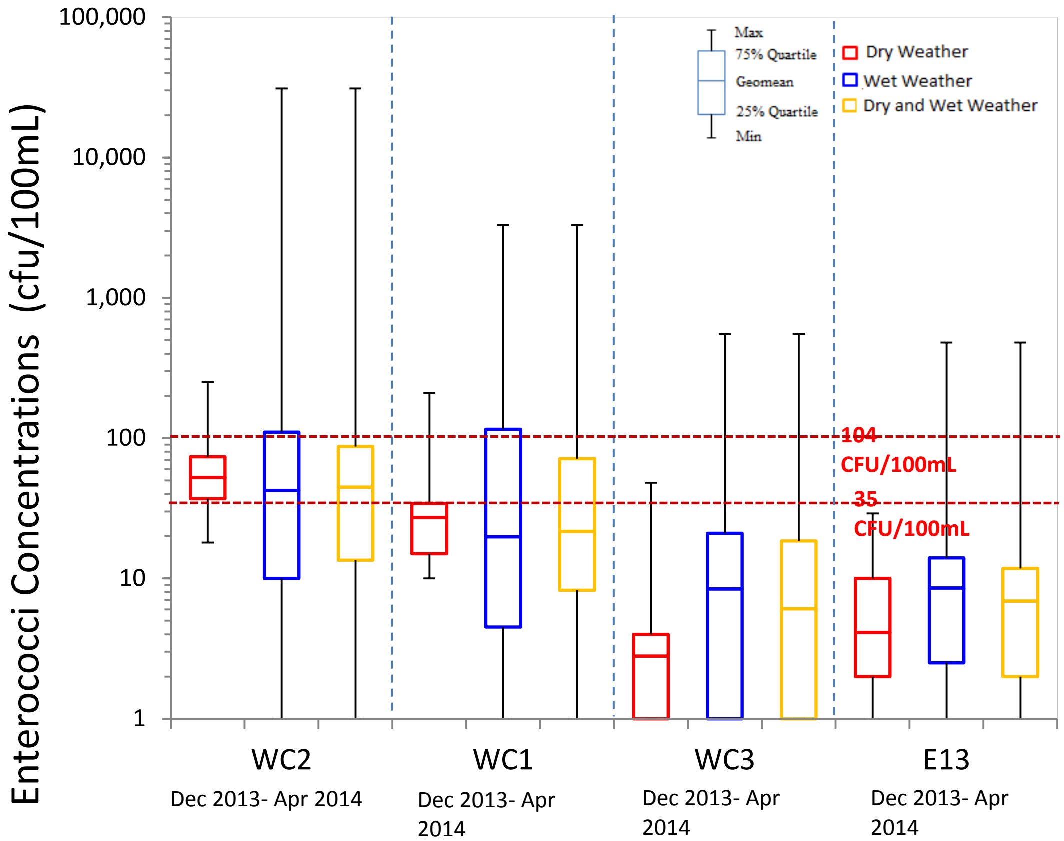


Figure 2-14. Enterococci Data from HSM, LTCP, and Sentinel Monitoring Programs – Westchester Creek, December 2013 – April 2014

As noted in these graphics, dry weather fecal coliform concentrations are generally lower than those for wet weather conditions. For enterococci concentrations, dry weather concentrations approximated wet weather concentrations at most locations. The general trend for both fecal coliform and enterococci bacteria is for the highest values to be at the head end of the creek, and decreasing downstream towards the East River.

Dry weather fecal coliform concentration results collected in Westchester Creek as part of the Sentinel Monitoring Program between 2009 and the end of 2013 are shown on Figure 2-15. The fecal coliform data collected vary from a low of 2 to a high of 280 cfu/100mL and have a geometric mean of 10.5 cfu/100mL. Overall, the values are low and not indicative of an area with potential illicit dry weather discharges.

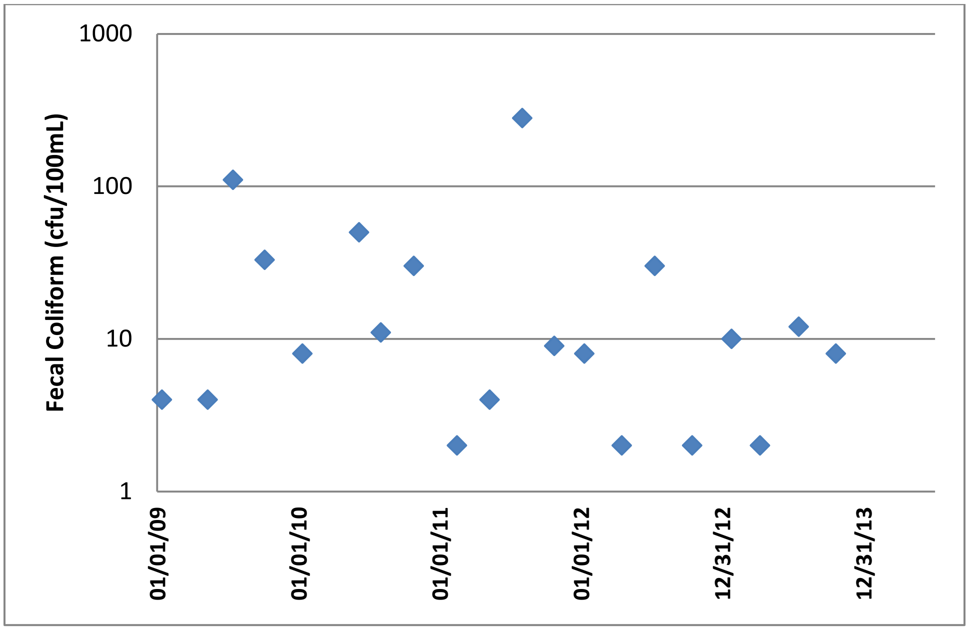


Figure 2-15. Dry Weather Sentinel Monitoring Fecal Coliform Concentrations

Wet weather sampling data collected during development of this LTCP are shown in Figures 2-16 and 2-17 as a time history of fecal and enterococci concentrations for 3-days following a 0.9-inch rain event on April 8, 2014. Data shown are the surface and bottom range along with the depth average (point). As shown in this figure pathogen concentrations are immediately elevated after the rain event revealing the impact of CSO and stormwater discharges. In the time following the initial spike in bacteria concentration, levels decrease as bacteria die-off and are flushed out of the creek during tidal exchange with the East River, which has lower pathogen concentrations. Within the 3-day period, fecal coliform concentrations are reduced by these mechanisms by two to three orders of magnitude.

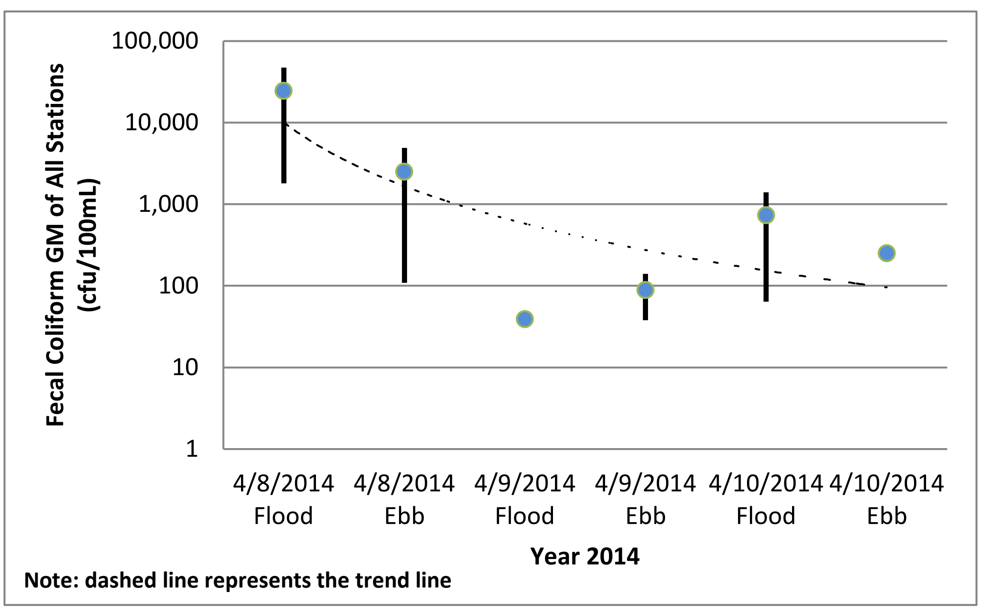


Figure 2-16. Wet Weather Fecal Coliform Bacteria – Station WC2

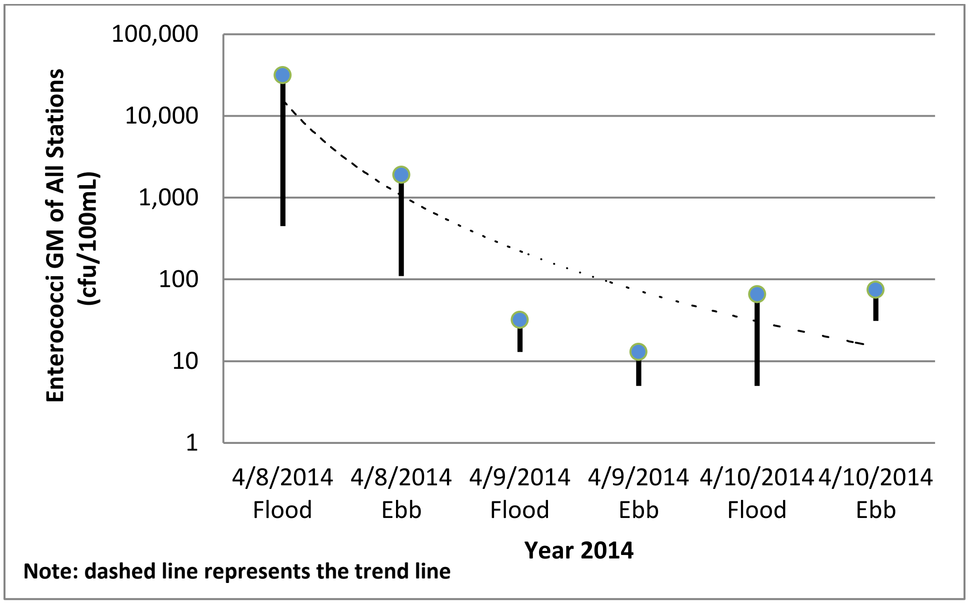


Figure 2-17. Wet Weather Enterococci – Station WC2

In general, pathogen concentrations within the Westchester Creek and the Upper East River boundary were low. Fecal coliform GM's were generally lower than the existing Class I criterion of 2,000 cfu/100mL, except during wet weather. Enterococci concentrations were found to be low, with long term GM concentrations below 50 cfu/100mL at all stations.

It should be noted that these sampling results were found to be lower than expected and lower than those previously registered by the 2005 sampling program (Figure 2-18); the other data set available for this waterbody. In 2005, fecal coliform sampling showed higher concentrations averaging between 1,000 and 50,000 cfu/100mL within the creek in wet weather and between 300 and 1,000 cfu/100mL in dry weather.

Possible reasons for these differences are not immediately obvious. However, one potential reason could be the severity of the winter snows and the wet spring. During this period, precipitation averaged close to 5 inches per month (normal monthly precipitation is 3.7 inches), much of which occurred in the form of snow. With snow slowly melting and the resulting transport of runoff to the WWTPs in CSS areas, CSO pathogen concentrations from typical buildup of pollutants would be lower than normal. It is possible that these conditions provided for much cleaner streets and lower concentrations of washed-off pathogens from stormwater runoff.

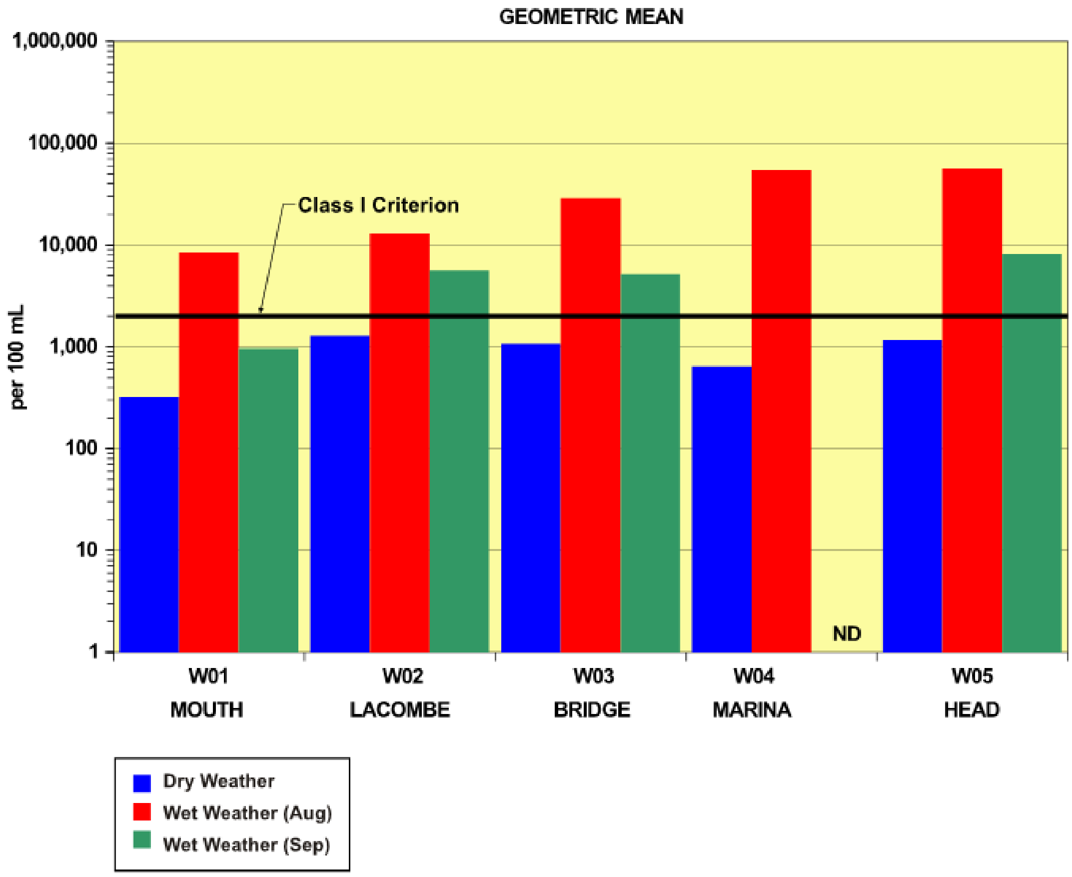


Figure 2-18. Westchester Creek 2005 Fecal Coliform Data

3.0 CSO BEST MANAGEMENT PRACTICES

The SPDES permits for all 14 WWTPs in New York City require DEP to report annually on the progress of the following 13 CSO BMPs:

1. CSO Maintenance and Inspection Program
2. Maximum use of Collection Systems for Storage
3. Maximize Flow to POTW
4. Wet Weather Operating Plan
5. Prohibition of Dry Weather Overflow
6. Industrial Pretreatment
7. Control of Floatable and Settleable Solids
8. Combined Sewer System Replacement
9. Combined Sewer Extension
10. Sewer Connection & Extension Prohibitions
11. Septage and Hauled Waste
12. Control of Runoff
13. Public Notification

These BMPs are equivalent to the Nine Minimum Controls (NMCs) required under the EPA National Combined Sewer Overflow Policy, which were developed by the EPA to represent BMPs 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 best available technology based controls that could be implemented within two years by permittees. EPA developed two guidance manuals that embodied the underlying intent of the NMCs for permit writers and municipalities, offering suggested language for SPDES permits and programmatic controls that may accomplish the goals of the NMCs (EPA 1995a, 1995b). A comparison of the EPA's NMCs to the 13 SPDES BMPs is as shown in Table 3-1.

This section is currently based on the practices summarized in the 2013 Best Management Practices Annual Report.

Table 3-1. Comparison of EPA Nine Minimum Controls Compared with SPDES Permit BMPs

EPA Nine Minimum Controls	SPDES Permit Best Management Practices
NMC 1: Proper Operation and Regular Maintenance Programs for the Sewer System and the CSOs	BMP 1: CSO Maintenance and Inspection Program BMP 4: Wet Weather Operating Plan BMP 8: Combined Sewer System Replacement BMP 9: Combined Sewer Extension BMP 10: Sewer Connection & Extension Prohibitions BMP 11: Septage and Hauled Waste
NMC 2: Maximum Use of the Collection System for Storage	BMP 2: Maximum Use of Collection Systems for Storage
NMC 3: Review and Modification of Pretreatment Requirements to Assure CSO Impacts are Minimized	BMP 6: Industrial Pretreatment
NMC 4: Maximization of Flow to the Publicly Owned Treatment Works for Treatment	BMP 3: Maximize Flow to POTW BMP 4: Wet Weather Operating Plan
NMC 5: Prohibition of CSOs During Dry Weather	BMP 5: Prohibition of Dry Weather Overflow
NMC 6: Control of Solid and Floatable Material in CSOs	BMP 7: Control of Floatable and Settleable Solids
NMC 7: Pollution Prevention to Reduce Contaminants in CSOs	BMP 6: Industrial Pretreatment BMP 7: Control of Floatable and Settleable Solids BMP 12: Control of Runoff
NMC 8: Public Notification	BMP 13: Public Notification
NMC 9: Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls	BMP 1: CSO Maintenance and Inspection Program BMP 5: Prohibition of Dry Weather Overflow BMP 6: Industrial Pretreatment BMP 7: Control of Floatable and Settleable Solids

This section presents brief summaries of each BMP and its respective relationship 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 (CSS), thereby reducing water quality impacts.

3.1 Collection System Maintenance and Inspection Program

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer Systems and CSOs) and NMC 9 (Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls). Through regularly-scheduled inspections of the CSO regulator structures and the performance of required repair, cleaning, and maintenance work, 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 events that cause discharge at outfalls during dry weather; and,

- DEC review of inspection program reports.

Details of recent preventative and corrective maintenance reports can be found in the Appendices of the BMP Annual reports.

3.2 Maximizing Use of Collection System for Storage

This BMP addresses NMC 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, thereby reducing the amount of overflow. DEP provides general information in the BMP Annual Report, describing the status of Citywide SCADA, regulators, tide gates, interceptors, in-line storage projects, and collection system inspections and cleaning.

3.3 Maximizing Wet Weather Flows to WWTPs

This BMP addresses NMC 4 (Maximization of Flow to the Publicly Owned Treatment Works for Treatment), and reiterates the WWTP operating targets established by the SPDES permits regarding the ability of the WWTP to receive and treat minimum flows during wet weather. The WWTP must be physically capable of receiving a minimum of two times design dry weather flow (2xDDWF) through the plant headworks; a minimum of 2xDDWF through the primary treatment works (and disinfection works, if applicable); and a minimum of 1.5xDDWF through the secondary treatment works during wet weather. The actual process control set points may be established by the Wet Weather Operating Plan (WWOP) required in BMP 4.

All of the City's WWTPs are physically capable of receiving a minimum of twice their permit-rated design flow through primary treatment and disinfection per their DEC-approved Wet Weather Operating Plans. The maximum flow that can reach a particular WWTP, however, is controlled by a number of factors including: hydraulic capacities of the upstream flow regulators; storm intensities within different areas of the collection system; and plant operators, who can restrict flow using "throttling" gates located at the WWTP entrance, to protect the WWTP from flooding and process upsets. DEPs operations staff are trained as to how to maximize pumped flows without impacting the treatment process, critical infrastructure, or public safety. For guidance, DEP's operations staff follow their plant's DEC-approved WWOP, which specifies the "actual Process Control Set Points," including average flow, as per Section VIII (3) and (4) of the SPDES permits. Analyses presented in the 2013 BMP report indicate that DEP's WWTPs generally complied with this BMP during 2013.

On May 8, 2014, DEC and DEP entered into an administrative consent order that includes an enforceable compliance schedule to ensure that DEP maximizes flow to and through the WWTP during wet weather events.

3.4 Wet Weather Operating Plan

To maximize treatment during wet weather events, WWOPs were developed for each WWTP drainage area in accordance with the DEC publication entitled *Wet Weather Operations and Wet Weather Operating Plan Development for Wastewater Treatment Plants*. Components of the WWOPs include:

- 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 BNR processes, if required.

This BMP addresses NMC 1 (Proper Operation and Regular Maintenance Programs for the Sewer System and the CSOs) and NMC 4 (Maximization of Flow to the Publicly Owned Treatment Works for Treatment). The Hunts Point WWTP WWOP, dated August 2010, was approved by DEC in October 2010.

3.5 Prohibition of Dry Weather Overflows

This BMP addresses NMC 5 (Prohibition of CSOs during Dry Weather) and NMC 9 (Monitoring to Effectively 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 BMP Annual Report.

Dry weather overflows from the CSS are prohibited and DEP's goal is to reduce and/or eliminate dry weather bypasses. An examination of the data for regulators, pump stations and the Hunts Point WWTP revealed that there was no dry weather bypassing to Westchester Creek due to regulators, WWTP or pump station bypasses.

3.6 Industrial Pretreatment Program

This BMP addresses three NMCs: NMC 3 (Review and Modification of Pretreatment Requirements to Assure CSO Impacts are Minimized); NMC 7 (Pollution Prevention Programs to Reduce Contaminants in CSOs); and NMC 9 (Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls). By regulating the discharges of toxic pollutants from unregulated, relocated, or new Significant Industrial Users (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-CSOs, 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 CSS and permitting of direct discharges of cooling water; and,
- Prioritization of industrial waste containing toxic pollutants for capture and treatment by the WWTP over residential/commercial service areas.

Since 2000, the average total industrial metals loading to NYC WWTPs has been declining. As described in the 2013 BMP Annual Report, the average total metals discharged by all regulated industries to the WWTPs was 13.9 lb/day, and the total amount of metals discharged by regulated industrial users remained very low. Applying the same percentage of CSO bypass (1.5 percent) from the CSO report to the current data, it appears that, on average, less than 0.2 lb/day of total metals from regulated industries bypasses to CSOs in 2013 (DEP, 2013a).

3.7 Control of Floatables 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 Effectively Characterize CSO Impacts and the Efficacy of CSO Controls), by requiring the implementation of the following four practices to eliminate or minimize the discharge of floating solids, oil and grease, or solids of sewage origin that cause deposition in receiving waters:

- Catch Basin Repair and Maintenance: This practice includes inspection and maintenance scheduled 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 also established.
- Institutional, Regulatory, and Public Education: Recommendations for alternative City programs and an implementation schedule that will reduce the water quality impacts of street and toilet litter.

3.8 Combined Sewer Replacement

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and CSOs), requiring all combined sewer replacements to be approved by the New York State Department of Health (DOH) and to be specified within DEP's Master Plan for Sewage and Drainage. Whenever possible, separate sanitary and storm sewers should be used to replace combined sewers. The BMP Annual Report describes the general citywide plan, and addresses specific projects occurring in the reporting year. There are no reported projects for the Hunts Point WWTP service area in the Best Management Practices 2013 Annual Report.

3.9 Combined Sewer Extension

To minimize storm water entering the CSS, this BMP requires combined sewer extensions to be accomplished using separate sewers whenever possible. If separate sewers must be extended from combined sewers, analyses must be performed to demonstrate 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 BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and CSOs). A brief status report is provided in the Best Management Practices 2013 Annual Report, although no combined sewer extension projects were completed during that year.

3.10 Sewer Connection & Extension Prohibitions

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and CSOs), and prohibits sewer connections and extensions that would exacerbate recurrent instances of either sewer back-up or manhole overflows. Wastewater connections to the CSS downstream of the last regulator or diversion chamber are also prohibited. The 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 2013, conditions did not require DEP to prohibit additional sewer connections or sewer extensions.

3.11 Septage and Hauled Waste

The discharge or release of septage or hauled waste upstream of a CSO (e.g., 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 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and CSOs). The 2008 CSO BMP Annual Report summarizes the three scavenger waste acceptance facilities controlled by DEP, and the regulations governing discharge of such material at the facilities. The facilities are located in the Hunts Point, Oakwood Beach, and 26th Ward WWTP service areas. The program remained unchanged through the 2013 CSO BMP Annual report.

3.12 Control of Runoff

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.

A rule to “reduce the release rate of storm flow from new developments to 10 percent of the drainage plan allowable or 0.25 cfs per impervious acre, whichever is higher (for cases when the allowable storm flow is more than 0.25 cfs per impervious acre),” was promulgated on January 4, 2012, and became effective on July 4, 2012.

3.13 Public Notification

BMP 13 addresses NMC 8 (Public Notification) as well as NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and CSOs) and NMC 9 (Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls).

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 DOHMH to implement and manage the notification program. Accordingly, the Wet Weather Advisories, Pollution Advisories and Closures are tabulated for all NYC public and private beaches. There are no bathing beaches in or near Westchester Creek. Bathing beaches are explicitly prohibited in the upper East River and its tributaries by Local Law.

3.14 Characterization and Monitoring

Previous studies have characterized and described the Hunts Point WWTP collection system and the water quality for Westchester Creek (see Chapters 3 and 4 of the Westchester Creek WWFP, 2011). Additional data were collected and are analyzed in this LTCP (see Section 2.2). Continuing monitoring occurs under a variety of DEP initiatives, such as floatables monitoring programs and DEP Harbor Monitoring Survey Study, and is reported in the BMP Annual Reports under SPDES BMPs 1, 5, 6 and 7, as described above.

3.15 CSO BMP Report Summaries

In accordance with the SPDES permit requirements, annual reports summarizing the citywide implementation of the 13 BMPs described above are submitted to DEC. DEP has submitted eleven annual reports to date, covering calendar years 2003 through 2013. Typical reports are divided into 13 sections, one for each of the BMPs in the SPDES permits. Each section of the annual reports describes ongoing DEP programs, provides statistics for initiatives occurring during the preceding calendar year, and discusses overall environmental improvements.

4.0 GREY INFRASTRUCTURE

4.1 Status of Grey Infrastructure Projects Recommended in Facility Plans

CSO facility planning in Westchester Creek began under the East River CSO Facility Planning Project, which focused on quantifying and assessing the impacts of CSO discharges to the Upper East River and certain tributaries, including the Hutchinson River, Westchester Creek, and the Bronx River. The initial recommendation for Westchester Creek was made in 1991, and called for a 12 MG storage tank for outfall HP-014. This planning effort pre-dated the issuance of the EPA CSO Control Policy in 1994 and as a result was not wholly consistent with it. The later June 2011 WWFP capitalized on the opportunity to reevaluate CSO abatement alternatives that might provide greater water quality benefit to Westchester Creek at a possibly lower overall cost. A summary of the grey infrastructure elements of the WWFP are listed as follows:

- Modification of relief structures designated CSO-29A and CSO-29 to reduce discharges from outfall HP-014, the largest discharge to Westchester Creek. The overflow weir in each control structure will be raised by two feet, and lengthened to conserve overflow capacity under the 5-year design storm and to provide additional capacity during larger storms. Figure 4-1 and Figure 4-2 show the locations of these two regulating structures and schematics of the proposed modifications.

- Construction of a new parallel sewer from the relief structure designated CSO-24 to a new junction chamber at Cornell Avenue on White Plains Road. Figure 4-3 shows the alignment of the parallel sewer, which will reduce CSO discharges to Pugsley Creek via outfall HP-013, which would otherwise increase after the weir levels are increased by two feet at CSO-29 and CSO-29A.

4.1.a Completed Projects

There are no completed grey infrastructure projects associated with CSO reduction in Westchester Creek.

4.1.b Ongoing Projects

No additional grey infrastructure projects associated with CSO reduction in Westchester Creek are ongoing.

4.1.c Planned Projects

Design of the weir modifications at CSO-29 and CSO-29A is to be completed by June 2014. The Pugsley Sewer design will be completed in June 2015. Both construction projects are scheduled to be completed by December 2019.

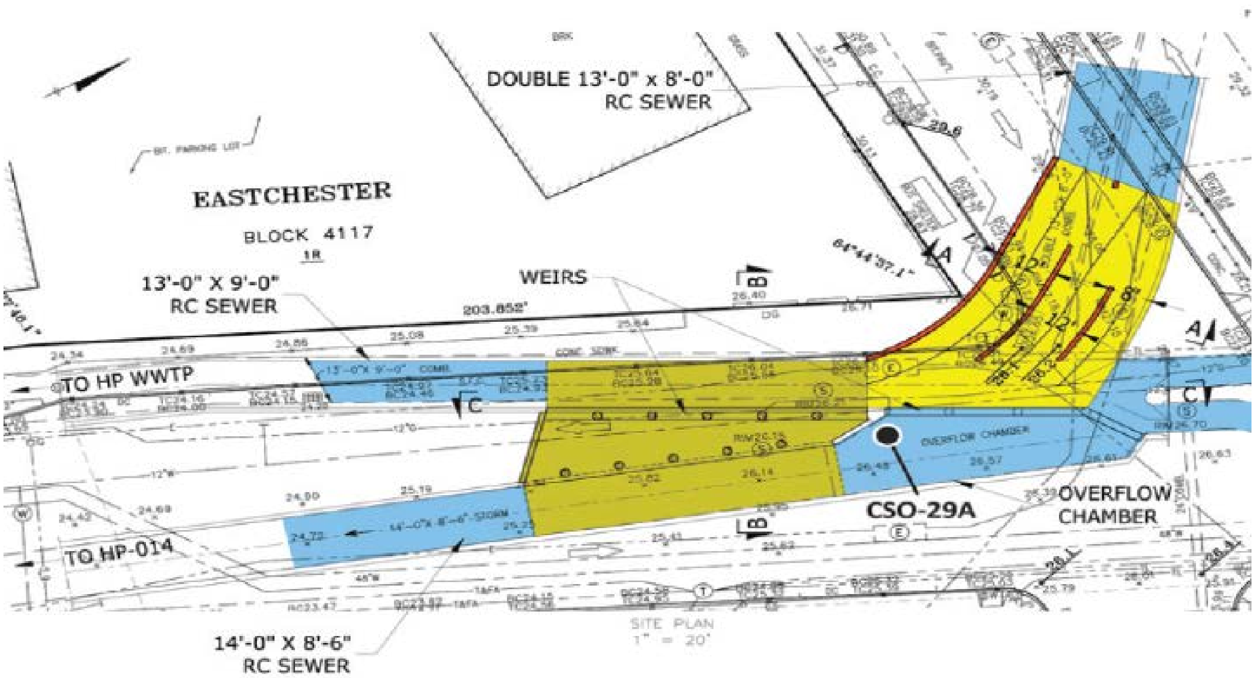


Figure 4-1. Proposed WWFP Element, Weir Modifications at CSO-29A

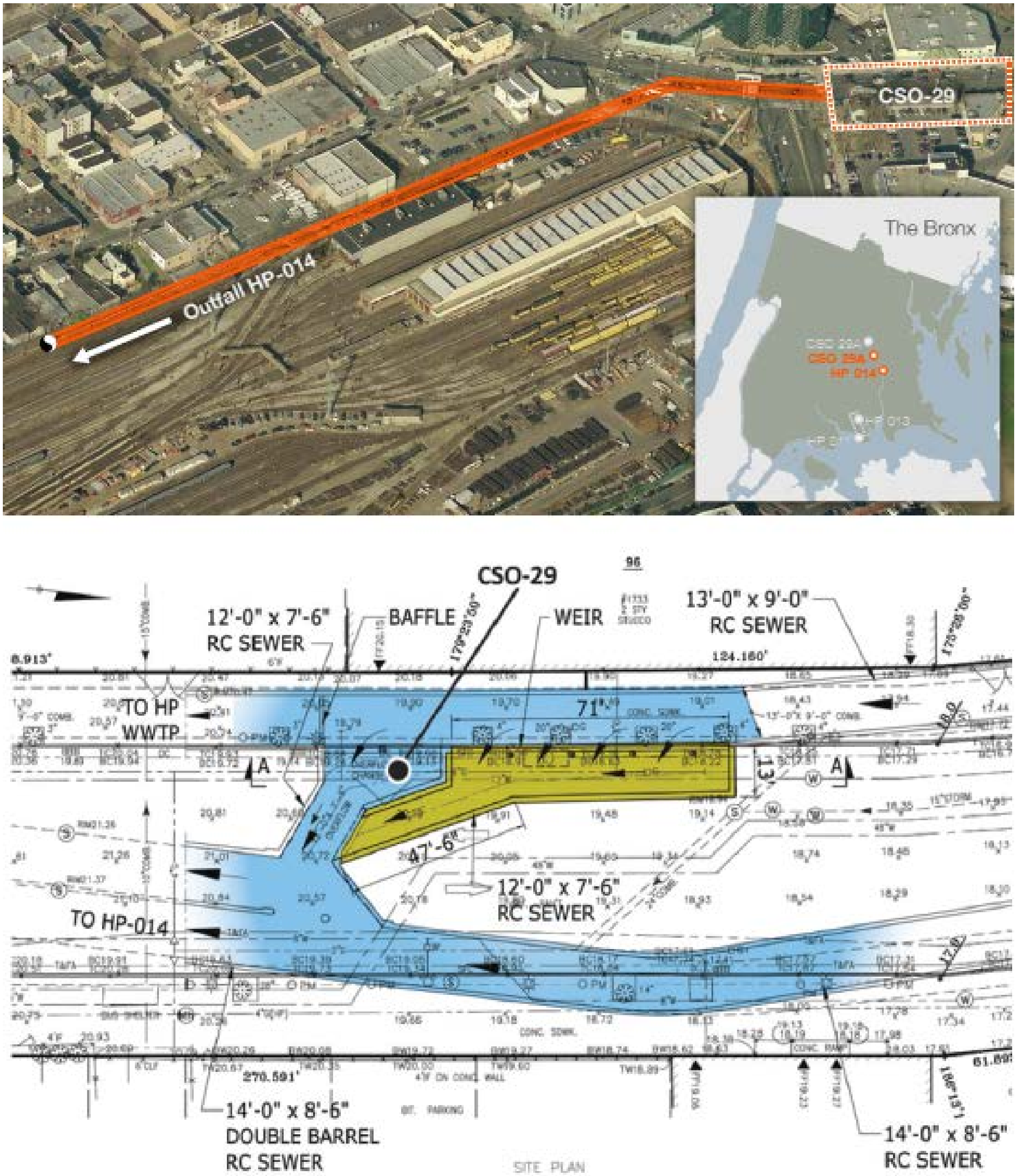


Figure 4-2. Proposed WWFP Element, Weir Modifications at CSO-29

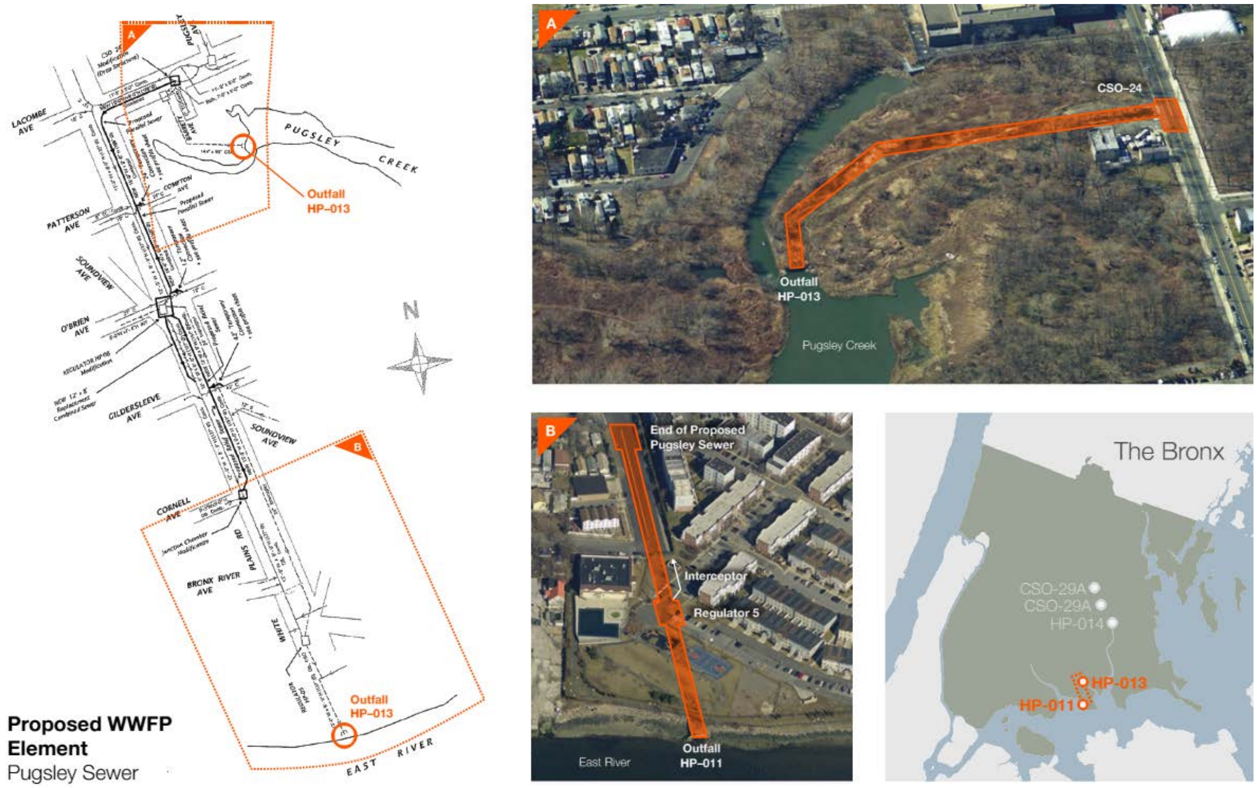


Figure 4-3. Proposed WWFP Element CSO-29A Modification, Pugsley Parallel Sewer

4.2 Other Water Quality Improvement Measures Recommended in Facility Plans (dredging, floatables, aeration)

There are no other water quality improvement measures planned for Westchester Creek at this time.

4.3 Post-Construction Monitoring

The Post-Construction Compliance Monitoring (PCM) Program is integral to the optimization of the Westchester Creek LTCP, providing data for model validation and feedback on system performance. Each year's data set will be compiled and evaluated to refine the understanding of the interaction between Westchester Creek and the planned CSO abatement facilities, with the ultimate goal of fully attaining compliance with current WQS or for supporting a UAA to revise such standards, as appropriate. The data collection monitoring will contain two basic components:

1. Receiving water data collection in Westchester Creek using existing DEP Harbor Survey Monitoring (HSM) locations and adding stations as necessary; and

2. Modeling of the collection system and receiving waters to characterize water quality using the existing IW and ERTM models, respectively.

The details provided herein are limited to the Westchester Creek PCM and may be modified as the DEP's CSO program advances through the completing of other LTCPs including the Citywide LTCP in 2017.

PCM in Westchester Creek will commence prior to the WWFP elements, and any additional CSO control measures proposed under this LTCP become operational. Build-out of any GI would be factored into the final scheduling. Monitoring will continue for several years after the controls are in place in order to quantify the difference between the expected and actual performance. Any 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. If it becomes clear that CSO control will not result in full attainment of applicable WQS, DEP will pursue the necessary regulatory mechanism for a UAA.

4.3.a Collection and Monitoring of Water Quality in the Receiving Waters

PCM for Westchester Creek will consist of sample collection at two locations in Westchester Creek (HSM Stations WC1 and WC2) and one location in the East River (HSM Station E13). Figure 4-4 presents a map of the HSM stations location. These locations have been recently sampled and have been sampled historically. All stations related to the Westchester Creek post-construction compliance monitoring program will be sampled a minimum of twice per month from May through September and monthly during the remainder of the year.

The parameters related to water quality that will be measured include dissolved oxygen, fecal coliform, enterococci, chlorophyll a, and Secchi depth. Except for enterococci, these parameters have been used by the City to identify historical and spatial trends in water quality throughout New York Harbor for decades. Dissolved oxygen and chlorophyll a are collected and analyzed at surface and bottom locations; the remaining parameters are measured at the surface only.

A more detailed discussion of the PCM methodologies can be found in the *Post Construction Compliance Monitoring and CSO Retention Facility Overflow Summary for Calendar Year 2012* (August 2013, NYC DEP).

4.3.b CSO Facilities Operations – Flow Monitoring and Effluent Quality

Any flow and effluent quality monitoring program would be dependent on the types and sizes of proposed CSO controls implemented under this LTCP. Effluent quality data is not expected to be collected routinely at an unmanned facility, nor is routine CSO flow and effluent quality data anticipated to be collected on outfalls for which no controls have been provided. If the implemented control is permitted under SPDES, stipulations under that permit regarding effluent monitoring would be followed.

4.3.c Assessment of Performance Criteria

CSO controls implemented under this LTCP will have been designed to achieve a specific set of water quality and/or CSO reduction goals as established in this LTCP, and as directed in the subsequent basis of design report (BODR) that informs the design process. If no additional CSO controls are proposed beyond the WWFP recommendations, then affirmation of water quality projections would be necessary. In both cases, the PCM data, coupled with the modeling framework used for annual reporting, will be used to assess the performance of the CSO controls implemented in comparison to the agreed-upon water quality goals.

Differences between actual overflows and model-predicted overflows are often attributable to the fact that the model results are based on the rainfall measured at a single NOAA rain gauge being taken to represent the rainfall over the entire drainage area. In reality, storms move through the area so that the rainfall actually varies over time and space. Because rainfall patterns tend to even out over the area over time, the practice of using the rainfall measured at one nearby location typically provides good agreement with long-term performance for the collection system as a whole; however, model results for any particular storm may vary somewhat from the observed.

Given the uncertainty associated with potentially widely varying precipitation conditions, rainfall analysis is an essential component of the PCM. For Westchester Creek, the most representative long-term rainfall data record is available from the National Weather Service's LaGuardia Airport (LGA) gauge. Rain data for each calendar year of the PCM program will be compared to the 10-year model period (2002-2011) and to the JFK 2008 rain data used for alternatives evaluations. Statistics including number of storms, duration, total annual and monthly depths, and relative and peak intensities will be used to classify the particular reporting year as wet or dry relative to the time series on which the concept was based.

The reporting year will be modeled using the existing IW-ERTM framework using the reporting year tides and precipitation. The resulting CSO discharges and water quality attainment will then be compared with available PCM data for the year as a means of validating model output. The level of attainment will be calculated from the modeling results and coupled with the precipitation analysis to determine relative improvement and the existence of any gap. Three successive years of evaluation will be necessary before capital improvements are considered, but operational adjustments will be considered throughout operation and reporting.

Figure 4-4. Harbor Survey Monitoring Stations Used for Westchester Creek Post Construction Monitoring

5.0 GREEN INFRASTRUCTURE

By controlling stormwater runoff through the processes of infiltration, evapotranspiration, and capture and use (rainwater harvesting), green infrastructure can help keep stormwater out of combined sewer systems. [1]Such an approach has been taken by the City of New York, and it has been incorporated into the 2012 Order on Consent (the "Order") with DEC.

The 2012 Order on Consent requires DEP to manage one-inch of runoff from 10 percent of impervious surfaces in combined sewer areas citywide by 2030. In the near term, DEP is to implement sufficient GI to attain an initial application rate of 1.5 percent, or encumber $187M toward implementation by December 31, 2015. If this 1.5 percent goal is not met, DEP must submit a contingency plan to DEC by June 20, 2016. Over the next 20 years, DEP is planning for $2.4 billion in public and private funding for targeted green infrastructure installations, and $2.9 billion in cost-effective grey infrastructure upgrades to reduce CSOs. The Green Infrastructure Program, including citywide and in-watershed based implementation are described below. It should be also noted that, as per the Order, DEP publishes the "Green Infrastructure Annual Report" every April 30th in order to provide details on multiple Green Infrastructure related efforts and implementation. These reports can be found at http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_plan.shtml

5.1 NYC Green Infrastructure Plan (GI Plan)

In September 2010, New York City published the *NYC Green Infrastructure Plan* (the "Plan"), effectively presenting an alternative approach to improving water quality through additional CSO volume reductions by outlining strategies to implement decentralized stormwater source controls. DEP estimated that a hybrid green/grey infrastructure approach would reduce CSO volume by an additional 3.8 billion gallons per year (BGY), or approximately 2 BGY more than implementing an all-grey strategy. In addition to its primary objective, enhancing water quality in NYC, the Plan will yield co-benefits which include but are not limited to, improved air quality, urban heat island mitigation, carbon sequestration, increased shade, and increased urban habitat for pollinators and wildlife.

In January 2011, DEP created the Office of Green Infrastructure (OGI) to implement the goals of the Green Infrastructure Plan, and budgeted over $730M including $5M in Environmental Benefits Project (EBP) funds, through FY 2023 for green infrastructure projects.[2] OGI, along with other DEP bureaus and partner city agencies, are tasked with designing and constructing green infrastructure practices that divert stormwater away from the sewers and direct it to areas where it can be infiltrated, evapotranspired, stored, or detained. OGI has developed design standards for Right-of-way bioswales (ROWBs) and designed other projects that include pervious pavement, rain gardens, and green and blue roofs. The Area-wide strategy and other implementation activities initiated by OGI to achieve the milestones in the 2012 Order on Consent are described in more detail below.

[1] *U.S. EPA, March 2014. Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control.*

[2] EBP projects are 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.

5.2 City-wide Coordination and Implementation

To meet the green infrastructure goals of the Order, DEP has identified, and will continue to identify Priority CSO Tributary Areas ("Priority Areas") for green infrastructure implementation based on several criteria. DEP reviews the annual CSO volume, frequency of CSO events, as well as outfalls that may be affected by Waterbody/Watershed Facility Plans (WWFPs) or other system improvements in the future. DEP also notes outfalls in close proximity to existing and future public access locations. DEP will continue to review and expand the number of Priority Areas to ensure sufficient green infrastructure implementation toward the Order milestones. The Priority Areas are shown in Figure 5-1.

The identification of Priority Areas enables DEP to focus resources on specific outfall tributary areas analyze potential opportunities, saturate these areas with green infrastructure as much as possible, and to achieve efficiencies in design and construction. This area-wide strategy is made possible by DEP's standardized designs and procedures that enable systematic implementation of green infrastructure. It also provides an opportunity to measure and evaluate the CSO benefits of area-wide green infrastructure implementation at the outfall level.

DEP utilizes the Area-wide strategy for all public property retrofits as well, as described in more detail in the Green Infrastructure Annual Reports. DEP works directly with its partner agencies on retrofit projects at public schools, public housing, parkland, and other city owned property within the Priority Areas. DEP coordinates on a regular basis with partner agencies to review designs for new projects and to gather current capital plan information to identify opportunities to integrate green infrastructure into planned public projects.

In addition to DEP managing its own design and construction contracts (including OGI and the Bureau of Engineering, Design, and Construction), the New York City Economic Development Corporation (EDC), Department of Parks and Recreation (DPR), and Department of Design and Construction (DDC) also manage several of these area-wide contracts on behalf of DEP.

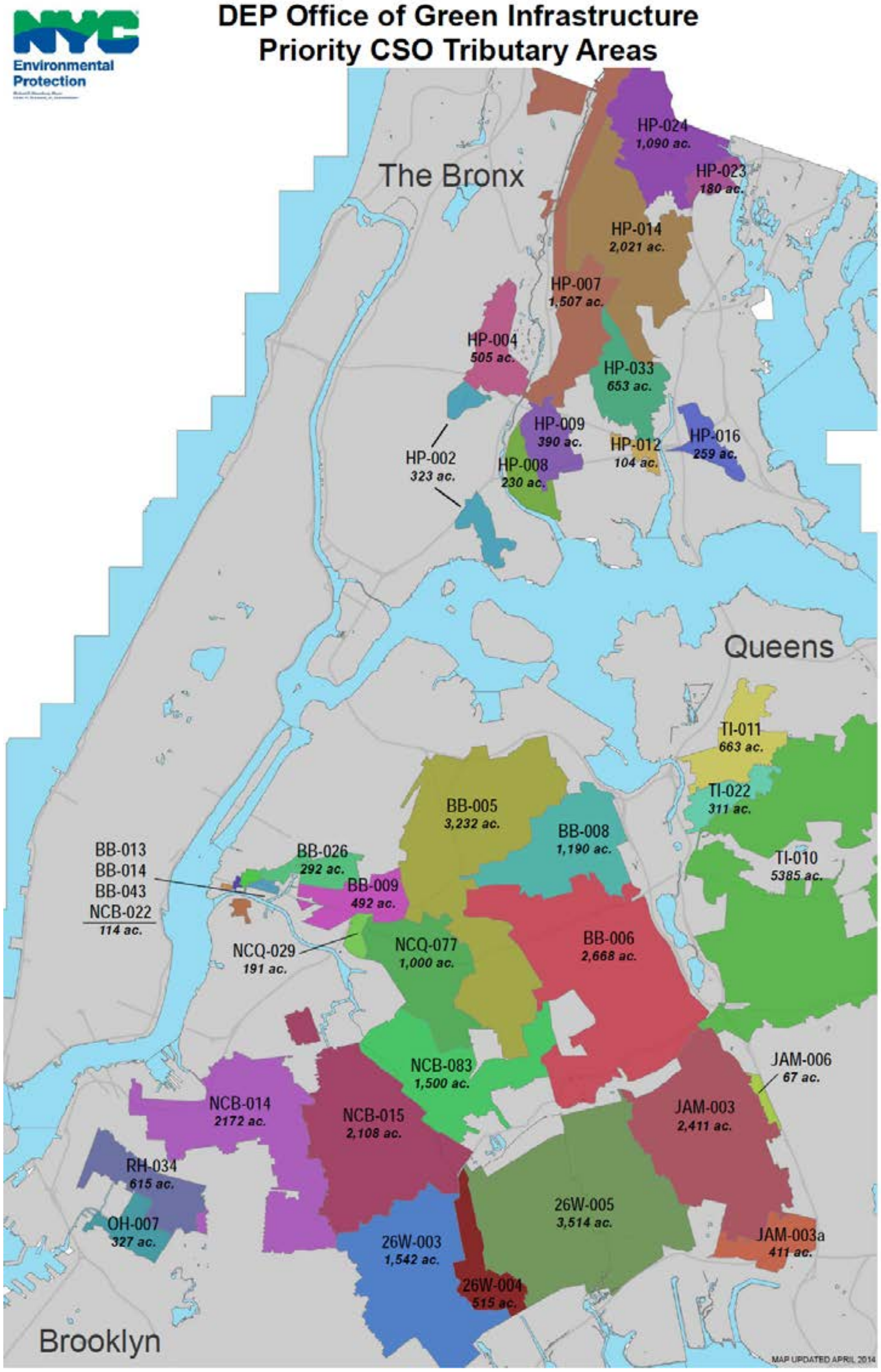


Figure 5-1. Priority CSO Tributary Areas for Green Infrastructure Implementation

5.2.a Community Engagement

Stakeholder participation is a critical success factor for the effective implementation of decentralized green infrastructure projects. To this end, DEP engages and educates local neighborhoods, community groups, and other environmental and urban planning stakeholders about their role in the management of stormwater. DEP's outreach efforts involve presentations and coordination with elected officials, community boards, stormwater advocacy organizations, green job non-profits, environmental justice organizations, schools and universities, Citizens Advisory Committees (CACs), civic organizations, and other City agencies.

DEP has updated its website at www.nyc.gov/dep. As part of this update, DEP reorganized and added new content to the green infrastructure pages at www.nyc.gov/dep/greeninfrastructure. Users can now easily access more information on the Green Infrastructure Program, including the types of green infrastructure practices most often employed, and DEP's research and development program. Users can also view a map of the Priority CSO Tributary Areas to learn if green infrastructure is coming to their neighborhood.

DEP also created an educational video on the Green Infrastructure Program. Posted to DEP's YouTube page, the video gives a brief explanation of the environmental challenges caused by combined sewer overflows while featuring green infrastructure technologies such as green roofs, rain gardens and permeable pavers. The video is available at DEP's YouTube page.

In order to provide more information about the Green Infrastructure Program, DEP developed an informational brochure that describes the site-selection and construction process for projects in the Right-of-way. The brochure also includes frequently asked questions and answers, and explains the co-benefits of green infrastructure.

In addition, DEP will distribute door hangers to notify abutting property owners in advance of green infrastructure Right-of-way construction projects. During construction in each contract area, DEP and its partner agencies will provide construction liaison staff to be present during construction and to distribute the door hangers to the adjacent property owners. The contact information for the construction liaison will be affixed to the door hangers if the need to alert the City to a problem arises during construction.

Additionally, DEP continues to make presentations to elected officials and their staff, community boards, and other civic and environmental organizations about the Green Infrastructure Program, upcoming construction schedules, and final green infrastructure locations as an ongoing part of its outreach efforts.

5.3 Completed Green Infrastructure to Reduce CSOs (Citywide and Watershed)

The Green Infrastructure Annual Report contains the most up to date information on completed projects and can be found on the DEP website. Reporting on completed projects on a Citywide and watershed basis by April 30th is a requirement. In addition, Quarterly Progress Reports are posted on the DEP LTCP webpage. http://www.nyc.gov/html/dep/html/cso_long_term_control_plan/index.shtml

5.3.a Green Infrastructure Demonstration and Pilot Projects

The Green Infrastructure Program applies an adaptive management approach, based on information collected and assessed for demonstration projects and on pilot monitoring results. In particular, accumulated information will be used to develop a green infrastructure performance metrics report by 2016, relating the benefits of CSO reduction with the amount of constructed green infrastructure.

Pilot Monitoring Program

DEP initiated site selection and design of its Pilot Monitoring Program in 2009. The program has provided DEP opportunities to test different designs and monitoring techniques, to determine the most cost-effective, adaptable, and efficient GI strategies that can be implemented citywide. Specifically, the pilot monitoring has aimed to assess the effectiveness of each of the evaluated source controls at reducing the volume and/or rate of stormwater runoff from the drainage area through measuring quantitative aspects (e.g., source control inflow and outflow rates) as well as qualitative issues (e.g., maintenance requirements, appearance and community perception). Since 2010, more than thirty pilot green infrastructure source controls, or green infrastructure installations, have been constructed and monitored as part of the pilot program for green infrastructure. These practices include Right-of-way green infrastructure such as enhanced tree pits; rooftop practices like blue roofs and green roofs; subsurface detention systems with open bottoms for infiltration; porous pavement; and bioretention facilities. Data collection began in 2010 and 2011, as construction for each of the 25 monitoring sites was completed. Pilot Monitoring Program results are currently being used to improve GI designs and validate modeling methods and parameters. Results are further discussed in Section 5.3.e.

Neighborhood Demonstration Area Projects

The 2012 Order outlined design, construction, and monitoring milestones for three Neighborhood Demonstration Area Projects ("Demonstration Projects"), which DEP met in 2012 and 2013. DEP has completed construction of green infrastructure within a total of 63 acres of tributary area in the Newtown Creek, Hutchinson River and Jamaica Bay CSO tributary areas, and is currently monitoring these practices to study the benefits of green infrastructure application on a neighborhood scale and from a variety of techniques. The Demonstration Projects will culminate in the submission of the Post-Construction Monitoring report in August 2014. These results will be incorporated into the 2016 Performance Metrics report, which will model the CSO reductions from of green infrastructure projects. Pre-construction monitoring for all three Demonstration Projects started in fall 2011, and post-construction monitoring continued throughout 2013.

Construction of Right-of-way Bioswales as part of the Hutchinson River Green Infrastructure Demonstration Area was completed in April 2013 by DPR. There were 22 Right-of-way Bioswales installed within the 24 acre tributary area, and the design and construction costs were approximately $545,000. In the 23 acre Jamaica Bay Green Infrastructure Demonstration Area, DEP completed 31 Right-of-way green infrastructure installations in 2012 and the permeable pavement retrofit projects at NYCHA's Seth Low Houses in 2013. The total design and construction costs were approximately $1.3M. In the 16 acre Newtown Creek Green Infrastructure Demonstration Area, DEP constructed 19 Right-of-way Bioswales, two rain gardens, and a subsurface storm chamber system on the site of NYCHA's Hope Gardens Houses. The projects were completed in 2013, and costs were approximately $1.4M for design and construction. For more information on the Neighborhood Demonstration Areas, see the *2012 Green Infrastructure Annual Report.*

While DEP's Pilot Monitoring Program provides performance data for individual green infrastructure installations, the Neighborhood Demonstration Area Projects will provide standardized methods and information for calculating, tracking, and reporting derived CSO volume reductions and other benefits associated with both multiple installations within a concentrated area and common connections to the sewer system. The data collected from each of the three demonstration areas will enhance DEP's understanding of the benefits of green infrastructure relative to runoff control and CSO reduction. The results will then be extrapolated for calculating and modeling water quality and cost-benefit information on a citywide and waterbody basis.

5.3.b Public Projects

See Section 5.2, "Citywide Coordination and Implementation" from The Green Infrastructure Annual Reports for up to date information on completed projects.

5.3.c Performance Standard for New Development

DEP's stormwater performance standard ("stormwater rule"), enables the City to manage stormwater runoff more effectively, and to reduce the rate of runoff into the City's combined sewer systems from new development or major site expansions. Promulgated in July 2012,[3] the stormwater rule requires any new house or site connections to the City's combined sewer system to comply with stricter stormwater release rates, effectively requiring greater onsite detention. DEP's companion document, Guidelines for the Design and Construction of Stormwater Management Systems,[4] assists the development community and licensed professionals in the selection, planning, design, and construction of onsite source controls that comply with the stormwater rule.

The stormwater rule applies to new development or the alteration of an existing development in combined sewer areas of the City. For a new development, the stormwater release rate[5] is required to be 0.25 cubic feet per second (cfs) or 10 percent of the drainage plan allowable flow, whichever is greater.[6] If the allowable flow is less than 0.25 cfs, then the stormwater release rate shall be equal to the allowable flow. For alterations, the stormwater release rate for the altered area will be directly proportional to the ratio of the altered area to the total site area, and no new points of discharge are permitted.[7]

5.3.d Other Private Projects (Grant Program)

Green Infrastructure Schoolyards

The "Schoolyards to Playgrounds" program, one of PlaNYC 2030's initiatives aimed at ensuring at all New Yorkers live within a ten-minute walk from a park, is a collaboration between the non-profit Trust for Public Land (TPL), DPR, DOE, and SCA to renovate school playgrounds and extended playground access to surrounding neighborhoods. In 2011, DEP joined TPL, NYC SCA, and NYC DOE, funding up to $5M for construction of ten green infrastructure public school playgrounds each year for the next four

[3] See Chapter 31 of Title 15 of the Rules of the City of New York Governing House/Site Connections to the Sewer System. (New York City, N.Y., Rules, Tit. 15, § 31)

[4] *The Guidelines are available at DEP's website, at*
http://www.nyc.gov/html/dep/pdf/green_infrastructure/stormwater_guidelines_2012_final.pdf

[5] New York City, N.Y., Rules, Tit. 15, § 31-01(b)

[6] Allowable flow is defined as the storm flow from developments based on existing sewer design criteria that can be released into an existing storm or combined sewer.

[7] New York City, N.Y., Rules, Tit. 15, § 31-03(a)(2)

years. The partnership is a successful component of DEP's strategy to leverage public-private partnerships to improve public property using green infrastructure retrofits.

Green Infrastructure Grant Program

Since its introduction in 2011, the Grant Program has sought to strengthen public-private partnerships and public engagement in regard to the design, construction and maintenance of green infrastructure.

The Order requires the Green Infrastructure Grant Program to commit $3M of Environmental Benefits Program (EBP) funds[8] to projects by 2015.

Green Roof Tax Abatement

The NYC Green Roof Tax Abatement (GRTA) has provided a fiscal incentive to install green roofs in private property since 2008. DEP has worked with the Mayor's Office of Long Term Planning and Sustainability (OLTPS), DOB, the Department of Finance (DOF) and the Office of Management and Budget (OMB), as well as environmental advocates and green roof designers, to modify and extend the GRTA through 2018. DEP has met with stakeholders and incorporated much of their feedback to improve the next version, and help increase the number of green roofs in the City. Additionally, DEP funded an outreach position to educate applicants and assist them through the abatement process, to help facilitate application approval and respond to issues that may arise.

The tax abatement includes an increase to the value of the abatement from $4.50 to $5.23 per square foot, to continue offsetting construction costs by roughly the same value as the original tax abatement. And given that rooftop farms tend to be larger than typical green roofs (generally around one acre in size), the abatement value cap was also increased from $100,000 to $200,000 to allow such applicants to receive the full value of the abatement. Finally, based on the amount allocated for this abatement, the total annual amount available for applicants (i.e., in the aggregate) is $750,000 in the first year, and $1,000,000 in each subsequent year through March 15, 2018. The aggregate amount of abatements will be allocated by the New York City Department of Finance on a pro rata basis. See the Green Infrastructure Annual Report for up to date information on the Green Roof Tax Abatement.

5.3.e Projected vs. Monitoring Results

Pilot Monitoring Program

As mentioned above, more than 30 pilot green infrastructure source controls, or green infrastructure installations, have been constructed and monitored as part of the pilot program for green infrastructure. Quantitative monitoring parameters included:

- Water quantity: inflow, outflow, infiltration, soil moisture and stage.
- Weather: evaporation, rainfall, wind, relative humidity and solar radiation.

[8] EBP Projects are undertaken by DEP in connection with the settlement of an enforcement action taken by New York State and the New York State Department of Environmental Conservation for violations of New York State law and DEC regulations.

- Water/soil quality: diesel/gas, nutrients, TSS, TOC, salts, metals, soil sampling and infiltrated water sampling.

Quantitative monitoring was conducted primarily through remote monitoring equipment, such as pressure transducer water level loggers in conjunction with weirs or flumes to measure flows, monitoring aspects of source control performance at a five-minute interval. On-site testing and calibration efforts included infiltration tests and metered discharges, to calibrate flow monitoring equipment and assess the validity of assumptions used in pilot performance analysis.

Monitoring efforts focused on the functionality of the green infrastructure and their impact on runoff rates and volumes, along with water and soil quality and typical maintenance requirements. Monitoring activities largely involved remote monitoring equipment that measured water level or flows at a regular interval, supporting analysis of numerous storms throughout at each site.

Monitoring analyses through 2013 demonstrated that all pilot green infrastructure types are providing effective stormwater management, particularly for storms with depths of one-inch or less. All green infrastructure practices have provided benefits for storms greater than one-inch, with specific impacts varying based upon location and the type. In many cases, bioretention practices have fully retained the volume of one-inch storms they receive

Monitoring activities will be discontinued at several sites that have multiple years of performance data and have exhibited relatively consistent performance throughout that period. Further monitoring at these locations may be resumed in the future to further examine long-term performance. Monitoring data for these locations is included in the *2012 Pilot Monitoring Report*. In addition, up to date information on the Pilot Monitoring Program can be found in the Green Infrastructure Annual Report.

Neighborhood Demonstration Area Projects

As previously discussed, the objective of DEP's Neighborhood Demonstration Area Projects is to maximize management of stormwater runoff near where it is generated, and then monitor the reduction of combined sewage originating from the drainage sub-basins. The development of these demonstration projects will culminate in the submission of a PCM Report in August 2014, and ultimately in a 2016 performance metrics report. The 2016 report will relate the benefits of CSO reduction associated with the amount of green infrastructure constructed, and detail methods by which DEP will use to calculate the CSO reduction benefits in the future.

The three Neighborhood Demonstration Areas where DEP will test the effectiveness of green infrastructure implementation were selected because the existing CSSs were suitable for monitoring flow in a single sewer pipe of a certain size, and are not influenced by surcharging hydraulic conditions. In each of the Demonstration Areas, DEP has identified green infrastructure opportunities such as bioswales and stormwater greenstreets in the Right-of-way, and on-site detention and retention opportunities on City-owned property.

The combined sewer flow reductions achieved by green infrastructure implementation will be monitored through the collection of high quality flow monitoring data at the point at which the combined sewers exit Demonstration Area catchments. Monitoring activities consist of recording flow and depth, using meters placed within key outlet sewers. Data acquisition is continuous, with measurements recorded at 15-minute intervals.

Data analysis will involve a review of changes in pervious and impervious surface coverage between pre- and post-construction conditions, consisting of several elements, including statistical analyses and modeling refinements. The statistical analyses will enable DEP to:

- Determine the overall amount of CSO reduction associated with green infrastructure implementation;
- Determine rules of thumb (gallons per acre controlled) for use in scaled-up green infrastructure planning and implementation in other (non-demo) areas of the City;
- Determine a representative permeability range for ROWBs infiltration; and
- Utilize monitoring data to inform future ROWB designs.

Project data collected will be used to calibrate the IW computer model to the monitored flows for both pre- and post-construction conditions. Post-construction performance data will be used to ensure that retention modeling techniques adequately account for the degree of flow reduction within subcatchments with planned green infrastructure and equivalent CSO volume reductions.

5.4 Future Green Infrastructure in the Watershed

5.4.a Relationship Between Stormwater Capture and CSO Reduction

CSO reduction and pollutant load reduction through additional stormwater capture in the Westchester Creek watershed was evaluated using the landside model, developed in IW modeling software, based on the extent of retention and detention practices in combined sewer areas. The extent of retention and detention is configured in terms of a percent of impervious cover where one inch of stormwater is managed through different types of source controls. Retention at different source controls is lumped on a sub-basin or subcatchment level in the landside model, due to their distributed locations within a watershed; this is also due to the fact that the landside model does not include small combined sewers, and cannot model them in a distributed manner. Retention is modeled with the applicable storage and/or infiltration elements. Similarly, the distributed detention locations within a watershed are represented as lumped detention tank, with the applicable storage volume and constricted outlet configured based on allowable peak flows from their respective drainage areas. Modeling methods designed during the development of DEP's Green Infrastructure Plan have been refined over time to better characterize the retention and detention functions.

5.4.b Opportunities for Cost-Effective CSO Reduction Analysis

There were no GI-related cost-effective opportunities for CSO reduction to report in this section.

5.4.c Watershed Planning to Determine 20 Year Penetration Rate for Inclusion in Baseline Performance

To meet the 1.5-, 4-, 7-, and 10-percent Citywide green infrastructure application rates by 2015, 2020, 2025 and 2030, respectively, DEP has developed a watershed prioritization system based on watershed-specific needs. This approach has provided an opportunity to build upon existing data and make informed estimates available.

Watershed-specific implementation rates for green infrastructure are estimated based on the best available information from modeling efforts. Specific waterbody/watershed facility plans, the Green

Infrastructure Plan, CSO outfall tiers data, and historic building permit information were reviewed to better assess waterbody-specific green infrastructure application rates.

The following criteria were applied to compare and prioritize watersheds in order to determine watershed-specific green infrastructure application rates:

- WQS
  - Fecal Coliform
  - Total Coliform
  - Dissolved Oxygen

- Cost effective grey investments
  - Planned/constructed grey investments
  - Projected CSO volume reductions
  - Remaining CSO volumes
  - Total capital costs

- The ratio of separate stormwater discharges to CSO discharges

- Preliminary watershed sensitivity to green infrastructure in terms of cost per gallon of CSO reduced

- Additional considerations:
  - Background water quality conditions
  - Public concerns and demand for higher uses
  - Site specific limitations (i.e., groundwater, bedrock, soil types, etc.)
  - Presence of high frequency outfalls
  - Eliminated or deferred CSO storage facilities
  - Additional planned CSO controls not captured in WWFPs or 2012 Order on Consent (i.e., high level storm sewers, HLSS)

The overall goal for this prioritization is to saturate green infrastructure implementation rates within the priority watersheds, such that the total managed impervious acres will still be achieved in accordance with the 2010 Green Infrastructure Plan, except for the East River and Open Waters.

Green Infrastructure Baseline Application Rate – Westchester Creek

Based on the above criteria, Westchester Creek's characterization ultimately determined that the watershed is a priority CSO tributary area for DEP and green infrastructure has been planned there. This particular watershed has a total combined sewer impervious area of 3,480 acres out of a total of drainage area of 4,952 acres. DEP projects application rates as follows:

- 348 acres (10 percent) are expected to be managed using green infrastructure Right-of-way-bioswales

- 122 acres (3.5 percent) to be managed in onsite private properties in Westchester Creek by 2030 through new development and compliance with the Stormwater Performance Standard.

- 17 acres (0.5 percent) to be managed in onsite public properties.

This acreage would represent 14 percent of the total combined sewer impervious area in the watershed by 2030.

DEP conservatively estimated new development trends based on DOB building permit data from 2000 to 2011 and has projected that data out for the 2012-2030 period to account for compliance with the stormwater performance standard.

Furthermore, as LTCPs are developed, baseline green infrastructure application rates for specific watersheds may be adjusted based on the adaptive management approach and requirements set forth in the 2012 Order on Consent. The model has predicted a reduction in annual overflow volume of 66 MG from this green infrastructure implementation based on the 2008 baseline rainfall condition.

DEP is working on the implementation of right-of-way green infrastructure contracts in the CSO tributary areas of HP-012/HP-016, HP-014 and HP-033, as shown in the Figure 5-2.

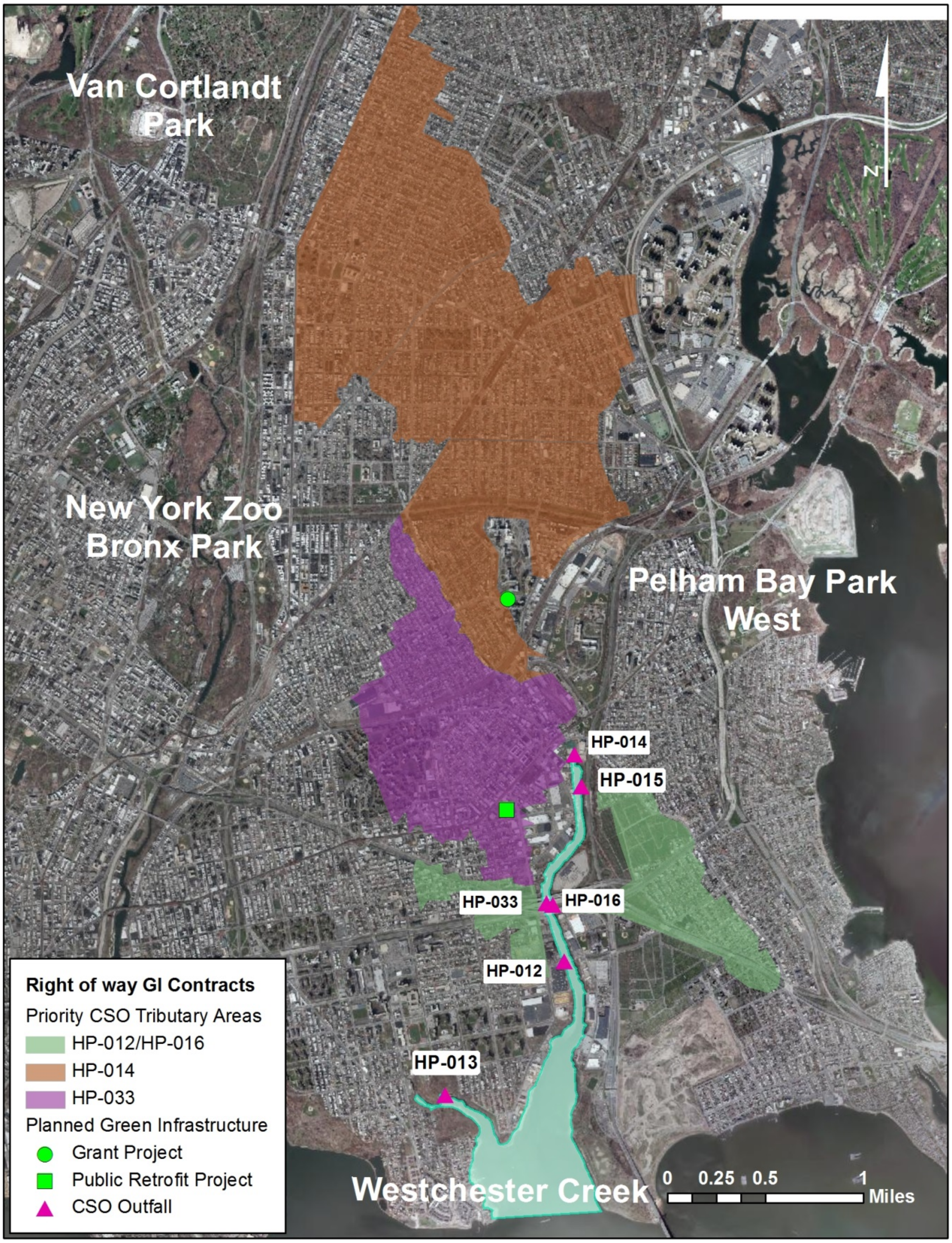


Figure 5-2. Green Infrastructure Contracts

6.0 BASELINE CONDITIONS AND PERFORMANCE GAP

Key to development of the Westchester Creek LTCP is the assessment of water quality with applicable water quality standards within the waterbody. Water quality was assessed using the ERTM water quality model, verified with both Harbor Survey and the synoptic water quality data collected in 2013 and 2014. The ERTM water quality model simulated ambient bacteria concentrations within Westchester Creek for a set of baseline conditions, as described in this section. The InfoWorks CS (IW) sewer system model was used to provide flows and loads from intermittent wet weather sources as input to the water quality model.

Two types of continuous water quality simulations were performed to evaluate the gap between the calculated bacteria levels under baseline conditions and the Existing WQ Criteria and Future Primary Contact WQ Criteria. As detailed below, a one-year (using average 2008 rainfall) simulation was performed for bacteria and dissolved oxygen (DO). This shorter term continuous simulation served as a basis for evaluation of control alternatives. A 10-year (2002-2011) simulation was performed for bacteria, to assess the baseline conditions, evaluate the performance gap, and analyze the impacts of the final alternative.

This section of the LTCP describes the baseline conditions and the bacteria concentrations and loads calculated by the IW model and the resulting bacteria concentrations calculated by the ERTM water quality model. It further describes the gap between calculated baseline bacteria concentrations and the WQS, when the calculated baseline concentrations exceed the criteria. These analyses are presented for the Existing WQ Criteria (Class I); the existing Primary Contract WQ Criteria (Class SC) and for Future Primary Contract WQ Criteria (2012 EPA RWQC). It should be noted that enterococci criterion does not apply to tributaries such as Westchester Creek under the BEACH Act of 2000; therefore Westchester Creek water quality assessments for existing Class SC considered the fecal coliform criterion only. Future Primary Contract WQ Criteria assessments take into account both enterococci and fecal coliform criteria for primary contact recreation.

6.1 Define Baseline Conditions

Establishing baseline conditions is an important step in the LTCP process, since the baseline conditions will be used to compare and contrast the effectiveness of CSO controls and to predict whether water quality goals would be attained after the implementation of the recommended LTCP. Baseline conditions for this LTCP were established in accordance with guidance established by DEC to represent future conditions. Specifically, these conditions included the following assumptions:

- The design year was established as 2040.
- The Hunts Point WWTP receives peak flows at 2xDDWF.
- Grey infrastructure includes those recommended in the 2011 WWFP.
- Green Infrastructure (GI) in 14 percent of the impervious surfaces within the combined sewer service areas.

Mathematical modeling tools were used to calculate the CSO volume and pollutants loads and their impacts on water quality. The performance gap between calculated WQS was assessed herein by comparing the baseline conditions with WQS. In addition, complete removal of CSO was evaluated. Further analyses were conducted for CSO control alternatives in Section 8.0.

The IW model was used to develop stormwater flows, conveyance system flows, and CSO volumes for a defined set of future or baseline conditions. For the Westchester Creek LTCP, the baseline conditions were developed in a manner consistent with the earlier WWFP approved by DEC. However, based on more recent data as well as the public comments received on the WWFP, it was recognized that some of the baseline condition model input data needed to be updated, to reflect more recent meteorological conditions as well as current operating characteristics of various collection and conveyance system components. Furthermore, the mathematical models were also updated from their configurations and levels of calibration developed and documented during development of the earlier WWFP. IW model alterations reflected a better understanding of dry and wet weather sources, catchment areas, and new or upgraded physical components of the system. In addition, a model recalibration report was issued in 2012 (*InfoWorks Citywide Recalibration Report – June 2012*) that used improved impervious surface satellite data. Water quality model updates included more refined model segmentation. The new IW model network was then used to calculate CSO overflows and loads for the baseline conditions and was used as a tool to evaluate the impact on CSO overflows of potential alternative operating strategies and other possible physical changes to the collection system.

Following are the baseline modeling conditions primarily related to DWF rates, wet weather capacity for the Hunts Point WWTP, sewer conditions, precipitation conditions, and tidal boundary conditions. Each of these is briefly discussed in the section below:

- **Wet Weather Capacity**: The rated wet weather capacity at the Hunts Point WWTP is 400 MGD (2xDDWF). A project was completed in 2004 to upgrade the treatment plant including the plant headworks and main sewage pumps so that the plant is capable of accepting, pumping and treating combined sewage to a maximum flow of 400 MGD. On May 8, 2014, DEC and DEP entered into an administrative consent order that includes an enforceable compliance schedule to ensure that DEP maximizes flow to and through the WWTP during wet weather events.

- **Sewer Conditions**: The IW model was developed to represent the sewer system on a macro scale that included including all conveyance elements greater than 48-in in equivalent diameter, along with all regulator structures and CSO outfall pipes. Post cleaning levels of sediments were also included for the interceptors in the collection system, to better reflect actual conveyance capacities to the WWTPs.

6.1.a Hydrologic Conditions

Previous evaluations of the Westchester Creek watershed used the 1988 precipitation characteristics as the representative typical precipitation year. However, for this LTCP, the precipitation characteristics for 2008 were used for the baseline condition, as well for alternatives evaluations. In addition to the 2008 precipitation pattern, the observed tide conditions that existed in 2008 were also applied in the models as the tidal boundary conditions at the CSO outfalls that discharge to tidally influenced waterbodies. For longer term 10-year evaluations, the period from 2002 through 2011 was analyzed.

6.1.b Flow Conservation

Consistent with previous studies, the dry weather sanitary sewage flows used in the baseline modeling were escalated to reflect anticipated population growth in the City. In 2012, DEP completed detailed analysis for water demand and wastewater flow projections. A detailed GIS analysis was performed to apportion total population among the 14 WWTP drainage areas. For this analysis, Transportation Analysis Zones (TAZs) were overlaid with WWTP drainage areas. Population projections for 2010-2040 were derived from Population Projections developed by the Department of City Planning (DCP) and New York Metropolitan Transportation Council (NYMTC). These analyses used the 2010 census data to reassign population values to the watersheds in the model and project up to 2040 sanitary flows. These projections also reflect water conservation measures that have already significantly reduced flows to the WWTPs and freed-up capacity in the conveyance system.

6.1.c BMP Findings and Optimization

A list of BMPs, along with brief summaries of each and their respective relationships to the EPA NMCs, were reported in Section 3.0, as they pertain to Westchester Creek CSOs. 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 CSS, thereby improving water quality conditions.

The following provides an overview of the specific elements of various DEP, SPDES and BMP activities as they relate to development of the baseline conditions, specifically in setting up and using the IW models to simulate CSO discharges, and in establishing non-CSO discharges that impact water quality in Westchester Creek:

- Sentinel Monitoring – In accordance with BMPs #1 and #5, DEP collects quarterly samples of bacteria water quality at the mouth of Westchester Creek in dry weather to assess whether dry weather sewage overflows occur or illicit connections to storm sewers exist. No evidence of illicit sanitary sewer connections was observed based on these data. Although illicit sources of pollution were included in the water quality model calibration exercises to accurately simulate the observed ambient bacteria concentrations, these sources were excluded from the baseline conditions, to reflect future corrected conditions.

- Interceptor Sediments – Sewer sediment levels determined through the post-cleaning inspections are included in the IW model.

- Combined Sewer Sediments – The IW models assume no sediment in upstream combined trunk sewers in accordance with BMP #2.

- WWTP Flow Maximization – In accordance with BMP #3, the plant treats wet weather flows up to 2xDDWF that are conveyed to the Hunts Point WWTP. DEP follows the wet weather operating plan and receives and treats 2xDDWF regularly. Cleaning of the interceptor sediments has increased the ability of the system to convey 2xDDWF to the treatment plant.

- Wet Weather Operation Plans (WWOP) – The Hunts Point WWOP (BMP #4) establishes procedures for pumping at the plant headworks to assure treatment of 2xDDWF.

6.1.d Elements of Facility Plan and GI Plan

The Westchester Creek LTCP includes the following grey projects recommended in the 2011 WWFP:

- Modifications to the regulator structures that discharge to HP-014 (CSO-29 and CSO-29A) to capture more frequent smaller storms without increasing flooding risk in the collection system,

- Construction of a parallel sewer from the regulator structure that discharges to HP-013 (CSO-24) and a new junction chamber at Cornell Avenue on White Plains Road to divert flow away from Pugsley Creek into the well-mixed Upper East River.

These capital projects were included in the 2012 Order on Consent with construction completion milestones of December 2019 for both projects. Design of the CSO-29 and CSO-29A modifications is to be completed by June 2014; the parallel sewer is being designed by NYC Design and Construction (DDC) and is expected to be completed by June 2015.

As discussed in Section 5.0, the Westchester Creek watershed is one of the more promising areas for GI build-out in the City. DEP has projected 14 percent level of GI implementation, which has been assumed in the baseline model.

6.1.e Non-CSO Discharges

In several sections of the Hunts Point WWTP drainage area, stormwater drains directly to receiving waters without entering the combined system or separate storm sewer system. These areas were depicted as “Direct Drainage” in Figure 2-6 (Section 2.0), and were delineated based on topography and the direction of stormwater runoff flow in those areas. In general, shoreline areas adjacent to waterbodies comprise the direct drainage category. However, these areas are comparatively small: of the 4,952 acres of drainage area tributary to Westchester and Pugsley Creeks, 86 percent (4,271 acres) is served by combined sewers. The remaining 14 percent is evenly divided between direct drainage (341 acres) and separately sewered stormwater outfalls (340 acres). Overall, the Hunts Point WWTP receives flow from 12,241 acres, of which 11,435 acres (93 percent) is served by combined sewers.

6.2 Baseline Conditions – Projected CSO Volumes and Loadings after the Facility Plan and GI Plan

The IW model was used to develop CSO volumes for the baseline conditions. It incorporated the implementation of a 14-percent GI build-out and operation of the recommended Westchester Creek WWFP elements. Using these overflow volumes, pollutant loadings from the CSOs were generated using the enterococci, fecal coliform, and BOD concentrations and provided input to the receiving water quality model- ERTM. ERTM was assessed against 2014 monitoring data collected in Westchester Creek under LTCP as well as Harbor Survey data for the same period. The assessment consisted of comparing the cumulative frequency distribution of 2014 collected concentration data against the cumulative frequency distribution of the model for storms of similar sizes from the pre-WWFP simulation. The year 2014 was used as the sampling cut off point in order to provide enough time to process the samples, calibrate and run the model for alternatives analysis comparison included in the LTCP by the submission date.

In addition, to CSO pollutant loadings, storm sewer discharges and direct drainage impact the water quality in Westchester Creek. The pollutant concentrations assigned to the various sources of pollution to

Westchester Creek are summarized in Table 6-1. Concentrations in Table 6-1 represent concentrations considered typical of stormwater, direct drainage and sanitary sewage for the Westchester Creek drainage area. These values were used in the analysis since sampling data were not available when the modeling simulations were performed.

Table 6-1. Pollutant Concentrations for Various Sources in Westchester Creek

Pollutant Source	Enterococci (cfu/100mL)	Fecal Coliform (cfu/100mL)	BOD_5[1] (mg/L)
Stormwater[2]	50,000	120,000	15
Direct Drainage[3]	6,000	4,000	15
Sanitary Sewage[2]	1,000,000	4,000,000	110

Notes: (1) 2011, 2012, 2013 DEP Process Control HP WWTP operational records
(2) Hydroqual Memo to DEP, 2005a
(3) Basis – NYS Stormwater Manual., Charles River LTCP, National Stormwater Data Base for commercial and industrial land uses

Typical (2008) baseline volumes of CSO, stormwater and direct drainage to Westchester Creek are summarized in Table 6-2. The specific SPDES permitted outfalls associated with these sources were shown in Figure 2-7. Additional tables can be found in Appendix A. The information in these tables is provided for the 2008 rainfall condition.

For the modeling simulations, CSO effluent concentrations were calculated using the stormwater and sanitary concentrations assigned in Table 6-1, multiplied by the flow calculated by the IW model. The model provides a calculated fraction of flow from stormwater and flow from sanitary sources, as follows:

$C_{cso} = fr_{san}*C_{san} + fr_{sw}*C_{sw}$

where: C_{cso} = CSO concentration
C_{san} = sanitary concentration
C_{sw} = stormwater concentration
fr_{san} = fraction of flow that is sanitary
fr_{sw} = fraction of flow that is stormwater

For 2008, the IW model calculates that a total of 289 MG of discharges from CSOs, with 127 MG from HP-014 and 63 MG from HP-016. For these two locations, the fraction of the overflow that was calculated by the IW model to be associated with sanitary sewage ranges from 3.8 percent (HP-015) to18.0 percent, (HP-016) with the remainder being stormwater. This mixture of flows results in CSO concentrations for enterococci of 86,000 to 221,000 cfu/100mL, for fecal coliform of 267,000 to 818,000 cfu/100mL, and for BOD_5 of 18 to 31 mg/L. An example of the IW CSO concentration calculation for CSO enterococci concentration is presented below using sanitary and storm runoff concentrations from Table 6-1:

86,100 cfu/100mL* = 0.038 x 1,000,000 cfu/100mL + 0.962 x 50,000 cfu/100mL

Generally, the calculated GM bacteria concentrations are higher than those measured in 2014, but the ranges in values overlap significantly. This in part could be associated with the use of historical sanitary bacteria concentrations (Table 6-1), which are higher than concentrations recently measured in the

Westchester Creek sewershed during the spring of 2014 which ranged from 160,000 to 800,000 cfu/100mL for enterococci and 510,000 to 4,100,000 cfu/100 ml for fecal coliform bacteria. However, since the 2014 data are limited, the calculated concentrations are used herein for the baseline conditions, representing conservative estimates of the CSO loadings. As DEP has moved the program forward, it has been determined that monitoring of CSO overflow quality is required at key locations and sampling sanitary concentrations in the combined sewer lines is also required to develop a better database that can be used to improve the accuracy of the CSO loadings.

Table 6-2 provides the total annual average source loadings. Refer to Figure 2-7 for the location of the Westchester Creek SPDES permitted outfalls.

Table 6-2. Annual CSO, Stormwater, and Direct Drainage Volumes and Loads (2008 Rainfall)

Source	Volumetric Discharge (MG/yr)	Enterococci Load (cfu x 10^{12})	Fecal Coliform Load (org x 10^{12})	BOD Load (Lbs)
CSO	289	1,660	5,857	71,876
Stormwater/Direct Drainage	327	348	766	40,658
Total	**627**	**2,007**	**6,623**	**112,534**

6.3 Performance Gap

Concentrations of bacteria and DO in Westchester Creek are controlled by a number of factors, including the volumes of all sources of pollutants into the waterbodies and the concentrations of the respective pollutants. Since almost all of the flow and pollutant loads discharged into this waterbody is the result of runoff from rainfall events, the frequency, duration and amounts of rainfall strongly influence Westchester Creek's water quality. The Westchester Creek portion of the ERTM model was used to simulate bacteria and DO concentrations in the Creek for the baseline conditions, using 2002-2011 rainfall and tidal data. Hourly model calculations were saved for post-processing and comparison with the existing, swimmable/fishable, and Future Primary Contract WQ Criteria as further discussed below in Section 6.3.c. The performance gap was then developed as the difference between the model-calculated baseline waterbody DO and bacteria concentrations and the applicable numerical WQS. Accordingly, the analysis is broken up into three sections:

- Existing WQ Criteria (Class I);
- Assessment of Westchester Creek compliance with the Primary Contact WQ Criteria (Class SC); and
- Future Primary Contact WQ Criteria (2012 EPA RWQC).

Within these sections, analyses are developed to reflect the differences in attainment both spatially and temporally. The spatial assessment mainly focuses on the two different waterbodies under evaluation herein: inner Westchester Creek at Stations WC2, WC1 and WC3 and outer Westchester Creek, E13. However, as noted in the discussions that follow, there are calculated spatial differences in the projected attainment of water quality criteria with each of those areas. The temporal assessment basically focuses on compliance with the applicable water quality criteria over the entire year or in the case of bacteria, during the recreational season of May 1st through October 31st inclusive.

A summary of the criteria that were applied is shown in Table 6-3.

Table 6-3. Classifications and Criteria Applied for Gap Analysis

Analysis	Numerical Criteria Applied
Existing WQ Criteria	I: Fecal Monthly GM ≤ 2,000
Primary Contact WQ Criteria*	SC: Fecal Monthly GM≤200
Future Primary Contact WQ Criteria **	Entero: rolling 30-d GM – 35 cfu/100 mL Entero: STV – 130 cfu/100 mL

Note: GM = Geometric Mean; STV = 90 Percent Statistical Threshold Value
*This water quality criteria is not currently assigned to Westchester Creek. For such criteria to take effect, DEC must first adopt the criteria in accordance with rulemaking and environmental review requirements.
**This Future Primary Contract WQ Criteria has not yet been proposed by DEC. For such criteria to take effect, DEC must first adopt the criteria in accordance with rulemaking and environmental review requirements. In addition, DEC must follow the required regulatory procedures to reclassify Westchester Creek from I to SC.

Analyses in this LTCP are performed using the 30-day rolling GM of 35 cfu/100mL and the STV of 130 cfu/100mL for enterococci. In addition, DEC has recently advised DEP that it plans to adopt the 30-d rolling GM for enterococci of 30 cfu/100 ml, with a not to exceed the 90^{th} percentile statistical threshold value (STV) of 110 cfu/100 ml, which is more stringent of the options presented by the 2012 EPA Recommended Recreational Water Quality Criteria. However, sufficient time was not available to update all of the LTCP; as directed by DEC, DEP will conduct this analysis and provide the results of such analysis to DEC when it is available. The recommendations will not be significantly impacted.

6.3.a CSO Volumes and Loadings Needed to Attain Current Water Quality Standards

2008 Rainfall Annual Simulation

Typical model results are shown in Figures 6-1 through 6-4, for Westchester Creek (Stations WC2, WC1, WC3, E13) with 2008 rainfall and tidal conditions. As described in Section 2.0, Westchester Creek is currently designated as a Class I waterbody and has a fecal coliform criterion. Although evaluated in this section, the recreational season GM enterococci criterion is currently not applicable to Westchester Creek. The panels in each figure show the Class I fecal coliform criterion of 2,000 org/100mL (dashed green line). The post-processed monthly GM water quality output lines are shown as solid black lines. As shown by the figures, the modeling results indicate that Westchester Creek fecal coliform concentrations are calculated to be in full attainment with the Existing WQ Criterion of a monthly GM of 2,000 org/100mL.

10-Year Long-Term Simulation

A 10-year baseline simulation of bacteria water quality was also performed for the baseline loading conditions, to assess year-to-year variations in water quality. The results of these simulations are summarized in Table 6-4.

Table 6-4. Calculated 10-Year Baseline Fecal Coliform Attainment of Existing WQ Criteria (Class I)-Percent of Months in Attainment

Station	Projection Year										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Percent Attainment
WC2	100	100	100	100	100	100	100	100	100	100	100
WC1	100	100	100	100	100	100	100	100	100	100	100
WC2	100	100	100	100	100	100	100	100	100	100	100
E13	100	100	100	100	100	100	100	100	100	100	100

This table shows that the calculated 10-year long term attainment of the existing fecal coliform criterion under baseline conditions are in full attainment annually with the Existing WQ Criterion of a monthly GM of 2,000 org/100mL. As noted in the table, fecal coliform concentrations are calculated to be in attainment 100 percent of the time at all locations for each of the 10 years within the simulation period. It should be noted that because the waterbody is classified for secondary contact recreation, there is no enterococci limit for the Existing WQ Criteria. Because the model results for the 10-year baseline period indicate that Westchester Creek would meet the Existing WQ Criteria, there is no performance gap for bacteria based on the currently applicable bacteria criterion.

2008 Rainfall Annual Simulation – Dissolved Oxygen

Water quality model simulation of DO concentrations and measures of attainment with the numerical WQS are presented in Table 6-5. Water quality calculations indicate that the overall attainment of the Class I criterion of 4 mg/L is 80 percent for the year at the same location. Even though there are excursions below the DO criteria in a few summer months, DO concentrations were calculated to be in attainment with the WQS a high percent of the time. As noted in Table 6-5, annual DO attainment is between 80 and 99 percent, depending on the area of the Creek.

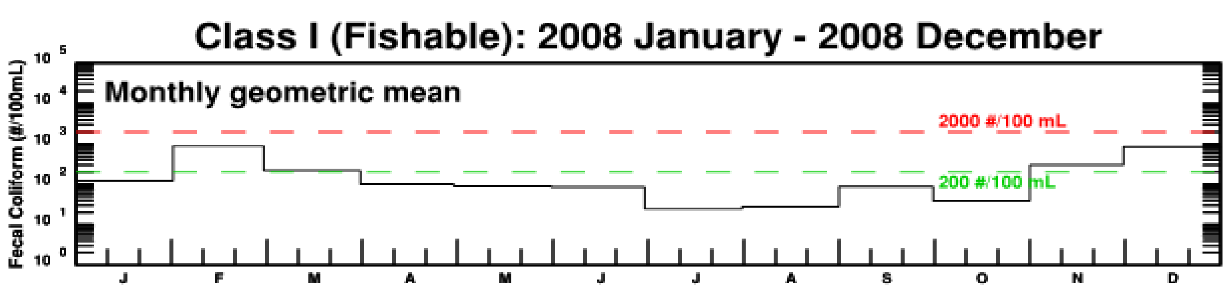


Figure 6-1. Calculated Baseline WC2 Fecal Coliform Concentration (2008 Rainfall)

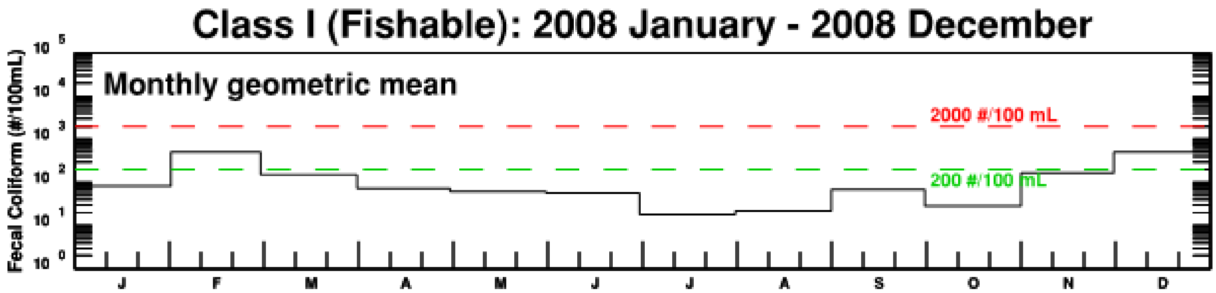


Figure 6-2. Calculated Baseline WC1 Fecal Coliform Concentration (2008 Rainfall)

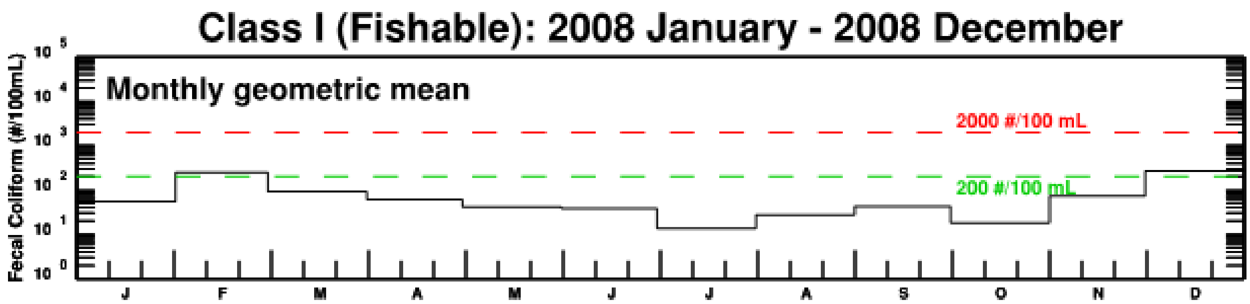


Figure 6-3. Calculated Baseline WC3 Fecal Coliform Concentration (2008 Rainfall)

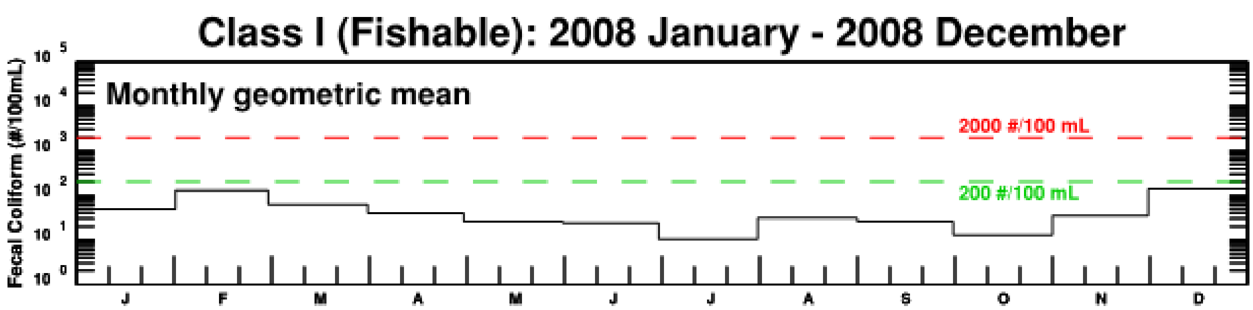


Figure 6-4. Calculated Baseline E13 Coliform Concentration (2008 Rainfall)

Table 6-5. Model Calculated DO Attainment (2008)

Station	Annual Attainment (%)
WC2	80
WC1	97
WC3	99
E13	99

6.3.b CSO Volumes and Loadings that would be Needed to Support the Next Highest Use or Swimmable/Fishable Uses

Bacteria

The DEC is required to periodically review whether a waterbody can be reclassified to its next higher classification. This LTCP assessed the level of attainment for Westchester Creek, which is a Class I waterbody, if DEC were to re-classify it to Class SC (limited primary contact recreation).

Model calculations presented in Figures 6-1 through 6-3 show that Westchester Creek at Stations WC2, WC1, and WC3 would not be expected to meet the Class SC fecal coliform criteria during certain non-recreational months (February, March, November, December) for the 2008 rainfall condition. Table 6-6 presents the calculated compliance with the 200 cfu/100mL fecal coliform criterion for Class SC waters at the head end of Westchester Creek (Station WC2). As noted in the table, compliance is calculated to be less than 100 percent on an annual basis. At Station WC2, the annual compliance for the 10-year baseline period is calculated to be 78 percent.

Table 6-6. Calculated 10-Year Baseline Fecal Coliform Attainment of Class SC Criterion - Percent of Months in Attainment – Location WC2

Year	Annual Attainment – (%)		Recreational Season Attainment – (%)	
	Baseline	100 Percent CSO Control	Baseline	100 Percent CSO Control
2002	92	92	100	100
2003	67	100	83	100
2004	92	100	83	100
2005	83	100	83	100
2006	75	92	83	100
2007	67	92	83	100
2008	83	83	100	100
2009	75	83	83	83
2010	83	100	100	100
2011	67	92	83	100
10-year average	**78**	**92**	**88**	**98**

In addition, Table 6-6 provides a summary of the calculated fecal coliform compliance with the SC criterion during the recreational season (May 1st – October 31st). As shown in this table, fecal coliform bacteria are calculated to be in compliance during the recreational months a high percentage of the time

(88 percent) for the baseline conditions for Station WC2. 100 percent CSO control improves compliance during the recreational season to 98 percent but annual attainment remains to be $\leq$95%, which is considered as full attainment with bacteria targets in accordance with guidance from DEC. , The results suggest that site specific criteria could be considered for Westchester Creek as attainment values with Primary Contract WQ Criteria vary both spatially and temporally.

Dissolved Oxygen

Upgrading Westchester Creek to Class SC would require that it meet the DO criterion of a daily average DO concentration of greater than or equal to 4.8 mg/L, with some allowance for excursions based on the DO exposure-duration curve, as well as an acute criterion of never less than 3.0 mg/L. Table 6-7 presents the annual attainment with the Class SC DO criteria at Station WC2, the location calculated to have the lowest DO concentrations. Attainment of the chronic criterion would be 71 percent measured over the year.

Table 6-7. Model Calculated DO Results for Class SC Criterion at WC2 – Baseline and 100 Percent CSO Control Conditions

Station	Annual Attainment (%)	
	Chronic	Acute
Baseline	71	89
100 Percent CSO Control	88	98

The 100 percent CSO control scenario was evaluated to assess the impact of CSO discharges on non-attainment of the DO criteria, or the gap between attainment and non-attainment caused by CSO discharges. The attainment of the Class SC criteria for DO at Station WC2 with 100 percent CSO control is also presented in Table 6-7. The annual attainment of the chronic criterion would increase from 71 percent to 88 percent. This scenario suggests that complete control of the CSO input into Westchester Creek would not be sufficient for it to meet the Class SC criteria for DO.

6.3.c Future Primary Contact WQ Criteria

As noted in Section 2.0, EPA released its RWQC recommendations in December 2012. These included recommendations for recreational water quality criteria for protecting human health in all coastal and non-coastal waters designated for primary contact recreation use. The standards would include a rolling 30-day GM of either 30 cfu/100mL or 35 cfu/100mL, and a 90th percentile statistical threshold value (STV) during the rolling 30-day period of either 110 cfu/100mL or 130 cfu/100mL. An analysis of the 10-year baseline and 100 percent CSO control conditions model simulation results was conducted using the 35 cfu/100mL GM and 130 cfu/100mL 90th percentile criteria, to assess attainment with these future Primary Contract WQ Criteria. As noted earlier, DEC has recently advised DEP that it plans to adopt the 30-day rolling GM for enterococci of 30 cfu/100 ml, with a not to exceed the 90th percentile statistical threshold value (STV) of 110 cfu/100 ml, which is more stringent of the options presented by the 2012 EPA Recommended Recreational Water Quality Criteria.

10-Year Long-Term Simulation

Table 6-8 presents the 10-year recreational season attainment of the future Primary Contract WQ Criteria of enterococci for the baseline and 100 percent CSO control scenarios. Comparison between the baseline and 100 percent CSO scenarios resulted in some improvements at Station WC2 with compliance increasing 22 percentage points, from 64 percent to 86 percent as measured against a GM of 35. Stations WC1, WC3 and E13 have lower increases in attainment for the 30-day rolling GM but higher attainment in absolute terms. Attainment of the 90th percentile STV criteria would remain very low at all locations, regardless of whether CSOs are completely controlled or not.

Table 6-8. Recreational Season Attainment with Future Primary Contact WQ Criteria with 2012 EPA RWQC for Enterococci

Station	Enterococci Attainment							
	Baseline				100 Percent CSO Control			
	30-day rolling GM		90th percentile		30-day rolling GM		90th percentile	
	≤35 cfu/100mL	≤30 cfu/100mL	≤130 cfu/100mL	≤110 cfu/100mL	≤35 cfu/100mL	≤30 cfu/100mL	≤130 cfu/100mL	≤110 cfu/100mL
WC2	64	58	4	4	86	82	9	8
WC1	77	71	16	14	94	93	42	31
WC3	87	84	24	20	95	93	40	32
E13	96	95	52	43	97	95	54	45

These analyses indicate that complete removal of CSOs alone will not close the gap between the predicted baseline fecal coliform and Class SC criterion or the enterococci concentrations and the future Primary Contract WQ Criteria rolling 30-day GM criterion of 35 cfu/100mL to achieve 100 percent annual attainment.

6.3.d CSO Volumes and Loadings Needed to Attain Future Primary Contact Water Quality Criteria

Additional water quality modeling analyses were performed to assess the extent to which CSO and non-CSO sources impact enterococci concentrations at key locations in Westchester Creek. A load source component analysis was conducted for the 2008 baseline condition, to provide a better understanding of how each source type contributes to bacteria concentrations in Westchester Creek. The source types include the East River at the mouth of Westchester Creek, stormwater (including direct drainage), and CSOs. The analysis was completed at Stations WC2, WC1, WC3, and E13 using the ERTM model. The analysis included the calculation of fecal coliform and enterococci GMs in total and from each component. For fecal coliform, a maximum winter month was analyzed because the decay rate is lower in winter, resulting in generally higher fecal coliform concentrations, and a maximum summer month was selected in consideration of use impact during the recreational season (May 1st – October 31st). Enterococci were evaluated on both an annual and bathing season (Memorial Day to Labor Day) basis. The calculated values can then be compared to applicable numeric criteria to determine the relative contribution of a component to non-attainment of those criteria.

Table 6-9 summarizes the fecal coliform component analysis. In comparison with the Class SC fecal coliform concentration of 200 org/100 mL, annual attainment occurs at all four stations and the only exceedances of this criterion occur in non-recreational season (November 1st through April 30th) at the upper two stations (WC2 and WC1). If DEP were to fully remove the CSO, only Station WC1 would change from non-attainment to attainment; at Station WC2, reduction from other sources would still be required to comply with the Primary Contract WQ Criteria (Class SC) on an annual basis.

Table 6-9. Fecal Coliform GM Source Components

Source	Station	Fecal Coliform Contribution, cfu/100mL		
		Annual GM	Maximum Winter Month	Maximum Summer Month
East River	WC2	3	17	3
Stormwater	WC2	44	305	25
CSO	WC2	39	259	34
Total	**WC2**	**86**	**581**	**62**
East River	WC1	7	37	5
Stormwater	WC1	22	125	13
CSO	WC1	24	155	19
Total	**WC1**	**53**	**317**	**37**
East River	WC3	18	80	11
Stormwater	WC3	14	59	10
CSO	WC3	11	47	9
Total	**WC3**	**43**	**186**	**30**
East River	E13	32	112	21
Stormwater	E13	0	2	0
CSO	E13	1	1	1
Total	**E13**	**33**	**115**	**22**

Table 6-10 summarizes the enterococci component analysis. The 30-day GM concentrations are calculated to exceed the 35 cfu/100mL criterion at locations within the creek on an annual basis and during the bathing season (Memorial Day to Labor Day). The 30-day GM maximum concentration attributable to CSO sources, during the bathing season is calculated to be 16 cfu/100mL at Station WC2, which is less than 35 cfu/100mL, suggesting that CSO by itself would not have the potential to exceed the criterion. As this concentration is less than 35 cfu/100mL, CSO alone would not cause an excursion of 35 cfu/100mL during the bathing season (Memorial Day – Labor Day).

Table 6-10. Enterococci GM Source Components

Source	Station	Enterococci Contribution, 30-day Max GM, cfu/100mL	
		Annual	Bathing Season
East River	WC2	7	2
Stormwater	WC2	214	36
CSO	WC2	108	16
Total	**WC2**	**328**	**54**
East River	WC1	16	3
Stormwater	WC1	84	16
CSO	WC1	61	14
Total	**WC1**	**160**	**34**
East River	WC3	34	8
Stormwater	WC3	32	8
CSO	WC3	23	11
Total	**WC3**	**89**	**27**
East River	E13	47	17
Stormwater	E13	1	0
CSO	E13	1	1
Total	**E13**	**49**	**18**

CSO Contribution to Non-Attainment

Table 6-9 and Table 6-10 also indicate that CSO impacts to attainment are limited to the upper portions of Westchester Creek, although the CSO contribution varies both spatially and temporally at those locations. This LTCP identifies the alternatives focusing on reduction of the remaining CSO discharges to Westchester Creek.

6.3.e Time to Recover

> **From NYS DOH**
>
> **https://www.health.ny.gov/regulations/nycrr/title_10/part_6/subpart_6-2.htm**
>
> **Operation and Supervision**
>
> 6-2.15 Water quality monitoring
> (a) No bathing beach shall be maintained … to constitute a potential hazard to health if used for bathing. To determine if the water quality constitutes a potential hazard … shall consider one or a combination of any of the following items: results of a sanitary survey; historical water quality model for rainfall and other factors; verified spill or discharge of contaminants affecting the bathing area; and water quality indicator levels specified in this section.
>
> (1) Based on a single sample, the upper value for the density of bacteria shall be: (i) 1,000 fecal coliform bacteria per 100 ml; or …(iii) 104 enterococci per 100 ml for marine water; ….

Another analysis that consisted of examining the calculated hourly fecal coliform and enterococci water quality model simulation results was performed to gain additional insight with respect to the impacts of CSO and non-CSO sources on Westchester Creek water quality. Analyses provided above examine the longer term impacts of wet weather sources, as required by existing and future primary contact bacteria criteria (monthly GM and 30-day GM). Shorter term impacts are not brought out through these regulatory measures. To gain insight to the shorter term impacts of wet weather sources of bacteria, DEP has reviewed the New York State Department of Health guidelines relative to single sample maximum bacteria concentrations that they believe “constitute a potential hazard to health if used for bathing”. The presumption being that if the bacteria concentrations are lower than these levels, then the water bodies do not pose potential hazardous if primary contact is practiced.

Fecal coliform concentrations that exceed 1,000 cfu/100mL and or enterococci concentrations exceeding 104 cfu/100ml are considered potential hazards by the State Department of Health. Water quality modeling analyses were conducted herein to assess the amount time following the end of rainfall required for the outer portion of Westchester Creek to recover and return to concentrations less than 1,000 cfu/100 mL fecal coliform and 130 cfu/100mL enterococci. The value 130 was used instead of 104 as recent EPA guidance (2012 EPA RWQC) indicates that the 104 value will no longer be relevant.

The analyses performed consisted of examining the water quality model calculation for Westchester Creek bacteria concentrations for recreation periods (May 1st to October 31st) abstracted from 10-years of model simulations. The time it takes for wet weather elevated bacteria concentrations to return to 1,000 or 130 was then calculated for each storm with the various size categories and the median time after the end of rainfall was then calculated for each rainfall category.

The process began with an analysis of the LaGuardia Airport rainfall data for the period of 2002-2011. The SYNOP model was used to identify each individual storm and calculate the storm volume, duration and start and end times. Rainfall periods separated by four hours or more were considered separate storms. Statistical analysis of the individual rainfall events for the recreational seasons of the 10-year period resulted in a 90th percentile rainfall event of 1.09 in.

The rainfall event data was then compared against water quality model bacteria results for the 10 recreational seasons to determine how long it took for the water column concentration to return to target threshold concentrations from the end of the rain event. Since the system is tidal, the change in concentration over time is not a constant decrease, so the last time the concentration returned to the target threshold after each rain event was considered (as opposed to the first, which might have been the result of tidal influences). To be conservative, the hour in which the concentration reached the target threshold concentration was included, so the minimum time to recover is one hour. The chosen target threshold concentrations were 1,000 cfu/100mL for fecal coliform, and 130 cfu/100mL for enterococci. The various rainfall events were then placed into rain event size “bins” ranging from less than 0.1 in. to greater than 1.5 in., as shown in Table 6-11. Only rain events that reached the target threshold concentrations before the beginning of the next storm were included. The median time to recover for each bin at each water quality station was calculated. The results for the baseline and 100 percent CSO control scenarios are shown in Table 6-11.

Table 6-11. Time to Recover

Rain Event Size (in)	Station	Time to Recover (hours)			
		Fecal Coliform Threshold (1000 cfu/100mL)		Enterococci Threshold (130 cfu/100mL)	
		Baseline	100% CSO Control	Baseline	100% CSO Control
<0.1	WC2	-	-	-	-
0.1-0.4	WC2	-	-	8	7
0.4-0.8	WC2	6	6	27	19
0.8-1.0	WC2	13	7	70	27
1.0-1.5	WC2	28	11	70*	35
>1.5	WC2	56	13	73	38
<0.1	WC1	-	-	-	-
0.1-0.4	WC1	-	-	-	-
0.4-0.8	WC1	2	-	19	3
0.8-1.0	WC1	23	-	58	24
1.0-1.5	WC1	29	-	58*	31
>1.5	WC1	52	10	69	38
<0.1	WC3	-	-	-	-
0.1-0.4	WC3	-	-	-	-
0.4-0.8	WC3	-	-	11	5
0.8-1.0	WC3	3	-	27	21
1.0-1.5	WC3	17	-	36	29
>1.5	WC3	41	13	55	38
<0.1	E13	-	-	-	-
0.1-0.4	E13	-	-	-	-
0.4-0.8	E13	-	-	-	-
0.8-1.0	E13	3	3	16	15
1.0-1.5	E13	3	3*	24	21
>1.5	E13	19	12	37	33

* - In a few cases the time to recover was calculated to be less than the next smaller rain event bin. In those cases, both bins were set equal to the higher time to recover.

7.0 PUBLIC PARTICIPATION AND AGENCY COORDINATION

DEP is committed to implementing a proactive and robust public participation program to inform the public of the development of the watershed-specific and Citywide LTCPs. Public outreach and public participation are important aspects of plans designed to reduce CSO-related impacts to achieve waterbody-specific WQS, consistent with the federal CSO Policy and the CWA, and in accordance with EPA and DEC mandates.

DEP's Public Participation Plan was released to the public on June 26, 2012, and describes the tools and activities DEP will use to inform and involve and engage a diverse group of stakeholders and the broader public throughout the LTCP process. The purpose of the Plan is to create a framework for communicating with and soliciting input from interested stakeholders and the broader public concerning water quality and the challenges and opportunities for CSO controls. As described in the Public Participation Plan, DEP will strategically and systematically implement activities that meet the information needs of a variety of stakeholders, in an effort to meet critical milestones in the overall LTCP schedule outlined in the 2012 Order on Consent signed by DEC and DEP on March 8, 2012.

As part of the CSO Quarterly Reports, DEP will report to DEC on public participation activities outlined in the Public Participation Plan. Updates to the Public Participation Plan that are implemented as a result of public comments received will be posted annually to DEP's website, along with the quarterly summary of public participation activities reported to DEC.

7.1 Local Stakeholder Team

DEP began the public participation process for the Westchester Creek LTCP by reaching out to the Bronx Borough President's Office and Community Board 10, to identify the stakeholders who would be instrumental to the development of this LTCP. Stakeholders identified included both citywide and regional groups, including environmental organizations (Friends of Ferry Point Park, Bronx Council for Environmental Quality, Riverkeeper, New York City Watertrail Association, Hutchinson River Restoration Project); community planning organizations; design and economic organizations; academic and research organizations; and City government agencies (Bronx Borough Office).

7.2 Summaries of Stakeholder Meetings

DEP has held public meetings and several stakeholder group meetings to aid in the development and execution of the LTCP. The objective of the public meetings and a summary of the discussion are presented below:

Public Meetings

- Public Meeting #1: Westchester Creek LTCP Kickoff Meeting (February 26, 2014)

  Objectives: Provide overview of LTCP process, public participation schedule, watershed characteristics and improvement projects; solicit input on waterbody uses.

DEP and DEC co-hosted a Public Kickoff Meeting to initiate the water quality planning process for long term control of CSOs in the Westchester Creek Waterbody. The two-hour event, held at the Henry Hudson Junior High School in the Bronx, served to provide overview information about DEP's LTCP Program, present information on the Westchester Creek watershed characteristics and status of waterbody improvement projects, obtain public information on waterbody uses in Westchester Creek, and describe additional opportunities for public input and outreach. The presentation can be found at http://www.nyc.gov/dep/ltcp. Approximately 20 stakeholders attended the event, from non-profit, community planning, environmental, economic development, and governmental organizations, as well as the general public.

The Westchester Creek LTCP Kickoff Public Meeting was the first opportunity for public participation in the development of the LTCP. In response to stakeholder comments, DEP provided detailed information about each of the following as part of the development of the LTCP:

- CSO reductions and cost of existing and future CSO-related projects in Westchester Creek;
- Modeling baseline assumptions utilized during LTCP development;
- Rainfall numbers and assumptions utilized during LTCP development;
- Water quality data collection;
- Existing Westchester Creek CSO discharges; and
- Future public meeting announcements.

Stakeholder comments and DEP's responses were posted to DEP's website, and are also described in Appendix B, Long Term Control Plan (LTCP) Westchester Creek Kickoff Meeting – Summary of Meeting and Public Comments Received.

- <u>Public Meeting #2: Westchester Creek LTCP Alternatives Review Meeting (May 7, 2014)</u>

Objectives: Review proposed alternatives, related waterbody uses and water quality conditions.

On May 7, 2014, DEP hosted a second Public Meeting to continue discussion of the water quality planning process for long term control of CSOs in Westchester Creek. The purpose of the two-hour event, held in the Bronx, were to describe the alternatives identification and selection process, and receive public comment on the information. The presentation is on DEP's LTCP Program Website: http://www.nyc.gov/dep/ltcp. About 13 stakeholders attended the event, from several different non-profit, community planning, environmental, economic development, and governmental organizations, as well as the general public.

In response to stakeholder comments, DEP provided detailed information for each of the following as part of the development of the LTCP:

- Modeling baseline assumptions utilized during LTCP development, including the rainfall conditions utilized;
- Existing and future predicted CSO discharges;
- Water quality data collection;
- Stormwater inputs/contributions to Westchester Creek;
- Green infrastructure and grey infrastructure potential alternatives;

- Opportunity to review and comment on the draft Westchester Creek LTCP; and
- Future public meeting announcements.

Stakeholder comments and DEP's responses were posted to DEP's website, and are also described in Appendix C, Long Term Control Plan (LTCP) Westchester Creek Public Meeting #2 – Summary of Meeting and Public Comments Received.

During this Public Meeting #2, there was a high degree of public support for the DEP's findings that additional grey infrastructure-based CSO controls were not warranted, due to the currently ongoing improvements based on the 2011 WWFP and the concern that additional construction projects could affect the natural ecosystem conditions in the Westchester Creek watershed.

- Public Meeting #3: Draft LTCP Review Meeting

Objectives: Present LTCP after review by DEC

This meeting schedule is to be announced. The purpose is to present the final recommended plan to the public after DEC review. Outcomes of the discussion and a copy of presentation materials will be posted to DEP's website.

Stakeholder Meetings

February 5, 2014

DEP attended the Bronx Borough Cabinet Meeting (Community Board 11) and presented information on public outreach for the Westchester Creek LTCP to the Bronx Borough President and Borough Cabinet members. In addition to presenting information on public outreach, DEP answered questions regarding the Westchester Creek LTCP development schedule and process, elements of the approved Westchester Creek WWFP and CSO controls. DEP provided Community Board representatives with a PowerPoint presentation on February 5, 2014, to be forwarded to their constituents. The presentation was also posted to DEP's LTCP Program website: http://www.nyc.gov/dep/ltcp.

February 10, 2014

DEP attended the Bronx Community Board 9 Land Use Committee meeting.

March 5, 2014

DEP attended the Bronx Borough Board meeting with the Borough Services Cabinet

March 11, 2014

DEP attended the Bronx Community Board 10 Municipal Services Committee and presented information on public outreach for the Westchester Creek LTCP, similar to the February 5, 2014 Community Board 11 meeting.

7.3 Coordination with Highest Attainable Use

In cases where existing WQS do not meet the Section 101(a)(2) goals of the CWA, or where the proposed alternative set forth in the LTCP will not achieve existing WQS or the Section 101(a)(2) goals, the LTCP will include a UAA to examine whether applicable waterbody classifications criteria or standards should be adjusted by the State. The UAA assesses the waterbody's uses, which the State will consider in adjusting WQS, classifications, criteria and developing waterbody-specific criteria.

Comprehensive analysis of baseline conditions, along with the future anticipated conditions after implementing the recommended LTCP projects, show that Westchester Creek will remain a highly productive Class I waterbody that can fully support secondary uses, including including nature education and wildlife propagation. As discussed in Section 6.0, Westchester Creek is in attainment with its current Class I classification, but it is not feasible for the waterbody to meet the water quality criteria associated with the primary contact WQ criteria or Class SC classification. Furthermore, combinations of natural and manmade features prevent both the opportunity and feasibility of primary contact recreation in many parts of Westchester Creek, so while it often meets the Class SC criteria, it does not meet it 100 percent of the time, nor throughout its full extension. Primary contact recreation is prohibited by City law. The continued presence of non-CSO discharges, most notably stormwater from MS4 outfalls, prevents annual attainment of Class SC standards, even when 100 percent CSO volume reduction is considered.

7.4 Internet Accessible Information Outreach and Inquiries

Both traditional and electronic outreach tools are important elements of DEP's overall communication effort. DEP will ensure outreach tools are accurate, informative, up-to-date and consistent, and are widely distributed and easily accessible. Table 7-1 presents a summary of Westchester Creek LTCP public participation activities.

Table 7-1. Summary of Westchester Creek LTCP Public Participation Activities Performed

Category	Mechanisms Utilized	Dates (*if applicable*) and Comments
Regional LTCP Participation	Citywide LTCP Kickoff Meeting and Open House	• June 26, 2012
	Annual Citywide LTCP Meeting – Modeling Meeting	• February 28, 2013
Waterbody-specific Community Outreach	Public meetings and open houses	• Kickoff Meeting: February 26, 2014 • Meeting #2: May 8, 2014 • Meeting #3: TBD
	Stakeholder meetings and forums	• N/A
	Elected officials briefings	• Bronx Borough Cabinet Briefing: February 5 and March 5, 2014 • Bronx Community Board 9 Land Use

Table 7-1. Summary of Westchester Creek LTCP Public Participation Activities Performed

Category	Mechanisms Utilized	Dates (*if applicable*) and Comments
		meeting February 10, 2014 • Bronx Community Board 10 meeting March 11, 2014
Data Collection and Planning	Establish online comment area and process for responding to comments	• Comment area added to website on October 1, 2012 • Online comments receive response within two weeks of receipt
	Update mailing list database	• DEP updates master stakeholder database (700+ stakeholders) before each meeting
Communication Tools	Program Website or Dedicated Page	• LTCP Program website launched June 26, 2012 and frequently updated • Westchester Creek LTCP webpage launched February, 2014 and frequently updated
	Social Media	• TBD
	Media Outreach	• Published advertisements in newspapers Caribbean Life, Bronx Times, Bronx Times Reporter and La Voz.
	FAQs	• LTCP FAQs developed and disseminated beginning February 26, 2014 via website, meetings and email
	Print Materials	• LTCP FAQs: February 26, 2014 • LTCP Goal Statement: June 26, 2012 • LTCP Public Participation Plan: June 26, 2012 • Westchester Creek Summary: February 26, 2014 • LTCP Program Brochure: February 26, 2014 • Glossary of Modeling Terms: February 28, 2013 • Meeting advertisements, agendas and presentations • PDFs of poster board displays from meetings • Meeting summaries and responses to comments • Quarterly Reports • WWFPs
	Translated Materials	• As-needed basis

Table 7-1. Summary of Westchester Creek LTCP Public Participation Activities Performed

Category	Mechanisms Utilized	Dates (*if applicable*) and Comments
	Portable Informational Displays	• Poster board displays at meetings
Student Education	Participate in ongoing education events	• N/A
	Provide specific green and grey infrastructure educational modules	• N/A

DEP launched its LTCP Program website on June 26, 2012. The website provides links to documents related to the LTCP program, including CSO Orders on Consent, approved WWFPs, CSO Quarterly Reports, links to related programs such as the Green Infrastructure Plan, and handouts and poster boards distributed and displayed at public meetings and open houses. A LTCP feedback email account was also created to receive LTCP-related feedback, and stakeholders can sign up to receive LTCP Program announcements via email. . In general, DEP's LTCP Program website:

- Describes the LTCP process, CSO related information and Citywide water quality improvement programs to date;
- Describes waterbody-specific information including historical and existing conditions;
- Provides the public and stakeholders with timely updates and relevant information during the LTCP process including meeting announcements;
- Broadens DEP's outreach campaign to further engage and educate the public on the LTCP process and related issues; and
- Provides an online portal for submission of comments, letters, suggestions, and other feedback.

A specific Westchester Creek LTCP webpage was created in September 2012, and includes the following information:

- Westchester Creek public participation and education materials
  - ➢ Westchester Creek Summary Paper
  - ➢ Westchester Creek Waterbody/Watershed Facility Plan (2011)
  - ➢ LTCP Public Participation Plan
- Westchester Creek LTCP Meeting Announcements
- Westchester Creek Kickoff Meeting Documents – February 26, 2014
  - ➢ Advertisement
  - ➢ Meeting Presentation
  - ➢ Meeting Summary and Response to Comments
- Bronx Community Board meeting Presentations – February and March, 2014

- Westchester Creek Meeting #2 Meeting Documents – May, 2014
  - Meeting Advertisement
  - Meeting Presentation
- Meeting Summaries and Responses to Comments

8.0 EVALUATION OF ALTERNATIVES

This section of the LTCP describes the development and evaluation of CSO control measures and watershed-wide alternatives. A CSO control measure is defined as a technology (e.g., treatment or storage), practice (e.g., NMC or BMP), or other method (e.g., source control or GI) capable of abating CSO discharges or the effects of such discharges on the environment. Alternatives evaluated herein are comprised of a single CSO control measure or a group of control measures that will collectively address the water quality objectives for Westchester Creek.

This section contains the following information:

- Process for developing and evaluating CSO control alternatives that reduce CSO discharges and improve water quality (Section 8.1)
- CSO control alternatives and their evaluation (Section 8.2)
- CSO reductions and water quality benefits achieved by the higher-ranked alternatives as well as their estimated costs (Sections 8.3 and 8.4)
- Cost-performance and water quality attainment assessment for the higher ranked alternatives to select the preferred alternative (Section 8.5)

8.1 Considerations for LTCP Alternatives Under the Federal CSO Policy

This LTCP addresses the water quality objectives of the federal CWA and Federal EPA CSO Control Policy and the New York State (NYS) Environmental Conservation Law. It builds upon the EPA NMCs, CSO Control Policy, as well as the conclusions presented in DEP's June 2011 Waterbody/Watershed Facility Plan (WWFP). As required by the CSO Control Policy and the CSO Order on Consent, since the proposed alternative set forth in this LTCP will not (and cannot) achieve existing WQ criteria or the Section 101(a)(2) goals, it includes a UAA to examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State. The UAA assesses the waterbody's next higher classification, which the State will consider in adjusting WQS and developing waterbody-specific criteria.

The remainder of Section 8.1 discusses the development and evaluation of CSO control measures and watershed-wide alternatives to comply with the CWA in general, and with the CSO Control Policy in particular. The evaluation factors considered for each alternative are described, followed by the process for evaluating and ranking the alternatives.

8.1.a Performance

Section 6.0 presented evaluations of baseline LTCP conditions and concluded that there are no performance gaps because baseline conditions attain the current Class I bacteria criterion. Also, Westchester Creek cannot attain the Primary Contact WQ Criteria water quality classification (SC) for contact recreation even with complete CSO removal, due to limited tidal exchange and flushing particularly upstream locations, input from East River, and the presence of non-CSO sources of bacteria. Therefore, discussion of performance for Westchester Creek alternatives will focus on bacteria criteria for bot existing WQ criteria (Class I), Primary Contact WQ Criteria (Class SC) and future Primary Contact WQ Criteria (2012 EPA RWQC).

During the development of control alternatives, DEP examined performance more closely to evaluate WQS attainment. This was a two-step process that, based on the IW and water quality model runs with typical year rainfall, established the level of CSO control of each alternative, including CSO volume, fecal coliform and enterococci loading reduction. The second step used the previously estimated levels of CSO control to project levels of attainment beyond baseline conditions. LTCPs are typically developed with alternatives that span a range of CSO volumetric reductions. Accordingly, this LTCP includes alternatives that consider zero and 100 percent reductions in CSO volume as the two extremes. Intermediate levels of CSO volume control, around 25, 50 and 75 percent, are also evaluated. However, for some alternative control measures, such as disinfection, there would be no reduction in CSO volume, but a reduction in bacteria loading instead. Performance of each control alternative is measured against its ability to meet the CWA and water quality requirements for the 2040 planning horizon.

8.1.b Impact on Sensitive Areas

During the development of alternatives, special consideration was made to minimize the impact of construction, to protect existing sensitive areas, and to enhance water quality in sensitive areas. As described in Section 2.0, there are no sensitive areas within Westchester Creek.

8.1.c Cost

Cost estimates for the alternatives were computed using a costing tool based on parametric costing data. This approach provides an Association for the Advancement of Cost Engineering (AACE) Class 5 estimate (accuracy range of minus 20 to 50 percent to plus 30 to 100 percent), which is typical and appropriate for this type of planning evaluation. For the purpose of this LTCP, all costs are in June 2014 dollars.

For the LTCP alternatives, Probable Bid Cost (PBC) was used as the estimate of the capital cost. Annual operation and maintenance (O&M) costs are then used to calculate the total or Net Present Worth (NPW) over the projected useful life of the project. For the purpose of this LTCP, a lifecycle of 20 years and an interest rate of 3 percent were used resulting in a Present Worth Factor of 14.877.

To quantify costs and benefits, alternatives are compared based on reductions of both CSO discharge volume and bacteria loading against the total cost of the alternative. These costs are then used to plot the performance and attainment curves. Should a pronounced inflection point appear in the resulting graphs, a so-called knee-of-the-curve (KOTC), it would designate a potential cost-effective alternative for further consideration. In essence, this would reflect the alternative that achieves the greatest appreciable water quality improvements per unit of cost. However, this may not necessarily be the lowest cost alternative. The final recommended alternative must be capable of attaining water quality in a fiscally responsible and affordable manner to ensure that resources are properly allocated across the overall Citywide LTCP program. These monetary considerations also must be balanced with non-monetary factors such as technical feasibility and operability, which are discussed below.

8.1.d Technical Feasibility

Several factors were considered when evaluating technical feasibility, including:

- Effectiveness for controlling CSO
- Reliability
- Implementation

The effectiveness of CSO control measures was assessed based on their ability to reduce CSO frequency, volume, and pollutant load. Reliability is an important operational consideration, and can have an impact on overall effectiveness of a control measure. Therefore, reliability and proven history were used to assess the technical feasibility and cost effectiveness of a control measure.

Several site-specific factors were considered when evaluating an alternative's technical feasibility including available space, neighborhood assimilation, impact on parks and green space, and overall practicability of installing the CSO control. In addition, the method of construction was factored into the final selection. Some technologies require specialized construction methods that typically incur additional costs.

8.1.e Cost-Effective Expansion

All alternatives evaluated were sized to handle the 2040 design year CSO volume, with the understanding that the predicted and actual flows may differ. To help mitigate the difference between predicted and actual flows, adaptive management was considered for those CSO technologies that can be expanded in the future to capture additional CSO flows or volumes, should it be needed. In some cases, this may have affected where the facility would be constructed, or gave preference to a facility that could be expanded at a later date with minimal cost and disruption of operation.

Breaking construction into segments allowed adjustment of the design of future phases based on the performance of already-constructed phases. Lessons learned during operation of the current facilities can be incorporated into the design of the future facilities. However, phased construction also exposes the local community to a longer construction period. For those alternatives that can be expanded, the LTCP discusses how easily they can be expanded, what additional infrastructure may be required, and if additional land acquisition would be needed.

As regulatory requirements change, for example the need for improvements in nutrient removal or disinfection could arise. The ability of a CSO control technology to be retrofitted to handle process improvements improved the rating of that technology.

8.1.f Long Term Phased Implementation

The final recommended plan is structured in a way that makes it adaptable to change via expansion and modifications in response to new regulatory and/or local drivers. If applicable, the project(s) would be implemented over a multi-year schedule. Because of this, permitting and approval requirements have to be identified prior to selection of the alternative. These were identified along with permit schedules where appropriate. With the exception of GI, which is assumed to occur on both private and public property, most if not all of the CSO grey technologies are limited to City-owned property and right-of-way-acquisitions. DEP will work closely with other City agencies, and possibly NYS, to ensure proper coordination with these other agencies.

8.1.g Other Environmental Considerations

Impacts on the environment and surrounding neighborhood will be minimized as much as possible during construction. These considerations include traffic impacts, site access issues, park and wetland disruption, noise pollution, air quality, and odor emissions. To ensure that environmental impacts are minimized, they will be identified with the selection of the recommended plan and communicated to the public. Any identified potential concerns will be addressed in a pre-construction environmental assessment.

8.1.h Community Acceptance

As described in Section 7.0, DEP is committed to involving the public, regulators and other stakeholders throughout the planning process. The scope of the LTCP, background and newly collected data, WQS and the development and evaluation of alternatives were presented. Community acceptance of the recommended plan is essential to its success. The Westchester Creek LTCP is intended to improve water quality. The public's health and safety are a priority of the Plan. Raising awareness of and access to waterbodies is a goal for DEP and was considered during the alternative analysis. Several CSO control measures, such as GI, have been shown to enhance communities while increasing local property values and, as such, the benefits of GI were considered in the formation of the final recommended plan.

8.1.i Methodology for Ranking Alternatives

In developing the Westchester Creek LTCP DEP employed a multi-step process to evaluate control measures and alternatives. These steps included:

1. Evaluating benchmarking scenarios, including baseline and 100 percent CSO control, to establish the range of control within the Westchester Creek watershed. The results of this step were described in Section 6.0.

2. Using baseline conditions, prioritized the CSO outfalls for possible controls.

3. Developing a list of promising control measures for further evaluation based in part on the prioritized CSO list.

4. Conducting a "brainstorming" workshop on March 20, 2014, to review the most promising control measures and to solicit additional ideas to explore.

5. Establishing three levels of intermediate CSO control between baseline and 100 percent CSO removal for which receiving water quality simulations were conducted.

6. Evaluating alternatives according to the previously described LTCP criteria and the predicted (modeled) water quality benefits of each alternative.

7. Conducting a second LTCP workshop on April 29, 2014, which evaluated the water quality benefits, costs, and fatal flaws of the alternatives under consideration.

The focal points of this process were the two workshops listed above. Prior to the first workshop, the universe of control measures that were evaluated in the 2011 WWFP were revisited from the perspective of the LTCP goal statement and in light of the proposed WWFP projects: Pugsley sewer and CSO regulator 29/29A modifications. The resultant control measures were introduced at the first workshop where DEP operational and engineering staff applied their expertise for further analysis. A preliminary evaluation of these control measures was then conducted including an initial estimation of costs. The results of these evaluations became the topic of the second workshop which included a fatal-flaw analysis.

The range of the control measures that were considered included a variety of storage and conveyance improvement measures, including:

- In-line Storage at HP-014
- Disinfection and In-Line Storage at HP-014
- Throgs Neck PS Enhancement
- Storage Tanks or Tunnels
- Floatables Control
- Bronx River Siphon Enhancements
- Additional GI Build-out
- High-level Sewer Separation
- Dredging

All but dredging advanced to the next level of evaluation. Dredging was eliminated from further consideration because the DEP dredging program has targeted exposed CSO sediment mounds. No such mounds were evident at the head end of Westchester Creek, even during a monthly low tide. Further, the area that would be targeted for dredging near the CSO outfall would not have provided navigational benefit to the stakeholders who originally requested that DEP investigate this measure.

The evaluation of these retained control measures is described in Section 8.2.

8.2 Matrix of Potential CSO Reduction Alternatives to Close Performance Gap from Baseline

Each control measure was initially evaluated on three of the key considerations described in Section 8.1. These include (1) benefits, as expressed by level of CSO control and attainment (2) costs and (3) challenges, such as siting and operations. Using this methodology, the control measures listed in Section 8.1 were evaluated on a cost-performance basis and used to develop the basin-wide alternatives.

Following the LTCP outline, these control measures are described under the following categories: Other Future Grey Infrastructure, Other Future Green Infrastructure and Hybrid Green/Grey Alternatives, and subsets thereof. It should be noted that not all of the categories in the LTCP outline were applicable to Westchester Creek as will become evident in the subsequent discussions.

8.2.a Other Future Grey Infrastructure

For the purpose of this LTCP, “Other Future Grey Infrastructure” refers to potential grey infrastructure beyond existing control measures implemented based on previous planning documents. “Grey infrastructure" refers to systems used to control, reduce or eliminate discharges from CSOs. These are the technologies that have been traditionally employed by DEP and other wastewater utilities in their CSO planning and implementation programs, and includes retention tanks, tunnels and treatment facilities, including satellite facilities; and other similar capital-intensive facilities. Grey infrastructure implemented under previous CSO control programs and facility plans, such as the 2011 WWFP, is described in Section 4.0 and includes the Pugsley Creek Parallel Sewer and Weir Modifications to CSO regulators 029 and 029A. When completed in 2019, these are predicted to provide a significant (64 percent) reduction in CSO volume.

8.2.a.1 High Level Sewer Separation

High Level Sewer Separation (HLSS), also referred to as High Level Storm Sewers, is a form of partial separation that separates the combined sewers only in the streets or other public rights-of way, while leaving roof leaders or other building connections unaltered. In NYC, this is typically accomplished by constructing a new stormwater system and directing flow from street inlets and catch basins to the new storm sewers. Challenges associated with HLSS include constructing new sewers with minimal disruption to the neighborhoods along the proposed alignment and finding a viable location for any necessary new stormwater outfalls. Separation of sewers minimizes the amount of sanitary wastewater being discharged to receiving waters, but also results in increased separate stormwater discharges (which also carry pollutants) to receiving waters.

HLSS was considered in the WWFP. However, the heightened concern of the additional and more frequent pollution loadings that would result from the new stormwater discharges, resulted in the control measure to be dismissed. Typically, DEP BWSO implements HLSS projects to control localized flooding. BWSO does not have any HLSS projects planned for the watershed.

8.2.a.2 Sewer Enhancements

Sewer enhancements, also known as system optimization, aim to reduce CSO through improved operating procedures or modifications to the existing collection system infrastructure. Examples include control gate modifications, regulator or weir modifications, inflatable dams and real time control (RTC) or increasing the capacity of select conveyance system components including gravity lines, pump stations and/or force mains. Also, force main relocation would fall under this category. These control measures generally retain more of the combined sewage within the collection system during storm events. The benefits of retaining this additional volume must be balanced against the potential for sewer back-ups and flooding, or the relocation of the CSO discharge elsewhere in the watershed or an adjacent watershed. Viability of these control measures is system-specific, depending on existing physical parameters such as pipeline diameter, length, slope and elevation.

Throgs Neck PS Enhancements

The most promising sewer enhancement concept for Westchester Creek revolves around the Throgs Neck PS. Initially evaluated under the WWFP, this control measure was further evaluated as part of this LTCP development as described below.

A variety of scenarios involving increases in the capacity of the PS and relocation of the force main (FM) were evaluated. According to the IW modeling, the most valuable concept was retaining the current PS's 37.5 MGD wet weather pumping capacity but extending the FM to the Hunts Point WWTP (HP WWTP). This scenario also did not cause displacement of CSOs to other outfalls and resulted in a net positive reduction within the entire HP WWTP tributary area. This control measure is illustrated in Figure 8-1 and described below.

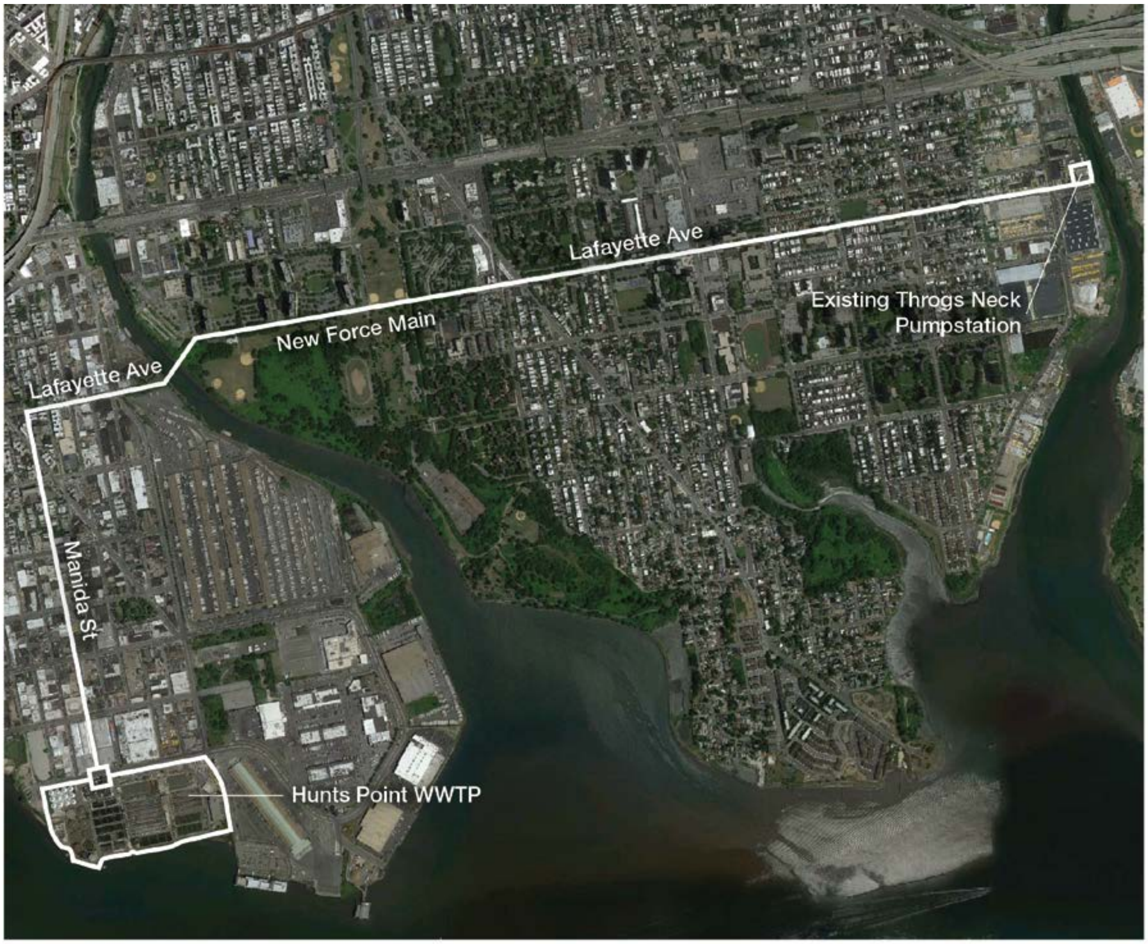


Figure 8-1. Proposed Route of Throgs Neck PS FM Extension to Hunts Point WWTP

A summary of the benefits, costs and challenges associated with this control measure include:

Benefits

There are two primary benefits associated with this control measure. First it reduces the CSO volume by 15 percent. Secondly, it builds on and expands upon existing grey infrastructure, thus saving cost.

Cost

The estimated NPW for this control measure is $137M. The development of this cost estimate is presented in Section 8.3.

Challenges

The major challenge associated with this control measure is the routing of the required 3.13-mile long, 42-inch diameter FM and the disruption that would occur during construction.

Bronx River Siphon Enhancements

Another promising sewer enhancement concept is to expand the capacity of the Bronx River Siphon to increase conveyance to the WWTP from the eastern portion of the service area, including the Westchester Creek watershed. An initial screening of the control measure was performed by adding a third 84-inch barrel to the existing 630-ft long, 84-inch double barrel siphon. According to the IW modeling, this control strategy did not benefit Westchester Creek in terms of CSO reduction; however, a net reduction of 46 MG of CSO was realized along the East River and the Bronx River. A summary of the benefits, costs and challenges associated with this control measure include:

Benefits

The primary benefit associated with this control measure is a 35 MG reduction in CSO from outfall HP-011, with an additional CSO volume reduction of 8 MG spread across several Bronx River outfalls.

Cost

The estimated NPW for this control measure is $38M. The development of this cost estimate is presented in Section 8.3.

Challenges

Siphons in general are prone to clogging, and because of the drop shafts on either side of the siphon, they tend to be difficult to maintain, either because of dewatering requirements or because of difficulties in controlling remote detection and repair equipment. A specific challenge associated with adding a third barrel would be tunneling beneath the Bronx River without damaging the existing pipes and aligning the additional barrel with the existing pipes so that flow is distributed appropriately across all conveyances.

Although there is no benefit to CSO reduction in Westchester Creek, this control measure could reduce CSO from HP-011 on the East River, which is expected to experience an increase in CSO volume upon implementation of the recommended Westchester Creek WWFP elements. However, because this outfall is part of the HP WWTP service area, the specific analysis of the most appropriate technologies will be deferred to the Bronx River LTCP, one of the other waterbodies whose drainage area is served by the HP WWTP. .

8.2.a.3 Retention/Treatment Alternatives

There were a number of the control measures considered for Westchester Creek that fall under this category. For the purposes of this LTCP, the term storage is used in lieu of retention. This includes in-line storage and deep tunnel storage. The only treatment technology being considered for this LTCP is disinfection. Each is described below.

Retention Alternatives – In-line Storage

In-line storage is typically used when existing conveyance elements can be retrofitted to provide cost-effective storage and resultant CSO volume reduction. Modifications to the existing system need to be made in order to realize the addition storage capacity in the form of bending weirs, inflatable dams or fixed weirs. In Westchester Creek, evaluations revealed that the HP-014 outfall sewer was the most conducive site for inline storage. The storage capacity that would be realized was estimated at 5.9 MG.

It was also determined that, due to the tidal influences, a fixed weir would be the most suitable modification.

Like all storage facilities, this inline tank would need to have suitable access locations in order to periodically wash down and remove settled solids and debris that would accumulate in the tank. Also, due to hydraulic limitations, a PS would be required to dewater the tank following the event. Finally, an odor control system would also be needed to prevent unwanted odors emanating from the facility.

There are a number of challenges that this in-line storage concept presents. Most important of these are siting the access hatches and the dewatering pump station and odor control facility. As shown in Figure 8-2, the in-line storage facility would be located below a New York Transit Authority (NYTA) rail yard.

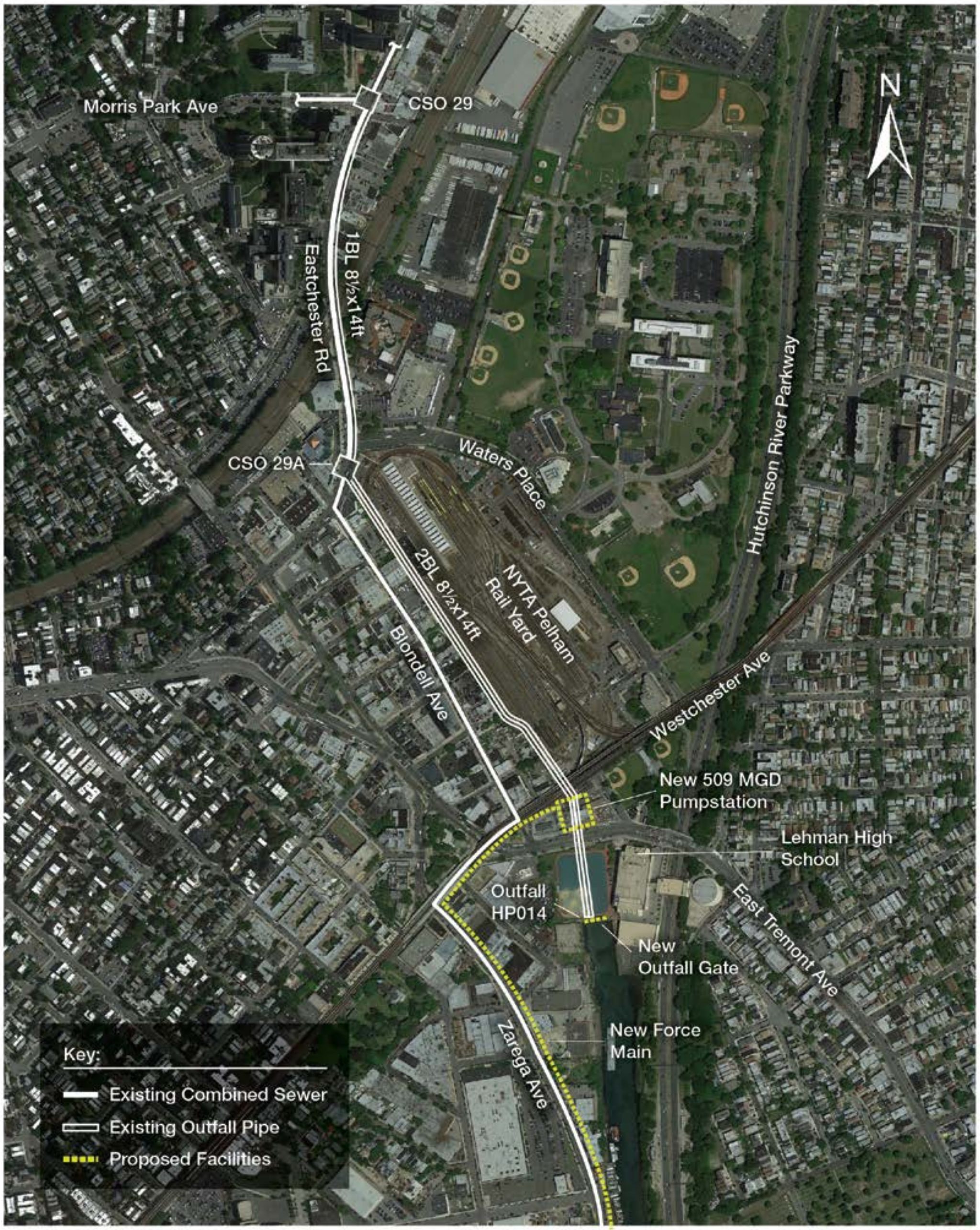


Figure 8-2. Layout of Inline Storage at Outfall HP-014

A summary of the benefits, costs and challenges associated with in-line storage include:

Benefits

There are two primary benefits associated with this control measure. First it reduces the CSO volume by 23 percent. Secondly, it would build on and expand existing grey infrastructure.

Cost

The estimated NPW for this control measure is $26M. The development of this cost estimate is presented in Section 8.3.

Challenges

As noted above, siting of the access hatches and the ancillary facilities within the NYTA rail yard that are needed to make this control measure viable, the dewatering PS and odor control system, present a major challenge to its implementation. Also, the physical condition of the outfall sewers would need to be evaluated.

Retention Alternatives – Deep Tunnels

Due to the limited availability of sites within the Westchester Creek watershed, deep storage tunnels were selected as the most viable type of off-line storage control measure. Unlike traditional tank storage, tunnel storage requires less permanent above ground property per equivalent unit storage volume. Tunnel construction involves the boring of linear storage conduits deep in the ground and typically in bedrock. Shafts are required in both the initial construction as well as during its operation. A dewatering pump station and odor control systems are also included with such facilities.

For the purpose of the Westchester Creek LTCP, tunnel storage was evaluated to accomplish a range of CSO volume controls including 44, 77 and 100 percent. The 44 percent tunnel concept would capture 100 percent of the CSO discharges from outfall HP-014. The 77 percent control concept would capture 100 percent of outfall HP-014 plus those from CSOs HP-015, HP-016 and HP-033. Finally, the 100 percent control tunnel concept includes all of the discharges from the 77 percent concept plus those from outfalls HP-012 and 013. Technical details of these tunnel concepts are summarized in Table 8-1. Figure 8-3 shows the layout of the 100 percent control tunnel concept.

Table 8-1. Deep Tunnel Characteristics

TUNNEL OPTIONS	**Contributing Outfalls**		
	HP-014	**HP-014 HP-015 HP-016 HP-033**	**HP-014 HP-015 HP-016 HP-033 HP-012 HP-013**
CSO Reduction (%)	44	77	100
Tunnel Volume (MG)	24.5	43	50
Tunnel Length (lf)	2,600	4,500	12,600
Tunnel Diameter (ft)	40	40	26
Cost ($M)	530	683	760

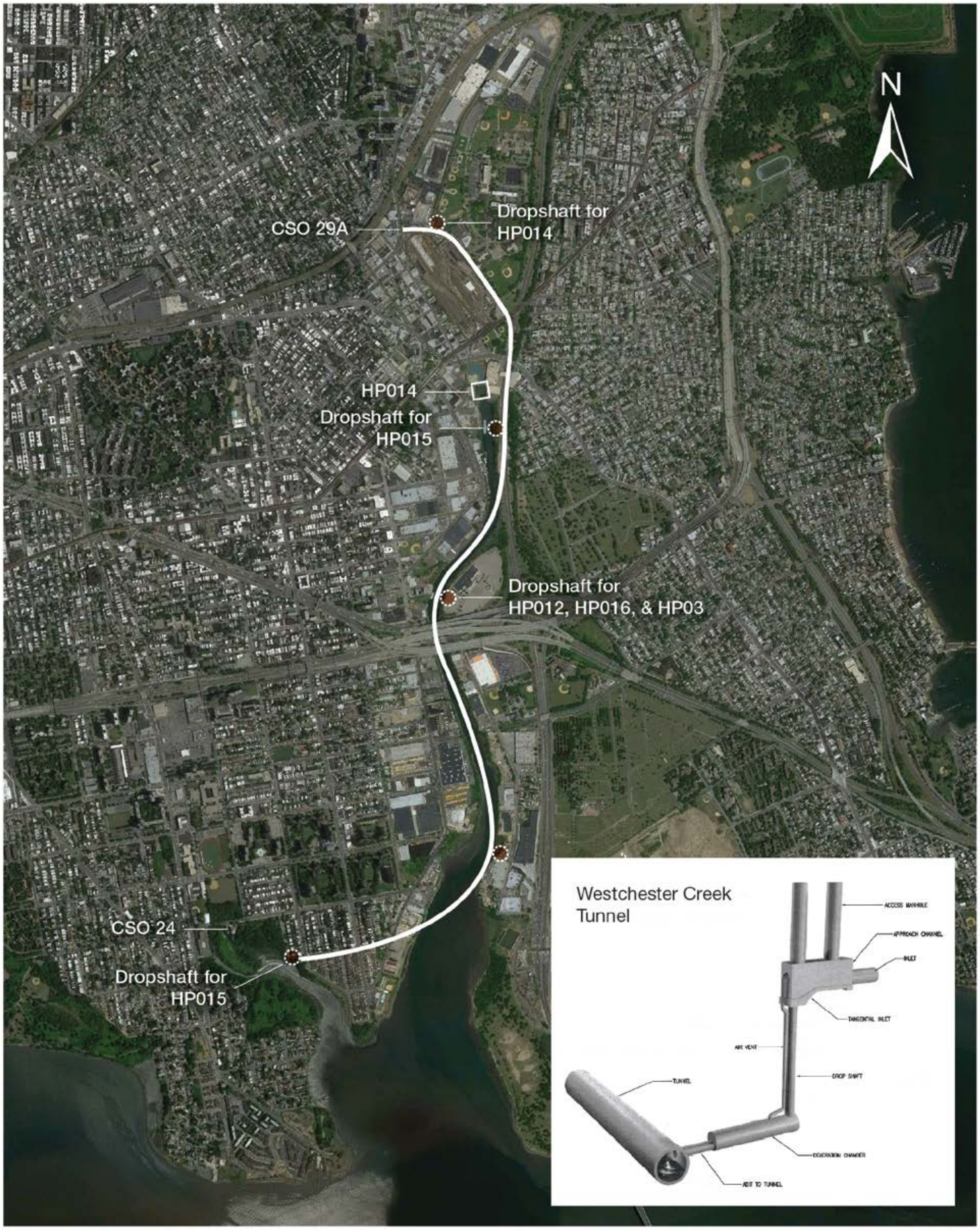


Figure 8-3. Proposed Route of 100 Percent CSO Volume Tunnel

A summary of the benefits, costs and challenges associated with tunnel storage include:

Benefits

The major benefit of tunnel storage is the high rate of CSO volume reduction. In this case, the range of reduction for the alternatives developed was a low of 44 percent to a high of 100 percent. A secondary benefit is in siting: tunnels require a smaller footprint than would be needed for traditional storage tanks of equivalent volume.

Cost

The estimated NPW ranges from a low of $530M for the 44 percent concept to a high of $760M for the 100 percent concept. The development of these cost estimates are presented in Section 8.3.

Challenges

Even with the reduced footprint over traditional storage tanks, tunnels present a number of siting and operational challenges. In addition to the downstream shaft, each outfall under consideration would also require a feed shaft and its own odor control; system. The dewatering PS would need to be sited, typically at the downstream end of the tunnel. Also, there could be major disruption during the actual construction with both the tunneling operation and trucking and disposal of the spoils. Land acquisition and easements may be required along the tunnel route. Periodic O&M of the tunnel components would pose a challenge due to their relative inaccessibility and depth.

Retention Alternatives – Tank Dewatering

As noted above, both categories of storage concepts included tank dewatering. Table 8-2 summarizes the required pumping rates for each concept based a maximum 2-day dewatering period. As shown in the table, pumping rates ranged from a high of 25 MGD for the 100 percent capture storage tunnel concept to a low of 3.0 MGD for the 23 percent capture inline storage concept. Should any of these storage alternatives be considered further, an analysis of the affected capacity of the downstream conveyance components must be performed to ensure that the additional flow can be safely accommodated.

Table 8-2. Dewatering Rates for Retention Concepts (2-Day Pump-back)

	23% Capture (Inline)	44% Capture (Tunnel)	77% Capture (Tunnel)	100% Capture (Tunnel)
Additional Storage Volume (MG)	5.9	24.5	42.3	50
Pumping Capacity (MGD)	3.0	12.3	21.2	25

Treatment Alternative – Disinfection

As noted above, disinfection was the only treatment technology considered for this Westchester Creek LTCP. Disinfection would reduce the bacteria loading to the creek associated with CSO discharges. Bacteria from the stormwater sources would not be controlled.

There are currently no facilities in the Westchester Creek watershed to which disinfection could be retrofitted, thus both disinfection storage and feed facilities would be required along a chlorine contact tank to provide the necessary contact time for effective kills. As such, its application was only considered in concert with inline storage, described above, where the converted outfall HP-014 could be used as the chlorine contact tank. In the typical year simulation (2008) the maximum projected flow rate of 647 MGD through the 5.9 MG storage volume would yield a contact time of 13 minutes. This is longer than what is considered necessary for high rate disinfection of CSO flows (5 to 10 minutes).

The disinfection system associated with inline storage would include chlorine dosing, in the form of sodium hypochlorite, at the upstream end of the HP-014 outfall and dechlorination dosing, using sodium bisulfite, near the discharge end of the outfall. These two processes would be housed in separate buildings for chemical delivery, storage, and feed equipment. Ancillary electrical, controls and HVAC systems would also be included. Although the dosing points are over one-half mile apart, the facilities would probably be sited in a shared location with one or both dosing points being served by a long force main, and possibly requiring a carrier water system to convey the chemical to the dosing point.

Siting these facilities would pose a challenge because the area is densely developed. Candidate sites include taking a portion of a nearby parking lot at the corner of Eastchester Road and Waters Place, within the Lehmann High School grounds, and placing facilities within the Hutchinson River Parkway right-of-way adjacent to Westchester Creek, just south of the high school. All siting considerations would require further evaluation. It is unclear at this time what permit requirements would possibly be imposed by DEC for this satellite CSO disinfection facility. It would be logical to only provide disinfection during the recreation season to conserve chemical usage and minimize the discharge of total residual chlorine to the waterbody. It should be noted that, according to a nationwide survey of satellite CSO facilities, all had bacteria limits and only one (North Yonkers facility in in neighboring Westchester County) did not have either TRC permit limits. Thus, dechlorination would likely be needed for compliance with possible permit limits for TRC and to protect the biota in Westchester Creek.

Floatables Control

Floatables control technologies or control measures are designed to reduce or eliminate aesthetically objectionable items from the CSOs, such as plastic, paper, polystyrene and sanitary “toilet litter” matter, etc. However, because they do not reduce the volume or frequency of overflows, these control measures cannot be evaluated on the cost-performance or cost-attainment bases as with the other control measures.

Floatables control technologies were evaluated in detail in the 2011 Westchester Creek WWFP, including ongoing institutional programs such as catch basin hooding and other CSO BMPs. However, New York City has devoted considerable resources to reducing floatables throughout the New York Harbor. Examples of floatables control technologies in service or planned include:

- In-line netting at upstream regulators tributary to outfalls HP-004 and HP-009 on the Bronx River;
- Mechanically cleaned bar screens within two Hunts Point control structures (CSO-27 and CSO-27A) tributary to outfall HP-007 on the Bronx River;
- Bending weir pilot at Red Hook regulator 2 in Brooklyn that is anticipated to become a permanent facility;

- Bending weirs with underflow baffles at Newtown Creek regulators B1, Q1, and the Saint Nicholas weir, and at Bowery Bay regulator L4, currently out to bid;
- Containment booms throughout the New York Harbor, including HP-014 in Westchester Creek; and
- Skimmer vessels to service containment boom sites and to conduct open-water operations.

DEP's current experience with end-of-pipe floatables control technologies, however, has not been favorable. The netting facilities and bar screens installed within the Bronx River watershed listed above have been particularly problematic, requiring maintenance and labor in excess of what was originally envisioned. These operational issues are compounded by the ongoing risk that the facilities may not be ready to treat the next CSO event because of the time required to reset the facilities. These negative experiences have led DEP to only consider those technologies that require little to low maintenance. As such, only low-maintenance floatables control technologies are being retained for further evaluation. Further, with respect to this LTCP, the focus of floatables control will be outfall HP-011 on the East River which is expected to experience an increase in CSO volume upon implementation of the recommended Westchester Creek WWFP elements. However, because this outfall is on the East River, the specific analysis of the most appropriate technologies will be deferred to the Citywide LTCP which includes the East River CSOs.

8.2.b Other Future Green Infrastructure (Various Levels of Penetration)

As discussed in Section 5.0, DEP expects 487 acres of total implemented green infrastructure (GI) to be managed in the Westchester Creek watershed by 2030. This acreage includes 348 acres of Right of Way (ROW) implemented GI, 122 acres of implemented GI to be managed in on-site private properties and 17 acres of GI to be managed in on-site public property. This acreage represents 14 percent of the total combined sewer system impervious area in the watershed. This GI has been included in the baseline model projections, and is thus not categorized as an LTCP alternative.

For the purpose of this LTCP, "Other Future Green Infrastructure" is defined as GI alternatives that are in addition to those implemented under previous facility plans and those included in the baseline conditions. Because the baseline level of GI penetration for this watershed is well above the 10 percent citywide goal, and due to the difficulties in finding sites to implement GI control measures in general, additional GI is not being considered for this LTCP at this time.

8.2.c Hybrid Green/Grey Alternatives

Hybrid green/grey alternatives are those that combine traditional grey control measures with GI control measures, to achieve the benefits of both. However, as noted above, the baseline GI penetration rate for this watershed is already substantial and further GI is not planned at this time. Therefore, this control is not proposed for the Westchester Creek LTCP.

8.2.d Retained Alternatives

A summary of the evaluation of the control measures presented above is contained in Table 8-3, including those which were retained for further evaluation as basin-wide alternatives. The reasons for dropping the non-retained controls from further consideration are also noted in the table.

Table 8-3. Summary of Preliminary Evaluations

Control Measure	Retained for Further Analysis?	Remarks
Inline Storage at HP-014	NO	Existing outfall pipes located beneath active NYTA rail yard resulting in very difficult construction and severely limited O&M access. Would also require complex control structure and dewatering pumping.
Disinfection with Dechlorination on Inline Storage at HP-014	NO	Without inline storage, would require siting of a new, separate chlorine contact tank in a highly congested area in close proximity to a high school and medical institutions. Also, not justified on a water quality standard attainment basis.
Throgs Neck PS Enhancements	YES	See Table 8-4 below
Storage Tanks or Tunnels	YES	See Table 8-4 below
Floatables Control	YES	See Table 8-4 below
Bronx River Siphon Enhancement	YES	See Table 8-4 below
Additional GI Build-out	NO	Planned GI buildout in the watershed (included in the baseline) is greater than citywide average; additional sites unlikely to be identified.
High-level Sewer Separation	NO	No HLSS projects planned in watershed and no potential cross-benefit with flood mitigation identified.
Dredging	NO	No visible sediment mound at head end and no navigational benefit to local stakeholders.

The alternatives controls that were not retained include inline storage and several of the Throgs Neck PS and force main concepts. Inline storage presented a number of technical and siting challenges that were deemed to be insurmountable. Disinfection, which would have been tied to the inline storage concept, was also dismissed accordingly. Further details of the retained alternatives are presented in Table 8-4.

Table 8-4. Summary of Retained Alternatives

Alternative	Description
1. Throgs Neck PS Force Main (FM) Extension	Extend FM to Hunts Point WWTP, maintain capacity at 37.5 MGD, and modify pumps to account for additional head loss. Maintaining current capacity at 37.5 MGD and extending the force main directly to the Hunts Point WWTP
2. 24.5 MG Storage Tunnel	40-ft. dia., 2,600 LF tunnel deemed to be the most viable technology for capturing outfall HP-014 volume. Includes 24.5 MGD dewatering PS.
3. 43 MG Storage Tunnel	40-ft. dia., 4,500 LF tunnel deemed to be the most viable technology for capturing CSO from outfalls HP-014, HP-015, HP-016 and HP-033. Includes 43 MGD dewatering PS.
4. 50 MG Storage Tunnel	26-ft. dia., 12,600 LF tunnel deemed to be the most viable technology for capturing CSO from outfalls HP-014, HP-015, HP-016, HP-033, HP-012 and HP-013. Includes 50 MGD dewatering PS.
5. Floatables Control	Targeting HP-011 at the East River to address the increased CSO volume resulting from the planned WWFP recommendations; evaluation deferred to the Bronx River LTCP.
6. Bronx River Siphon Enhancement	Targeting HP-011 at the East River to address the increased CSO volume resulting from the planned WWFP recommendations; evaluation deferred to the Bronx River LTCP.

The retained alternatives for Westchester Creek (Alternatives 1 through 4) were then analyzed further for their ability to reduce pollutants and improve water quality, as described in Sections 8.3 through 8.5 including the critically important cost performance and cost attainment evaluations.

8.3 CSO Reductions and Water Quality Impact of Retained Alternatives

To evaluate their effects on the pollutant loadings and water quality impacts, the retained alternatives listed in Table 8-3 were analyzed using both the Westchester Creek watershed (IW) and receiving water/waterbody or water quality (ERTM) models. Evaluations of CSO volume reductions and/or bacteria load reductions for each alternative are presented below. In all cases, the reductions shown are relative to the baseline conditions using 2008 JFK rainfall as described in Section 6.0. The baseline assumptions were described in detail in Section 6.0 and assume that the grey infrastructure projects from the WWFP have been implemented, along with the 14 percent GI penetration.

8.3.a CSO Volume and Bacteria Loading Reductions of Retained Alternatives

Table 8-5 summarizes the projected CSO volume reductions and bacteria for the retained alternatives. These data are plotted on Figure 8-4. Floatables control, Alternative 5, does not result in either CSO volume or bacteria control and thus not included on the subsequent plots.

Table 8-5. Westchester Creek Retained Alternatives[1] Summary (2008 Rainfall)

Alternative	CSO Volume (MGY)	CSO Volume Reduction[2] (Percent)	Fecal Coliform Reduction (Percent)	Enterococci Reduction (Percent)
Baseline Conditions	289	-	-	-
1. Throgs Neck PS FM Extension	245	15	15	15
2. 24.5 MG Tunnel	162	44	44	44
3. 43 MG Tunnel	66	77	77	77
4. 50 MG Tunnel	0	100	100	100

[1]Floatables control and Bronx River Siphon Enhancement did not directly benefit Westchester Creek and are retained for consideration under the Citywide LTCP.
[2]CSO volume reduction from baseline conditions.

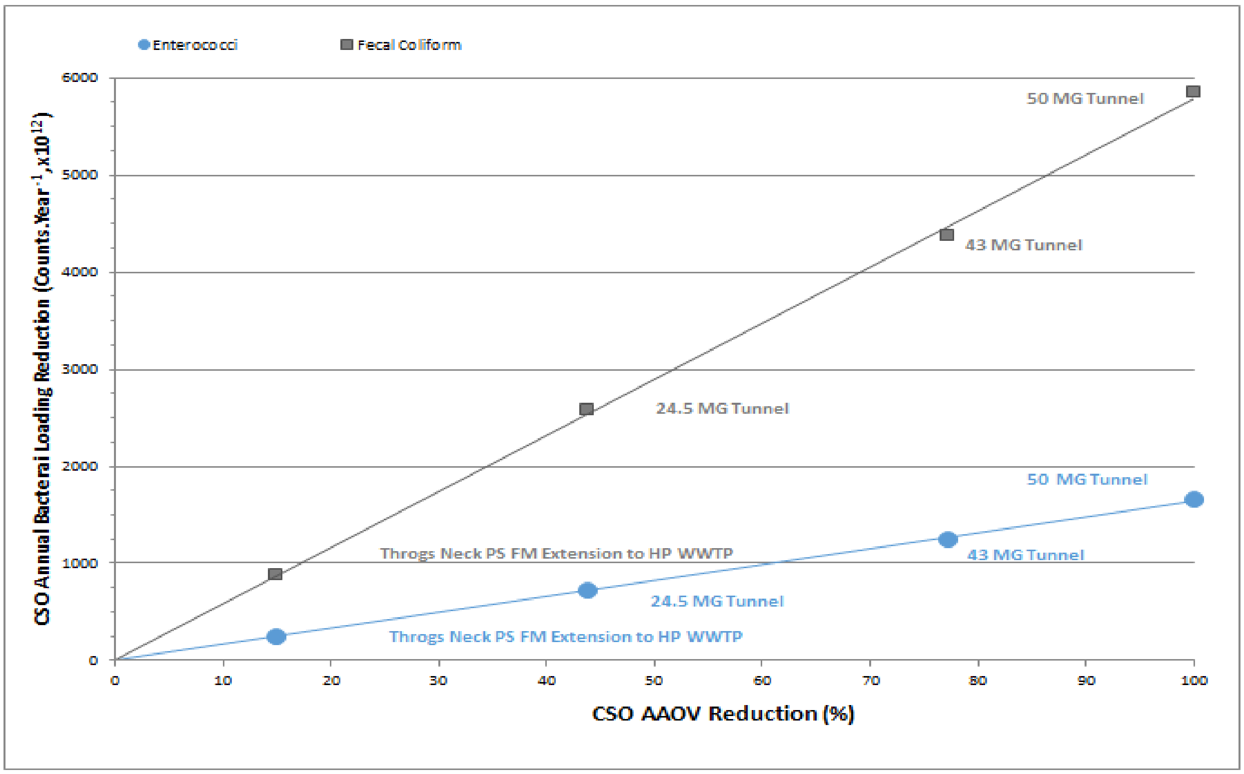


Figure 8-4. CSO Volume Reductions vs. Annual Total Bacteria Loading Reduction (2008 Rainfall)

It should be noted that because the Westchester Creek alternatives serve outfalls in predominantly combined areas, the bacteria loading reductions of the alternatives are aligned with their projected CSO volume reductions.

8.3.b Water Quality Impacts

This section qualitatively describes the levels of attainment with applicable bacteria criteria within Westchester Creek that would be achieved through implementation of the retained CSO control alternatives listed in Table 8-5.

Westchester Creek is a Class I waterbody. Historic and recent water quality monitoring, along with baseline condition modeling using ERTM, revealed that Westchester Creek is currently in attainment with the Class I fecal coliform criterion When the attainment is assessed with the existing Primary Contact WQ criteria of Class SC, none of the alternatives would result in full attainment. As explained in the gap analysis presented in Section 6.3, bacteria loadings from other sources influence the fecal and enterococci concentrations, to the extent that even removal of 100 percent of the CSO would not result in full attainment of the Class SC criteria.

8.4 Cost Estimates for Retained Alternatives

Evaluation of the proposed alternatives requires an appropriate level of cost estimating for each alternative. The methodology for developing these costs is dependent on the type of technology and its unique operation and maintenance requirements. As noted previously, the capital costs were developed as PBC and the total net present worth costs were determined using the PBC estimated plus the net present worth of the projected operation and maintenance (O&M) costs at an assumed interest rate of 3 percent over a 20-year life cycle. All costs are in June 2014 dollars.

8.4.a Alternative 1 – Throgs Neck PS FM Extension to HP WWTP

Costs for Alternative 1 include the 3.13-mi 48-in. FM and required modifications to the existing 37.5 MGD PS. The FM costs are based on the sewer diameter, length, and depth of cover.

The total cost for Alternative 1 is $133 million (June 2014 dollars) as shown in Table 8-6.

Table 8-6. Costs for Alternative 1 - Throgs Neck PS FM Extension to HP WWTP

Item		June 2014 Cost ($ Million)
PBC	PS Modifications	24.5
	FM	109.0
	Total	132.5
Annual O&M		0.04
Total Present Worth		133.0

8.4.b Tunnel Alternatives

Cost estimates for the three retained tunnel alternatives; Alternative 2 – 24.5 MG Tunnel, Alternative 3 – 43 MG Tunnel and Alternative 4 – 50 MG Tunnel, are summarized in Table 8-7. The estimated total NPW ranges between $509M to $731.4M for the smallest and largest tunnel, respectively. These costs include the boring of the deep tunnel, multiple shafts, dewatering PS, odor control systems and other ancillary facilities. The cost estimates of these retained alternatives were then used in the development of the cost-performance and cost-attainment plots presented in Section 8.5.

Table 8-7. Tunnel Alternatives Costs

Retention Alternative	24.5 MG Tunnel	43 MG Tunnel	50 MG Tunnel
June 2014 PBC ($ Million)	507.3	660.2	728.9
Annual O&M Cost ($ Million)	0.12	0.15	0.17
Total Present Worth ($ Million)	509.0	662.4	731.4

8.5 Cost-Attainment Curves for Retained Alternatives

The final step of the analysis is the evaluation of the cost-effectiveness of the alternatives based on their NPW and projected impact in attainment of applicable water quality standards.

8.5.a Cost-Performance Curves

Figure 8-5 presents the relationship of percent CSO control to the NPW of the retained alternatives. Percent CSO control ranges from a low of 15 percent (Alternative 1 – Throgs Neck PS FM Extension to HP WWTP) to a high of 100 percent control (Alternative 4 - 50 MG Tunnel), with costs spanning from a low of $133M to a high of $731M, for Alternative 1 and Alternative 4, respectively. A linear best-fit cost curve was developed based on alternatives that were judged more cost-effective for the CSO control level estimated by IW, based on the typical year rainfall.

Along with overall CSO control, a goal of the LTCP is to reduce bacteria loadings to the waterbody to the extent that such loadings are caused by CSOs. Figures 8-6 and 8-7 plot the cost of the retained alternatives against their associated projected annual CSO enterococci and fecal coliform loading reductions, respectively. The primary vertical axis shows percent CSO bacteria loading reductions and the secondary vertical axis shows the corresponding total bacteria loading reductions, as a percentage, when loadings from other sources of bacteria are included.

As implied by the previously described linearity between CSO volume reduction and bacteria loading reduction for both fecal coliform and enterococci is shown in Figure 8-5. Enterococci ranges from a low of 15 percent (Throgs Neck PS FM Extension to HP WWTP) to a high of 100 percent (50 MG Tunnel) with costs spanning up to $731M for the tunnel. Similarly, linearity is also observed when considering the total bacteria loading reductions. These reductions span from 13 percent to 88 percent for fecal coliform and from 12 percent to 83 percent for enterococci, as shown in Figures 8-6 and 8-7.

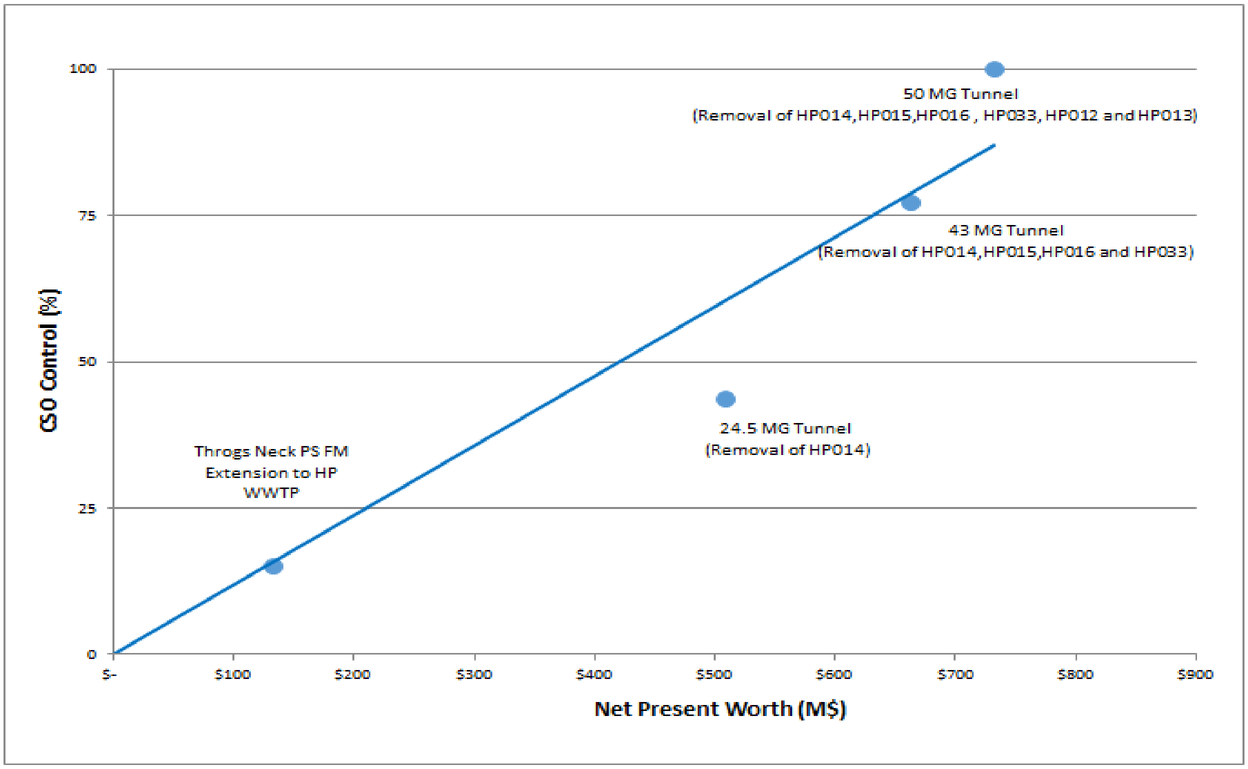


Figure 8-5. Cost vs. CSO Control (2008 Rainfall)

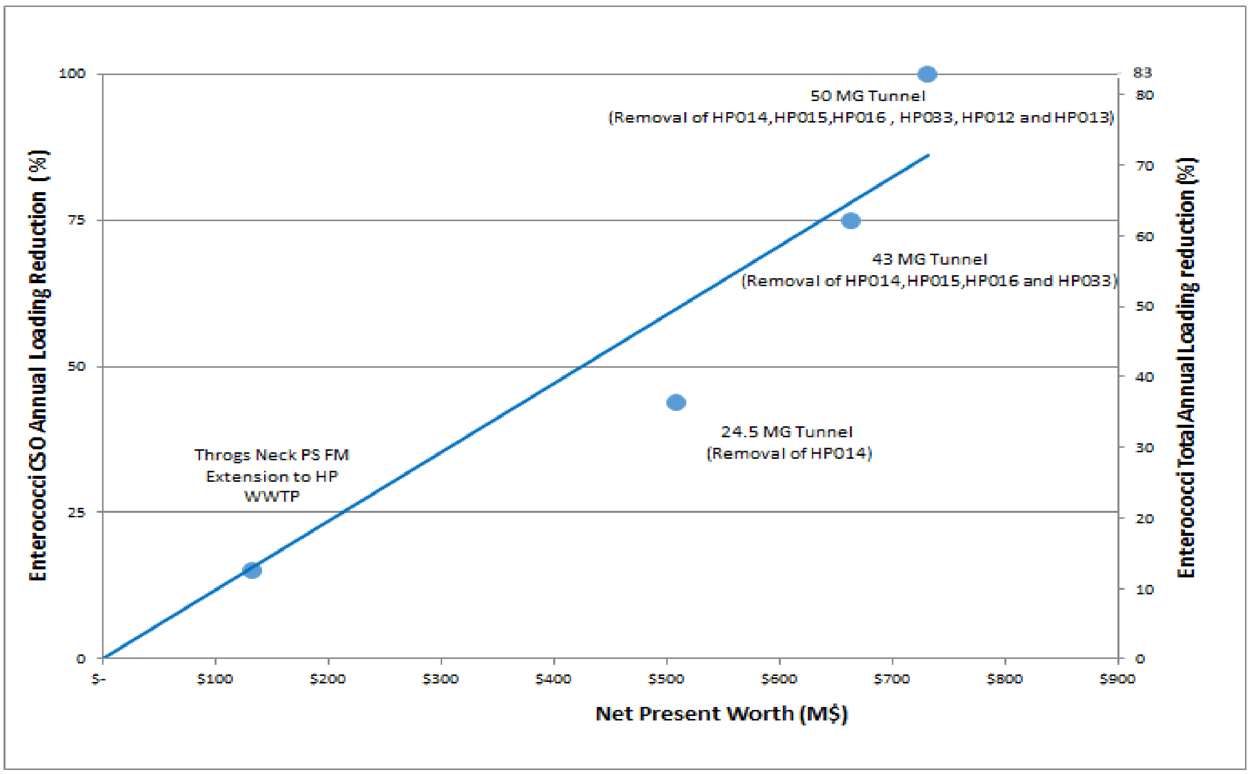


Figure 8-6. Cost vs. Enterococci Loading Reduction (2008 Rainfall)

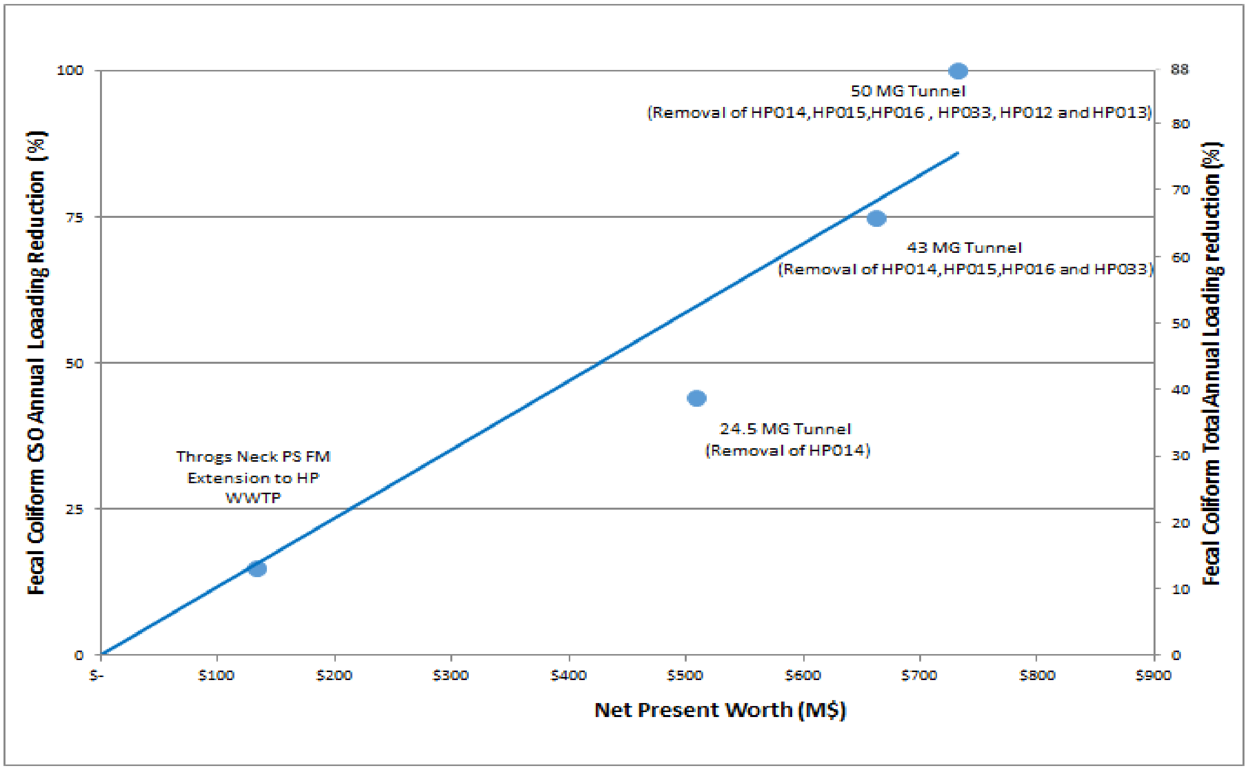


Figure 8-7. Cost vs. Fecal Coliform Loading Reduction (2008 Rainfall)

As with the previous best-fit curve comparing costs versus level of CSO control (Figure 8-5), there are no KOTCs for enterococci or fecal coliform. In summary, Figures 8-5 through 8-7 indicate that none of the retained alternatives represents an optimal gain in marginal performance.

8.5.b Cost-Attainment Curves

This section addresses costs of the CSO alternatives versus attainment of existing and Primary Contact WQ Criteria (Class SC) WQS modeled with the 2008 rainfall. As previously discussed in Section 2.0, and further analyzed in Section 6.0, attainment of existing applicable Class I bacteria standard, 2,000 cfu/100 mL fecal coliform monthly GM, occurs 100 percent of the time in Westchester Creek under baseline conditions. Also, it should be noted that entero criteria do not apply to tributaries such as Westchester Creek under the BEACH Act of 2000. Water quality assessments for Class SC considered fecal coliform (FC) criterion only. Accordingly, attainment curves are shown for the FC criterion only, specifically, the monthly GM of 200 cfu/100 mL. These curves are presented as Figures 8-8 through 8-11 for four select locations along Westchester Creek. It is noted that the lowest attainment of the existing Primary Contact WQ Criteria fecal coliform criterion under the baseline condition is 83 percent and occurs at Station WC2, at the head of the creek. When 2008 average rainfall year is used for alternative comparison purposes, even by implementing 100 percent CSO control, the baseline attainment with the Primary Contact WQ Criteria remains unaltered at this station although results vary under the 10 year projections.

Attainment of the Future Primary Contact WQ Criteria with 2012 EPA RWQC modification to the standards is also plotted in the figures where cost-attainment curves are shown for the proposed GM and STV criteria. Figure 8-8 shows the modeled improvement in annual attainment at Station E13 for each alternative. When considering an STV of 130 cfu/100mL, the performance gap is considerable, with annual attainment occurring 52 percent of the time under baseline conditions. The improvements in attainment of future Primary Contact WQ Criteria with 2012 EPA RWQC shown are marginal, rising a maximum of 2 percent, for the alternative with the greatest improvement, the 54 MG Tunnel. As noted earlier, DEC has recently stated that they plan to implement the more stringent GM of 30m CFU/100mL and STV of 110 cfu/100mL, however, the analyses in this LTCP are performed with the 35/130 values.

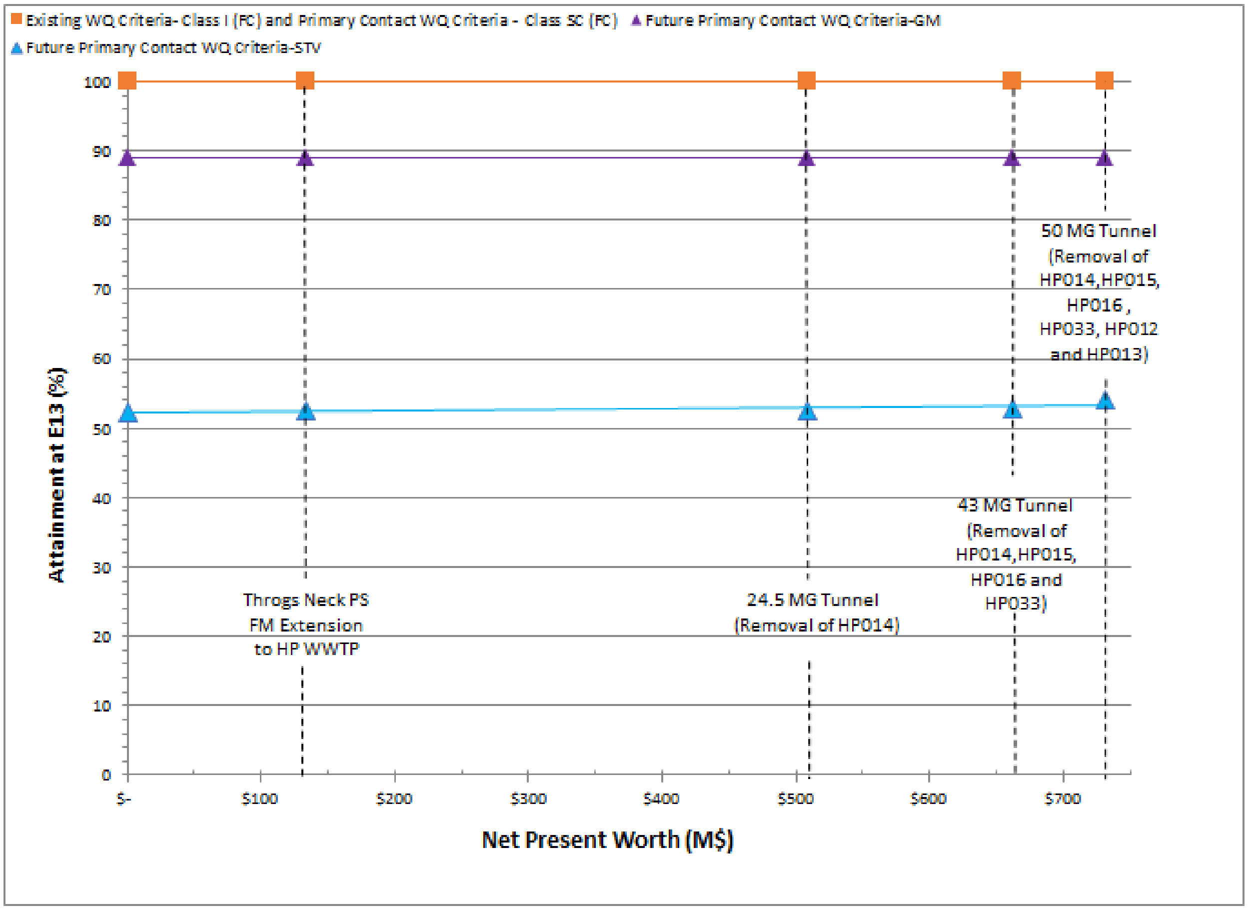


Figure 8-8. Cost vs. Bacteria Attainment at Station E13 (2008 Rainfall)

Figure 8-9 shows the modeled improvement in annual attainment at Station WC3 for each alternative. When considering an STV of 130 cfu/100mL, the performance gap is large, with annual attainment occurring only 7 percent of the time under baseline conditions. For Station WC3, the improvements in attainment of Future Primary Contact WQ Criteria with 2012 EPA RWQC shown are discernable, rising a maximum of 18 percent for the alternative with the greatest improvement (54 MG Tunnel), at a cost of $731M.

Figure 8-10 shows that improvements in attainment of Future Primary Contact WQ Criteria with 2012 EPA RWQC modified criteria, i.e., enterococci GM and STV, begin to be realized at Station WC1. Specifically, attainment gains of 12 percent and 22 percent between the baseline condition and the 50 MG Tunnel alternative are estimated for the GM and STV criteria, respectively. These improvements are realized upon corresponding baseline condition attainments of 59 percent for GM criterion and 3 percent for the STV criterion.

Figure 8-11 depicts the attainment gain that would result from multiple alternatives at Station WC2, close to the head of the creek. As shown, the largest improvement in annual attainment would be realized for the future Primary Contact WQ Criteria with 2012 EPA RWQC modification enterococci GM criterion by the 54 MG Tunnel alternative, for which the projected increase in attainment is 16 percent, from 43 percent under the baseline condition to 59 percent.

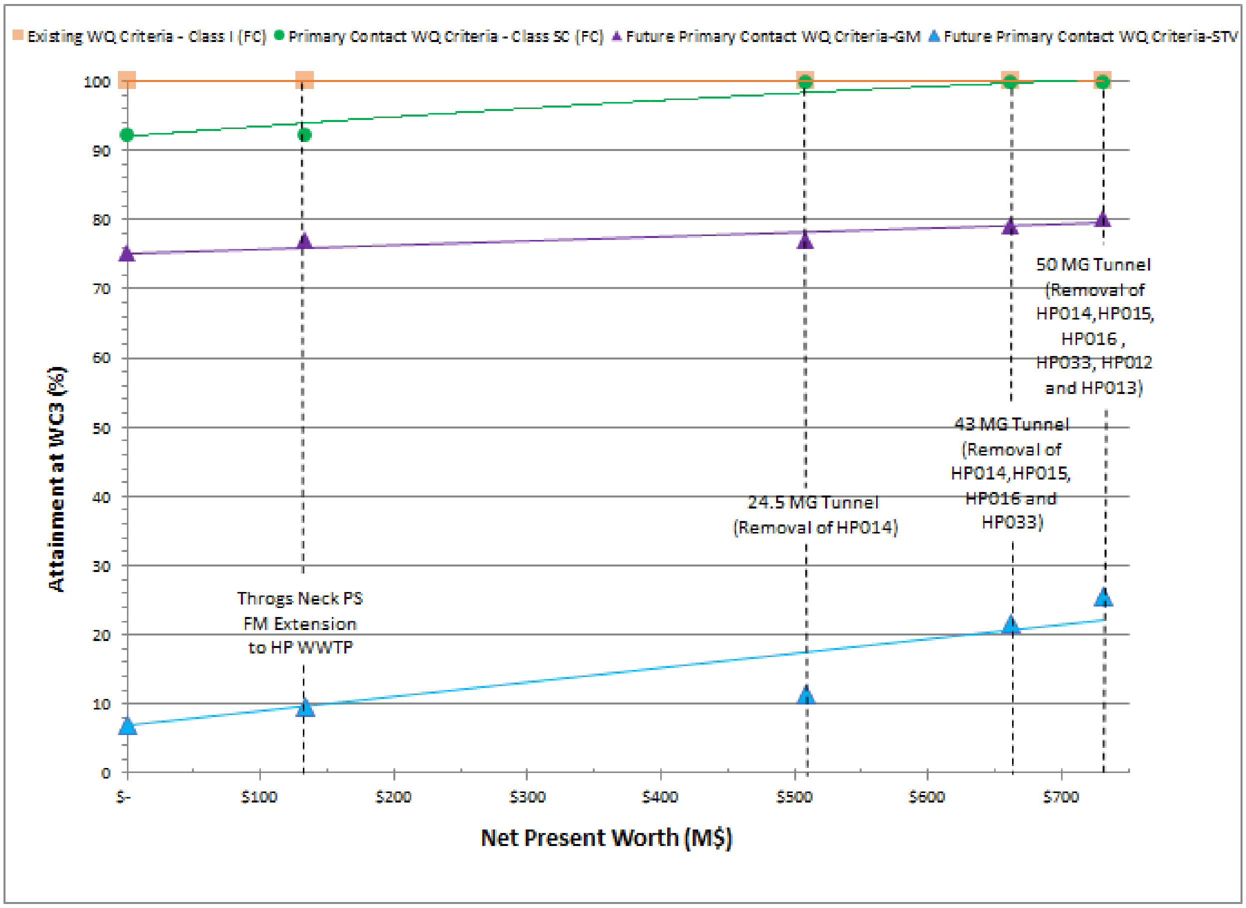


Figure 8-9. Cost vs. Bacteria Attainment at Station WC3 (2008 Rainfall)

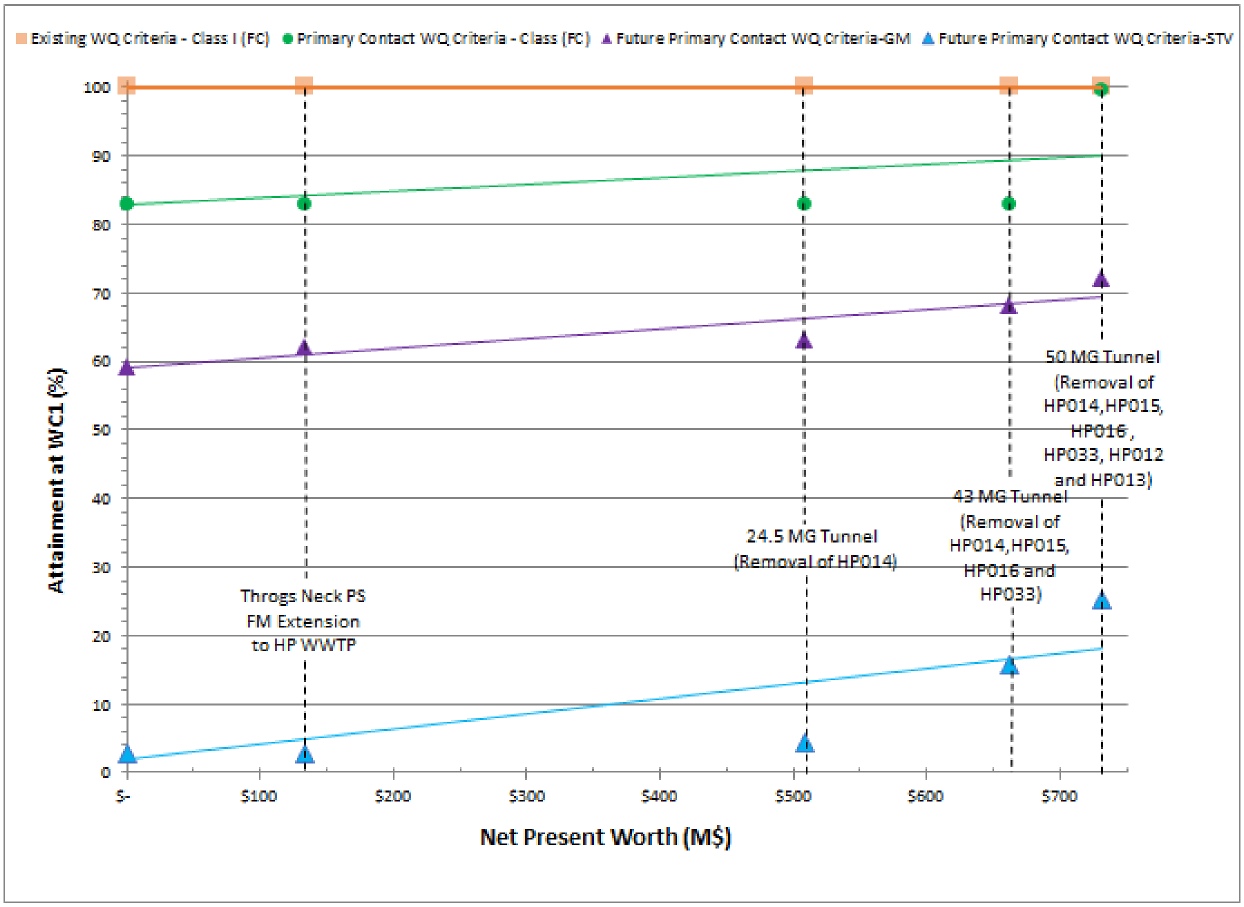


Figure 8-10. Cost vs. Bacteria Attainment at Station WC1 (2008 Rainfall)

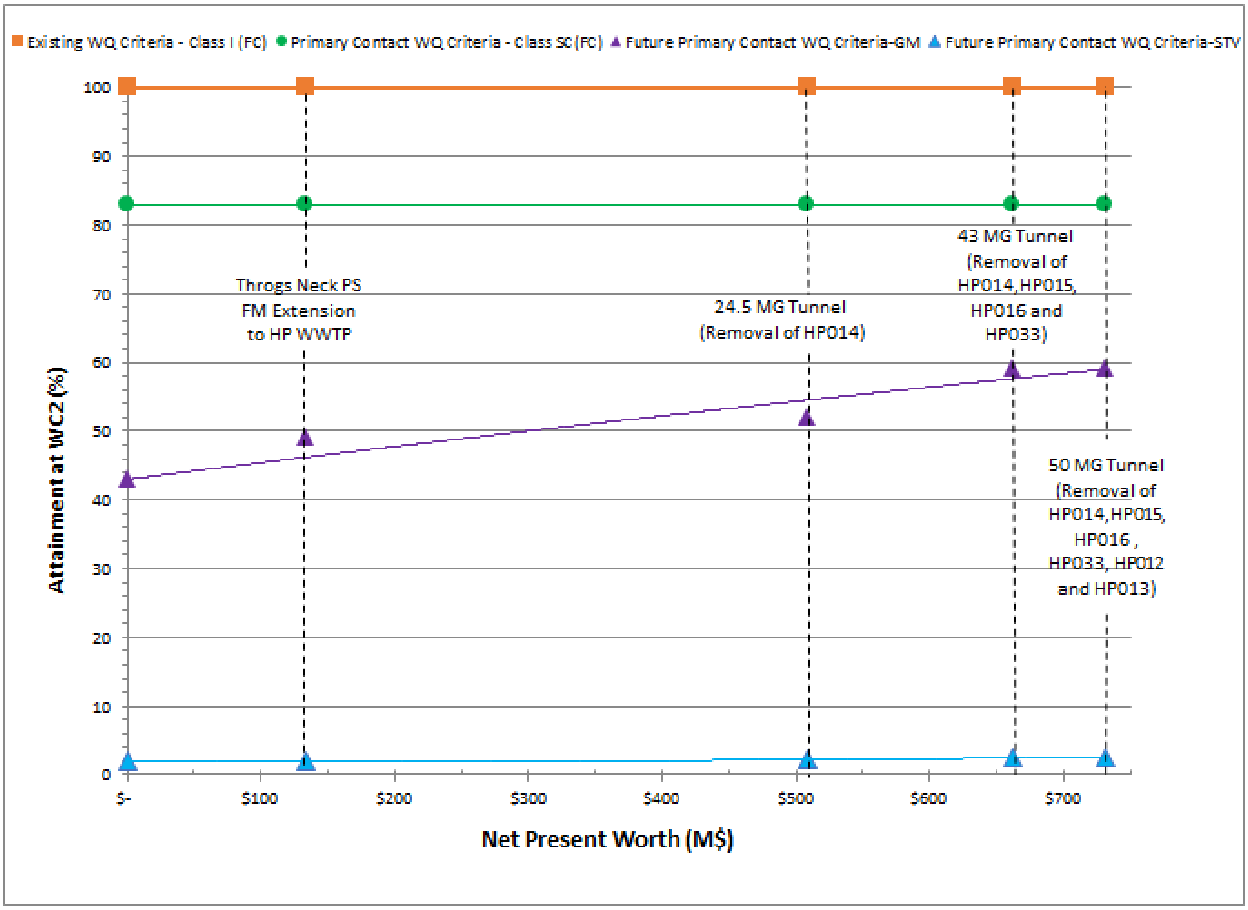


Figure 8-11. Cost vs. Bacteria Attainment at Station WC2 (2008 Rainfall)

These results clearly demonstrate that capturing additional volume of CSO, regardless of the degree of capture, does not cost-effectively improve the attainment of WQ criteria in Westchester Creek. In all cases, there are no clear inflection points (KOTCs), indicating a potential cost-effective degree of control. The remaining non-attainment of Primary Contact WQ Criteria and Future Primary Contact WQ Criteria with 2012 EPA RWQC is caused by other sources of pollution, as was discussed in earlier sections of this LTCP. Overall, the attainment status is more dependent on the criterion used than on the CSO control alternative evaluated.

8.5.c Conclusion on Preferred Alternative

Based upon the series of cost performance (Figures 8-5 through 8-7) and cost attainment (Figures 8-8 through 8-11) curves developed for this Westchester Creek LTCP, there is no preferred basin-wide alternative recommended to move forward into implementation. Even Alternative 1 - Throgs Neck PS FM Extension to HP WWTP, the lowest cost alternative with a TPW of $133M, was predicted to result in marginal increases in WQS attainment.

In summary, the following conclusions can be drawn from these analyses:

- Continued implementation of the 2011 WWFP recommendations will provide significant improvement in the WQS attainment of Westchester Creek over existing conditions.

- PCM will document these improvements.

- Committing at this time to extending the Throgs Neck PS FM to the HP WWTP, while providing some slight increase in attainment in Westchester Creek, could result in adverse impacts for two other watersheds which are also served by that plant: Hutchinson River and Bronx River LTCPs.

- During the development of the Citywide LTCP, Alternative 1, and others as well, could be reconsidered in order to determine if the HP WWTP capacity was still available and could be effectively used for Westchester Creek flows.

As there is no single alternative that is cost-effective with respect to CSO control, DEP is proposing to move forward with the construction of the grey infrastructure controls proposed in the WWFP as described in Section 4.0, and the GI as described in Section 5.0, collectively constituting the LTCP Baseline Conditions as defined in Section 6.0, as the recommended LTCP plan.

The WQ model was used to characterize WQS attainment for this recommended alternative by running the model for the full 10 years simulation period. As no additional grey or green infrastructures are being proposed at this time, this simulation is same as the Section 6.0 Baseline Conditions. The results of these runs are summarized in Tables 8-8 (annual attainment) and 8-9 (recreational season attainment).

Table 8-8. Calculated 10-year Bacteria Attainment for Recommended Plan (Baseline Conditions) – Annual Period

Station	Existing WQ Criteria (Class I)		Primary Contact WQ Criteria (Class SC)	
	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
WC2	Fecal ≤2,000	100	Fecal ≤200	78
WC1	Fecal ≤2,000	100	Fecal ≤200	87
WC3	Fecal ≤2,000	100	Fecal ≤200	94
E13	Fecal ≤2,000	100	Fecal ≤200	99

Table 8-9. Calculated 10-year Bacteria Attainment for Recommended Plan (Baseline Conditions) – Recreational Season (May 1st – October 31st)

Station	Existing WQ Criteria (Class I)		Primary Contact WQ Criteria (Class SC)		Future Primary Contact WQ Criteria	
	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
WC2	Fecal ≤2,000	100	Fecal ≤200	88	Enterococci ≤35	64
					STV≤130	4
WC1	Fecal ≤2,000	100	Fecal ≤200	93	Enterococci ≤35	77
					STV≤130	16
WC3	Fecal ≤2,000	100	Fecal ≤200	95	Enterococci ≤35	87
					STV≤130	24
E13	Fecal ≤2,000	100	Fecal ≤200	100	Enterococci ≤35	96
					STV≤130	52

Examination of projected attainment in Westchester Creek (Table 8-8 and Table 8-9) shows that the Primary Contact WQ Criteria for fecal criteria are not attained for the annual period but are attained a high percent of the time for the recreational season. Attainment is lowest for the Primary Contact WQ Criteria (Class SC) for the upstream portions of the Creek north of location WC3. Further, the Future Primary Contact WQ Criteria are not attained either during the recreational season for all but the very downstream end of the waterbody for GM criterion of 35 cfu/100mL. No areas of the creek are shown to be capable of attaining the STV value of 130 cfu/100mL.

8.6 Use Attainability Analysis

The CSO order requires a UAA to be included the LTCPs "where existing water quality standards do not meet the Section 101(a)(2) goals of the Clean Water Act, or where the proposed alternative set forth in the LTCP will not achieve existing water quality standards or the Section101(a)(2) goals. The UAA shall "examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State". The UAA process specifies that states can remove a designated use which is not an existing use if the scientific assessment can demonstrate that attaining the designated use is not feasible for at least one of six reasons:

1. Naturally occurring pollutant concentrations prevent the attainment of the use; or

2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or

3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or

4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use; or

5. Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or

6. Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

As part of the LTCP, elements of a UAA, including the six conditions presented above, will be used to determine if changes to the designated use is warranted, considering a potential adjustment to the designated use classification as appropriate. A UAA for Westchester Creek is attached hereto as Appendix D.

8.6.a Use Attainability Analysis Elements

The objectives of the CWA are to provide for the protection and propagation of fish, shellfish, wildlife, and recreation (CWA sect. 101(a)(2). Cost-effectively maximizing the water quality benefits associated with CSO reduction is a cornerstone of this LTCP. The 2012 CSO Consent Order Goal Statement stipulates that, in situations where the proposed alternatives presented in the LTCP will not achieve these objectives, the LTCP will include a UAA.

To simplify this process, DEP and DEC have developed a framework that outlines the steps taken under the LTCP in two possible scenarios:

- Waterbody meets WQ requirements. This may either be the existing WQ criteria (where primary contact is already designated) or assess for an upgrade (where the existing standard is not a primary contact WQ standard). In either case, a high-level assessment of the factors that define a given designated use is performed, and if the level of control required to meet this goal can be reasonably implemented, the State may make a change in designation.

- Waterbody does not meet WQ requirements. In this case, if a higher level of control is not feasible, the UAA must justify the shortcoming using at least one of the six criteria (see Section 8.6 above). For this LTCP, it is assumed that if 100 percent elimination of CSO sources does not result in attainment, the UAA would include factor number 3 at a minimum as justification (human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied, or would cause more environmental damage to correct than to leave in place).

8.6.b Fishable/Swimmable Waters

As discussed in Sections 2.0 and 6.0, municipal stormwater and direct drainage introduced through the urbanization of the Westchester Creek watershed contributes to bacteria levels in Westchester Creek to some extent based on model predictions. East River is also identified as a potential contributor to the bacteria loadings where its influence varies spatially and temporally. As noted in Table 6-9 of Section

6.0, stormwater discharges and direct drainage contribute a maximum summer monthly fecal coliform GM concentration of 25 cfu/100mL at Station WC2 whereas CSOs contribute 34 cfu/100 ml and East River contributes 3 cfu/100 ml. At the outer Bay location (E13), East River contribution becomes predominant, contributing a maximum summer month fecal coliform of 21 cfu/100ml whereas CSOs contributes only 1 cfu/100ml and stormwater contribution is none. Modeling component analyses for GM components for enterococci indicate similar observations and variation among sources temporally and spatially. As noted in Section 8.1, and in other previous sections, the goal of this LTCP is to identify appropriate CSO controls necessary to achieve waterbody-specific WQS, consistent with EPA's CSO policy and subsequent guidance. SA, SB, and SC classifications are fully supportive of the CWA. The recommended alternative summarized in Section 8.5 results in the following levels of attainment with fishable/swimmable criterion.

Water quality modeling analyses, conducted for Westchester Creek and summarized in Table 8-9, shows that Westchester Creek is predicted to comply with the Primary Contact WQ Criteria (Class SC) monthly fecal coliform criterion of 200 cfu/100mL 95 percent of the time at location WC3 in the 10-year simulation period. Compliance with the Future Primary Contact WQ Criteria for enterococci 30-day GM recreational season criterion of 35 cfu/100mL is predicted (Table 8-9) to be lower; 64 percent of the time at the head end, 87 percent of the time at location WC3 and 96% at E13 under the recommended plan conditions. Attainment of the associated STV values is much worse. As such, this inner portion of Westchester Creek would not comply with the Primary Contact WQ Criteria (Class SC) under the recommended plan conditions. As noted in Table 8-9, compliance with the Future Primary Contact WQ Criteria is predicted to be very low. Figure 8-12 shows the extension of the inner and outer areas of Westchester Creek as defined in this LTCP.

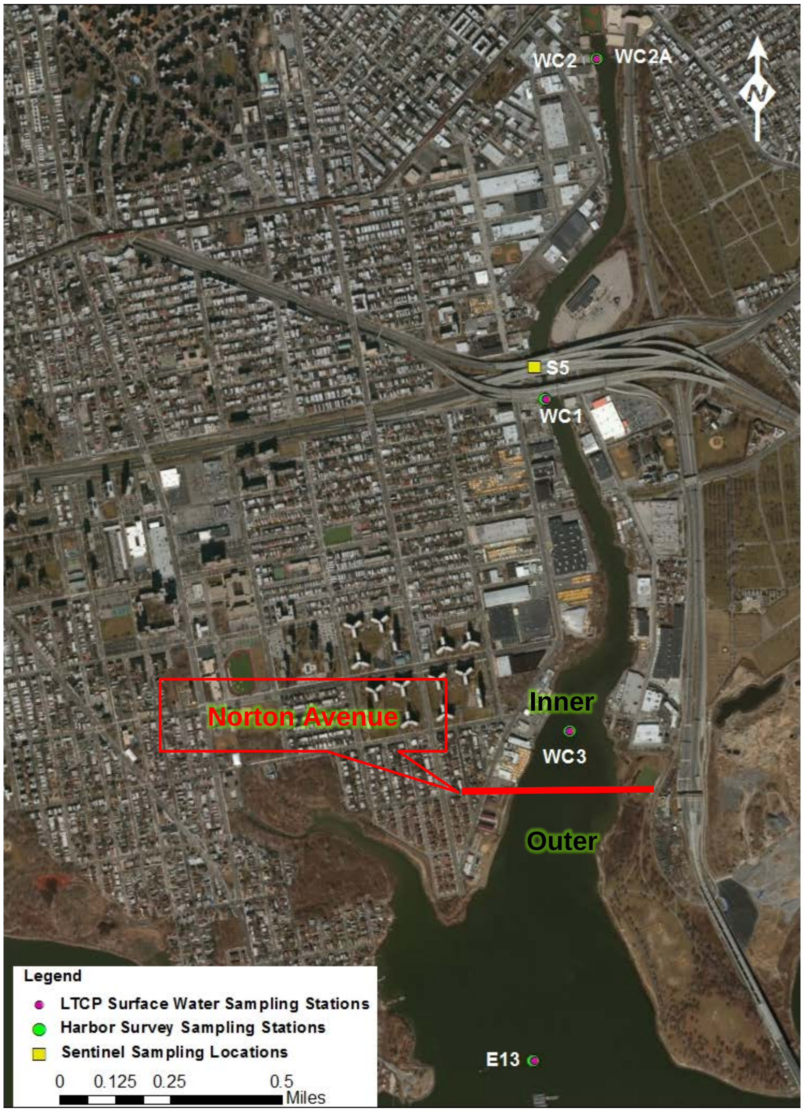


Figure 8-12. LTCP Delineation of Inner and Outer Areas of Westchester Creek

Conditions are predicted to be somewhat better downstream of Norton Avenue, between sampling location WC3 and the East River. In this portion of Westchester Creek, predictions indicate that compliance with the Primary Contact WQ Criteria (Class SC) monthly fecal coliform criterion of 200 cfu/100mL would be 99 percent of the time (annually – Table 8-8) and 100 percent of the time during the recreational season (Table 8-9). Within this area of the creek, compliance with the 30-day GM recreational season criterion of 35 cfu/100mL is predicted to be 96 percent of the time at station E13. Again Future Primary Contact STV Criterion could not be attained. These results indicate that this lower portion of Westchester Creek could potentially support Primary Contact WQ Criteria (Class SC).

8.6.c Assessment of Highest Attainable Use

The analyses contained herein, as noted above in Section 8.5.c and summarized in Table 8-9, indicate that the Primary Contact WQ Criteria (Class SC), is not projected to be attained 100 percent of the time annually within most of Westchester Creek with the recommended alternative. For the purpose of this

LTCP, attainment of the standards was calculated using a mathematical water quality model. As models are representations and simplifications of the actual receiving water conditions, they are not 100 percent accurate and provide only an estimate of the attainment with water quality criteria. As such, for this LTCP, a calculation of 95 percent attainment or higher is taken as fully attaining the criteria. A more accurate assessment of attainment will be performed once the regulator modifications and new parallel sewer constructed through the assessment of post construction monitoring data.

The modeling analysis assessed whether the recommended plan would improve water quality to allow for the Primary Contact WQ Criteria (Class SC), both annually and during the recreational season. As shown in Tables 8-8 and 8-9, fecal coliform bacteria levels approach the Class SC criterion but still do not attain the criterion in the inner portions of the Creek, although attainment is high during the recreational season. With construction of the WWFP recommendations and planned GI, Westchester Creek cannot fully attain a higher classification than the existing Class I through CSO controls alone in this area, without consideration of seasonal factors and site-specific criteria. This means that a UAA will be required for Westchester Creek. Table 8-10 summarizes the compliance for the identified plan.

However, Primary Contact WQ Criteria appears to be possible with consideration of site-specific criteria and a focus on the recreational season. As such, a UAA is not required for this outer area of the creek.

Table 8-10. Recommended Plan Compliance with Bacteria Water Quality Criteria

Location		Meets Existing WQ Criteria[1,2] (Class I)	Meets Primary Contact WQ Criteria[2] (Class SC)	Meets Future Primary Contact WQ Criteria[2]
Westchester Creek	Inner Area (Represented by Stations WC2,WC1 and WC3)	YES	NO	NO
	Outer Area (Represented by Station E13)	YES	YES	YES[(3)]

Note: YES indicates attainment is calculated to occur ≥ 95 percent of time.
NO indicates attainment is calculated to be less ≤ 95 percent of time.
(1) Annual attainment
(2) Recreational season attainment
(3) Calculated to comply 96 percent of the time with GM but STV values if adopted would not be attained.

8.7 Water Quality Goals

Based on the analyses of Westchester Creek, and the WQS associated with the designated uses, the following conclusions can be drawn:

Westchester Creek remains a highly productive Class I waterbody that can fully support existing uses, kayaking and wildlife propagation. Westchester Creek is in attainment with its current Class I classification. Furthermore, manmade features, shoreline access and industrial uses prevent the opportunity and feasibility of primary contact recreation in Westchester Creek.

This LTCP conducted assessments for attainment with the primary recreation water quality standard spatially and temporarily and identified site-specific targets that will allow DEP to continue to improve water quality over time. As such, the existing Primary Contact WQ Criteria of Class SC could be considered for the recreational period with site-specific targets, as further described below.

Future Water Quality

DEP is committed to improving water quality in Westchester Creek. Toward that end, DEP has identified site-specific water quality targets for Westchester Creek that will allow DEP to continue to improve water quality in the system over time. Site-specific targets are recommended for consideration to advance towards the numerical limits established, or under consideration by DEC, including SC pathogen standards and Future Primary Contact WQ Criteria consistent with the 2012 EPA RWQC. DEP notes that these targets are based on projections and may require adjustment based upon post-construction monitoring results. These targets are shown below.

- Recreational Season Site-Specific Targets: Uses of Westchester Creek generally oriented around the recreational season (May 1st – October 31st). However, some uses like kayaking extend further into the season on both ends. As such as a single annual target is recommended. DEP proposes that the following numerical site-specific targets be established for Westchester Creek for recreational season against which continual water quality improvements be measured:
    - Maximum rolling 30-day GM enterococci value of 300 cfu /100mL
    - Monthly fecal coliform GM concentration of 600 cfu/100mL

These water quality targets are summarized in Table 8-11 in comparison to the existing and primary contact pathogen WQ criteria. This table also provides a summary of the calculated pathogen criteria attainment. As noted in the table, the recommended plan results in a high level of attainment with these identified site-specific pathogen targets.

Also as noted above, DEP does not believe that adoption of the STV portions of the proposed 2012 EPA RWQC is warranted at this time. Analyses presented herein clearly show that adoption of STV values of 130 cfu/100mL is not attainable. Alternatively, DEP believes that if an STV value is required, it should be derived specifically for individual portions of Westchester Creek based on measured enterococci concentrations and their variability.

Table 8-11. Summary of Recommended Recreational Season Bacteria Water Quality Targets

Location	Existing WQ Criteria (Class I)	Primary Contact WQ Criteria (Class SC)	Site-specific Targets (cfu/100mL)	Attainment with Site-specific Targets (%)
Inner Creek	Fecal Coliform(1) ≤ 2000	Fecal Coliform(1) ≤ 200	Fecal Coliform ≤ 600	97
			Enterococci ≤ 300(2)	97
Outer Creek	Fecal Coliform(1) ≤ 2000	Fecal Coliform(1) ≤ 200	Fecal Coliform ≤ 200	99
			Enterococci ≤35(2)	96

Notes: (1) Monthly GM
(2) 30-day rolling average GM during recreation season

Although Westchester Creek could possibly be upgraded to Primary Contact WQ Criteria (limited primary contact), it will not be capable of supporting primary contact 100 percent of the time. Even with anticipated reductions in CSO overflows resulting from grey and green infrastructure, the water body could possibly be protective of primary contact should it occur as long as it did not occur during and following rainfall events. Toward that end, DEP has performed an analysis to assess the amount time following the end of rainfall required for Westchester Creek to recover and return to concentrations less than 1,000 cfu/100 mL fecal coliform and 130 cfu/100mL enterococci. The value 130 was used instead of 104 as recent EPA guidance indicates that the 104 value will no longer be relevant.

The analyses consisted of examining the water quality model calculated for outer Westchester Creek pathogen concentrations for recreation periods (May 1st to October 31st) abstracted from 10-years of model simulations. The time to return to 1,000 or 130 was then calculated for each storm with the various size categories and the median time after the end of rainfall was then calculated for each rainfall category.

The results of these analyses are summarized in Table 8-12 for Westchester Creek. As noted the duration of time within which pathogen concentrations are expected to be higher than NYS DOH considers safe for primary contact varies with location and with rainfall event size. Generally, a value of between 24 hours and 48 hours would be typical for the outer portion of Westchester Creek (E13) for storms with rainfall volumes of less than 1-inch.

Table 8-12. Time to Recover at Westchester Creek

Interval	WC2		WC1		WC3		E13	
	Fecal(1)	Entero(2)	Fecal(1)	Entero(2)	Fecal(1)	Entero(2)	Fecal	Entero(2)
<0.1	-	-	-	-	-	-	-	-
0.1 - 0.4	-	7.5	-	-	-	-	-	-
0.4 - 0.8	6	27	2	18.5	-	10.5	-	-
0.8 - 1.0	13	70	22.5	58	2.5	27	-	16
1.0 - 1.5	28	65.5	29	54	17	36	2.5	24
>1.5	56	73	52	69	41	55	19	37

Notes: (1) Threshold for Fecal coliform is 1000cfu/100ml
(2) Threshold for Enterococci is 130cfu/100ml

8.8 Recommended LTCP Elements to Meet Water Quality Goals

The LTCP elements described in this section are the culmination of efforts by DEP to attain existing WQ criteria. DEP recognizes that achieving water quality objectives requires more than the reduction of CSO discharges.

The Westchester Creek LTCP identified the following actions:

1. The LTCP includes a UAA that identifies feasible site-specific WQ targets based on the projected performance of the selected CSO controls. A post construction monitoring program will be initiated after the WWFP improvements are operational. Based upon the results of such monitoring, the site-specific WQ targets may need to be reviewed.

2. DEP will establish with the NYC Department of Health and Mental Hygiene through public notification a 24-hour wet weather advisory during the Recreational Season (May 1 to October 31), during which swimming and bathing would not be recommended in the outer Westchester Creek. The LTCP includes a recovery time analysis that can be used to establish the 24-hour wet weather advisory for public notification.

3. DEP will continue to implement the WWFP recommendations: Pugsley Creek parallel sewer and regulator modifications at CSO-29 and CSO-29A.

4. DEP will continue to implement the Green Infrastructure program.

5. DEP will include in the Bronx River LTCP an analysis to control floatables at the HP-011 at the East River to address the increased CSO volume resulting from the planned WWFP recommendations.

6. DEP will investigate as part of the Bronx River LTCP a new siphon targeting HP-011 at the East River. This analysis will investigate the AAOV resulting from the planned WWFP recommendations with goal of increasing CSO flow to the Hunts Point WWTP.

Section 9.0 presents the implementation of these actions.

When the WWFP construction is completed, CSO volumes are projected to be reduced from over 800 MG to 290 MG for the 2008 typical year. Several alternatives that captured a range of the remaining CSO discharge from the Westchester Creek outfalls were investigated. Based on water quality modeling, complete capture of CSO discharge to the waterbody would not result in the ability of Westchester Creek to attain the Primary Contact WQ Criteria (Class SC) pathogen quality and resulted in small improvements in water quality, despite substantial costs. Alternatives that controlled less than 100 percent of the CSO discharge would have even smaller effects on water quality. Therefore, DEP has determined that a reasonable approach moving forward is to complete the construction of the facilities recommended in the WWFP as well as the planned GI throughout the watershed and then to monitor pathogen levels, through the PCM and other ongoing programs, to determine the benefits of that work.

The water quality of Westchester Creek will be improved by the substantial reduction in CSO volume from the investments in grey and green infrastructure of over $100M in the next few years. Additional green or gray improvements are not identified at this time; however, DEP has identified the site-specific pathogen targets shown in Table 8-11 to continue to advance the improvements in Westchester Creek.

9.0 LONG-TERM CSO CONTROL PLAN IMPLEMENTATION

The evaluations performed for this Westchester Creek LTCP concluded that the recommendations being implemented by DEP as part of the 2011 WWFP, plus the planned GI penetration throughout the watershed as part of the citywide GI plan as incorporated into the LTCP program, will significantly improve the water quality of the waterbody. It is projected that Westchester Creek will meet and exceed its current water quality classification of I for bacteria. Further, analysis indicated that additional expenditures in grey infrastructure would not result in significant increases in the level of attainment with the Primary Contact WQ Criteria (SC) for bacteria. This is also true for the Future Primary Contact WQ Criteria. It is therefore recommended that DEP continue with implementation of the WWFP and GI projects, including PCM and other ongoing monitoring programs.

9.1 Adaptive Management (Phased Implementation)

Adaptive management, as defined by EPA, is the process by which new information about the characteristics of a watershed is incorporated into a watershed management plan. The process relies on establishing a monitoring program, evaluating monitoring data and trends and making adjustments or changes to the plan. In the case of this LTCP, DEP will continue to apply the principles of adaptive management based on its annual evaluation of PCM data which will be collected to optimize the operation and effectiveness once the planned LTCP components are constructed.

Another aspect of the LTCP's phased adaptive management deals with DEP's identification of site-specific water quality targets. Site-specific targets were identified for Westchester Creek in Sections 8.6 and 8.7 and are described in Section 9.7. The water quality of Westchester Creek will be monitored and compared with these site-specific targets as part of the LTCP implementation.

Finally, the findings from the Citywide LTCP, scheduled for a 2017 submittal to DEC, could have a bearing on Westchester Creek and possible post-LTCP CSO control measures. As noted in Section 8, the Westchester Creek alternatives would be reconsidered to determine if the capacity of the Hunts Point WWTP becomes fully utilized as a result of the Hutchinson River and Bronx River LTCPs. If capacity remains following these LTCPs, future planning for Westchester Creek could consider alternatives that would cost-effectively utilize that capacity.

9.2 Implementation Schedule

The implementation schedule for the Westchester Creek LTCP will be based on the planned grey infrastructure from the WWFP and the planned GI build-out. The completion dates of these LTCP components are listed in the CSO Order as follows:

1.	Weir Modifications	December 2019
2.	Pugsley Creek Parallel Sewer	December 2019
3.	GI Build-out	December 2030

9.3 Operation Plan/O&M

DEP is committed to effectively operating the Westchester Creek LTCP components as they are built-out during the implementation period.

9.4 Projected Water Quality Improvements

As previously noted, the construction and build-out of the LTCP components are expected to result in improved water quality in Westchester Creek and full attainment of the current Class I criterion for fecal coliform bacteria; the Class I DO criteria will not, however, be fully met.

9.5 Post Construction Monitoring Plan and Program Reassessment

As discussed in Section 4.0, a PCM program will be developed as part of the implementation of the LTCP. Specifically these include the WWFP components described in that section plus the build-out of the GI described in Section 5.0 which collectively comprises the LTCP Baseline Conditions of Section 6.0. Prior to the initiation of the PCM program, DEP will continue to perform its ongoing monitoring programs including Harbor Survey Monitoring and Sentinel Monitoring of the shoreline, the former being described in Section 4.0.

9.6 Consistency with Federal CSO Control Policy

The Westchester Creek LTCP was developed to comply with the requirements of the federal or EPA CSO Control Policy and associated guidance documents, and the CWA. The LTCP revealed that Westchester Creek currently attains the Class I fecal coliform criterion but cannot support the Primary Contact WQ Criteria classification (SC), even with 100 percent CSO control, within the full extension of the waterbody. It also showed, however, that Westchester Creek is not suitable for primary contact recreation due to several natural and manmade factors listed in the UAA discussion of Section 8.6. A UAA has therefore been prepared and is attached to this LTCP (see Appendix D).

9.6.a Affordability and Financial Capability

EPA has recognized the importance of taking a community's financial status into consideration, and in 1997, issued "Combined Sewer Overflows: Guidance for Financial Capability Assessment and Schedule Development." This financial capability guidance contains a two-phased assessment approach. Phase one examines affordability in terms of impacts to residential households. This analysis applies the residential indicator (RI), which examines the average cost of household water pollution costs (wastewater and stormwater) relative to a benchmark of 2 percent of service area-wide median household income (MHI). The results of this preliminary screening analysis are assessed by placing the community in one of three categories:

- Low economic impact: average wastewater bills are less than 1 percent of MHI.
- Mid-range economic impact: average wastewater bills are between 1 percent and 2 percent of MHI.
- Large economic impact: average wastewater bills are greater than 2 percent of MHI.

The second phase develops the Permittee Financial Capability Indicators (FCI), which examine several metrics related to the financial health and capabilities of the impacted community. The indicators are compared to national benchmarks and are used to generate a score that is the average of six economic indicators, including bond rating, net debt, MHI, local unemployment, property tax burden, and property tax collection rate within a service area. Lower FCI scores imply weaker economic conditions and thus the increased likelihood that additional controls would cause substantial economic impact.

The results of the RI and the Permittee Financial Capability Indicators are then combined in a Financial Capability Matrix to give an overall assessment of the permittee's financial capability. The result of this combined assessment can be used to establish an appropriate CSO control implementation schedule.

Importantly, EPA recognizes that the procedures set out in its Guidance are not the only appropriate analyses to evaluate a community's ability to comply with Clean Water Act requirements. EPA's 2001 "Guidance: Coordinating CSO Long-term Planning with Water Quality Standards Reviews" emphasizes this by stating:

> *The 1997 Guidance "identifies the analyses states may use to support this determination [substantial and widespread impact] for water pollution control projects, including CSO LTCPs. States may also use alternative analyses and criteria to support this determination, provided they explain the basis for these alternative analyses and/or criteria* (U.S. EPA, 2001, p. 31,).

Likewise, EPA has recognized that its RI and FCI metrics are not the sole socioeconomic basis for considering an appropriate CSO compliance schedule. EPA's 1997 Guidance recognizes that there may be other important factors in determining an appropriate compliance schedule for a community, and contains the following statement that authorizes communities to submit information beyond that which is contained in the guidance:

> *It must be emphasized that the financial indicators found in this guidance might not present the most complete picture of a permittee's financial capability to fund the CSO controls. … Since flexibility is an important aspect of the CSO Policy, permittees are encouraged to submit any additional documentation that would create a more accurate and complete picture of their financial capability* (U.S. EPA, 1997, p. 7,).

Furthermore, EPA in 2012 released its "Integrated Municipal Stormwater and Wastewater Planning Approach Framework," which is supportive of a flexible approach to prioritizing projects with the greatest water quality benefits and the use of innovative approaches like green infrastructure (U.S. EPA, 2012). EPA, in conversation with communities, the U.S. Conference of Mayors, and the National Association of Clean Water Agencies, is also preparing a Financial Capability Framework which clarifies and explains the flexibility within their CSO guidance.

This section of this Long Term Control Plan will begin to explore affordability and financial capability concerns as outlined in the 1997 and 2001 Guidance documents This section will also explore additional socioeconomic indicators that reflect affordability concerns within the New York City context. Since DEP is tasked with preparing 10 Long-Term Control Plans for individual waterbodies and 1 Long-Term Control Plan for the East River and Open Waters, we expect that a complete picture of the effect of the comprehensive CSO Program would be available in 2017 to coincide with the schedule for completion of all the plans.

9.6.a.1 Background on DEP Spending

As the largest water and wastewater utility in the nation, DEP provides over a billion gallons of drinking water daily to more than 8 million NYC residents, visitors and commuters as well as one million upstate customers. DEP maintains over 2,000 square miles of watershed comprised of 19 reservoirs, 3 controlled lakes, several aqueducts, and 6,600 miles of water mains and distribution pipes. DEP also collects and treats wastewater. Averaged across the year, the system treats approximately 1.3 billion gallons of wastewater per day collected through 7,400 miles of sewers, 95 pump stations and 14 in-city treatment plants. In wet weather, the system can treat up to 3.5 billion gallons per day of combined storm and sanitary flow. In addition to the treatment plants, DEP has four CSO storage facilities. DEP recently launched a $2.4 billion green infrastructure program, of which $1.5 billion will be funded by DEP, and the remainder will be funded through private partnerships.

9.6.a.1.1 Currently Budgeted and Recent Completed Mandated Programs

As shown in Figure 9-1, from Fiscal Year (FY) 2002 through FY 2013, 62 percent of DEP's capital spending was for wastewater and water mandates. Many projects have been important investments that safe-guard our water supply and improve the water quality of our receiving waters in the Harbor and its estuaries. These mandates and associated programs are described below.

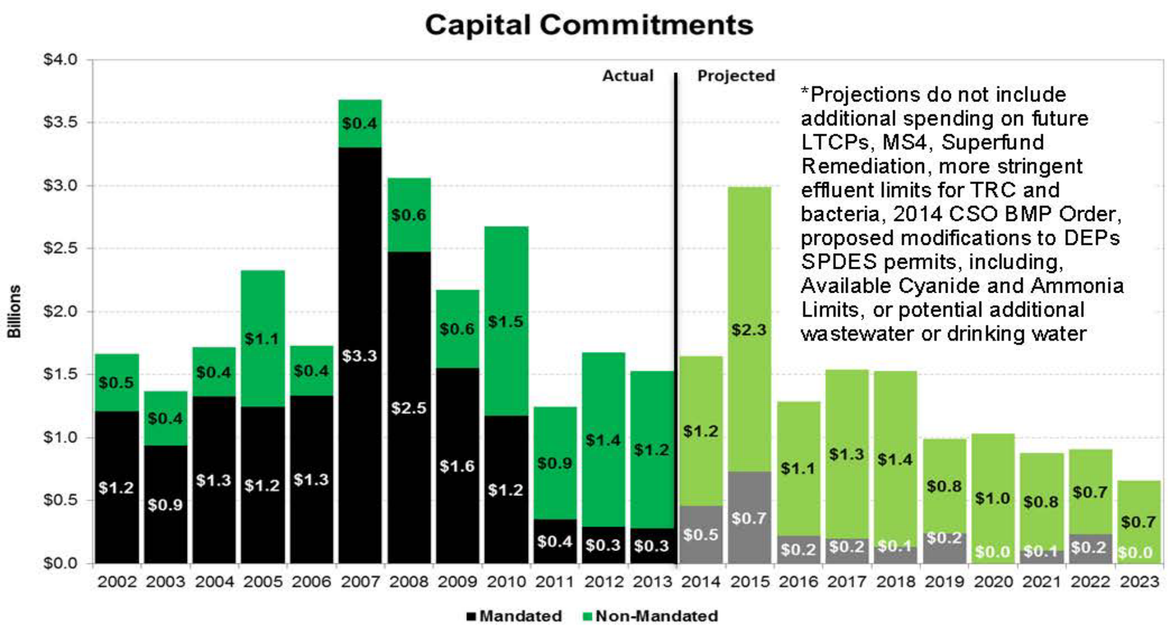


Figure 9-1. Historical and Projected Capital Commitments

Wastewater Mandated Programs

The following wastewater programs and projects have been initiated to comply with Federal and state laws and permits:

- CSO abatement and stormwater management programs

DEP has initiated a number of projects to reduce CSOs and eliminate excess infiltration and inflow of groundwater and stormwater into the wastewater system. These projects include: construction of CSO abatement facilities, optimization of the wastewater system to reduce the volume of CSO discharge, controls to prevent debris that enters the combined wastewater system from being discharged, dredging of CSO sediments that contribute to low dissolved oxygen (DO) and poor aesthetic conditions, and other water quality based enhancements to enable attainment of the WQS. These initiatives impact both the capital investments that must be made by DEP as well as operations and maintenance (O&M) expenses. Historical commitments on and those currently in DEP's 10 year capital plan for CSOs are estimated to be about $3.3 billion. FY13 annual operating costs for stormwater expenses are estimated to have been about $63M. DEP will be required to make additional investments in stormwater controls pursuant to MS4 requirements.

- Biological nutrient removal

  In 2006, NYC entered into a Consent Judgment (Judgment) with the DEC, which required DEP to upgrade five water pollution control plants by 2017 in order to reduce nitrogen discharges and comply with draft State Pollutant Discharge Elimination System nitrogen limits. Pursuant to a modification and amendment to the Judgment, DEP has agreed to upgrade three additional plants and to install additional nitrogen controls at one of the plants, which was included in the original Judgment. As in the case of CSOs and stormwater, these initiatives include capital investments made by DEP ($280 million to date and an additional $123M in the 10-year capital plan) as well as O&M expenses (chemicals alone in FY13 amounted to $2.5M),

- Wastewater Treatment Plant Upgrades

  The Newtown Creek WWTP has been upgraded to secondary treatment pursuant to the terms of a Consent Judgment with DEC. The total cost of the upgrade is estimated to be $5 billion. In 2011, DEP certified that the Newtown Creek plant met the effluent discharge requirements of the Clean Water Act, bringing all 14 plants into compliance with the secondary treatment requirements.

Drinking Water Mandated Programs

Under the federal Safe Drinking Water Act and the New York State Sanitary Code, water suppliers are required to either filter their surface water supplies or obtain and comply with a determination from EPA that allows them to avoid filtration. In addition, EPA has promulgated a rule known as Long Term 2 (LT2) that requires that unfiltered water supplies receive a second level of pathogen treatment [e.g., ultraviolet (UV) treatment in addition to chlorination] by April 2012. LT2 also requires water suppliers to cover or treat water from storage water reservoirs. The following DEP projects have been undertaken in response to these mandates:

- Croton Watershed- Croton Water Treatment Plant

  Historically, NYC's water has not been filtered because of its good quality and long retention times in reservoirs. However, more stringent federal standards relating to surface water treatment have resulted in a federal court consent decree (the Croton Water Treatment Plant Consent Decree), which mandates the construction of a full-scale water treatment facility to filter water from NYC's Croton watershed. Construction on the Croton Water Treatment Plant began in late 2004. DEP estimates that the facility will begin operating in 2015. To date, DEP has committed roughly $3.2 billion in capital costs. During start-up and after commencement of operations, DEP will also incur annual expenses for labor, power, chemicals, and other costs associated with plant O&M. For FY15, O&M costs are estimated to be about $23 million.

- Catskill/Delaware Watershed- Filtration Avoidance Determination

  Since 1993, DEP has been operating under a series of Filtration Avoidance Determinations (FADs), which allow the City to avoid filtering surface water from the Catskill and Delaware systems. In 2007, EPA issued a new FAD (2007 FAD), which requires the City to take certain actions over a 10-year period to protect the Catskill and Delaware water supplies. In 2014, the New York State Department of Health issued mid-term revisions to the 2007 FAD. Additional funding has been added to the CIP through 2017 to support these mid-term FAD revisions. DEP has committed about $1.5 billion to date and anticipates that expenditures for the current FAD will amount to $200M.

- UV Disinfection Facility

  In January 2007, DEP entered into an Administrative Order on Consent (UV Order) with EPA pursuant to EPA's authority under LT2, requiring DEP to construct a UV facility by 2012. Since late 2012, water from the Catskill and Delaware watersheds has been treated at DEP's new UV disinfection facility in order to achieve Cryptosporidium inactivation. To date, capital costs committed to the project amount to $1.6 billion. DEP is also now incurring annual expenses for property taxes, labor, power, and other costs related to plant O&M. FY13 O&M costs were $20.8M including taxes.

9.6.a.2 Future System Investment

Over the next nine years, the percentage of already identified mandated project costs in the CIP is anticipated to decrease, but DEP will be funding critical but non-mandated state of good repair projects and other projects needed to maintain NYC's infrastructure to deliver clean water and treat wastewater. Moreover, DEP anticipates that there will be additional mandated investments as a result of Municipal Separate Stormwater System (MS4) compliance, proposed modifications to DEP's in-city WWTP SPDES permits, Superfund remediation, CSO LTCPs, the 2014 CSO Best Management Practices Consent Order. It is also possible that DEP will be required to invest in an expensive cover for Hillview Reservoir, as well as other additional wastewater and drinking water mandates. Additional detail for anticipated future mandated and non-mandated wastewater programs is provided below, with the exception of CSO LTCPs which are presented in Section 9.6.f.

Potential or Unbudgeted Wastewater Regulations

- MS4 Permit Compliance

  Currently, DEP's separate stormwater system is regulated through DEP's 14 WWTP-specific SPDES permits. On February 5, 2014, DEC issued a draft MS4 permit that will cover MS4 separate stormwater systems for all City agencies. Under the proposed MS4 permit, the permittee will be NYC.

DEP will be responsible for developing a stormwater management program plan for NYC to facilitate compliance with the proposed permit terms as required by DEC. This plan will also develop the legal authority to implement and enforce the stormwater management program as well as develop enforcement and tracking measures and provide adequate resources to comply with the MS4 permit. Some of the potential permit conditions identified through this plan may result in increased costs to DEP and those costs will be more clearly defined upon completion of the plan. The permit also requires the NYC to conduct fiscal analysis of the capital and O&M expenditures necessary to meet the requirements of this permit, including any development, implementation and enforcement activities required, within three years of the Effective Permit date.

The draft MS4 permit compliance costs are yet to be estimated. DEP's annual historic stormwater capital and O&M costs have averaged $131.6 million. However, given the more stringent draft permit requirements, future MS4 compliance costs are anticipated to be significantly higher than DEP's current stormwater program costs. The future compliance costs will also be shared by other NYC departments that are responsible for managing stormwater. Total compliance costs for stormwater programs in other major urban areas, such as Philadelphia and Washington DC, are projected to be $2.4 billion and, $2.6 billion, respectively, which will result in extensive annual expenditures. Each of these programs contains both grey and green infrastructure components, similar to those anticipated for NYC, to meet mandated requirements. The geographic area covered by New York City's MS4 program is larger than the MS4 area in either Philadelphia or Washington DC. New York City's MS4 area is over 131 square miles, while Philadelphia's MS4 area is just over 78 square miles, and Washington DC's area is even less at approximately 31 square miles, or about 25 percent of that in New York City.

- Draft SPDES Permit Compliance

  In June 2013, NYSDEC issued draft SPDES permits which, if finalized, will have a substantial impact on DEP's Total Residual Chlorine (TRC) program and set more stringent ammonia and available cyanide limits. These proposed modifications include requirements that DEP:

  – Perform a degradation study to evaluate the degradation of TRC from the chlorine contact tanks to the edge of the designated mixing zone for comparison to the water-quality-based effluent limit and standard. The scope of work for this study is required within six months of the effective date of the SPDES permit, and the study must be completed 18 months after the approval of the scope of work. Based upon verbal discussions with DEC, DEP believes that this study may result in the elimination of the 0.4 mg/l uptake credit previously included in the calculation of TRC limits thereby decreasing the effective TRC limits by 0.4 mg/l at every plant.

  – Comply with new unionized ammonia limits. These proposed limits will, at some plants, potentially interfere with the chlorination process, particularly at 26th Ward and Jamaica.

  – Monitor for available cyanide and ultimately comply with a final effluent limit for available cyanide. Available cyanide can be a byproduct of the chlorination process.

  – DEC has also advised DEP that fecal coliform, the parameter that has been historically used to evaluate pathogen kills and chlorination performance/control will be changing to enterococcus. This change will likely be incorporated in the next round of SPDES permits scheduled in the next five years. Enterococcus has been shown to be harder to kill with chlorine and may require process changes to disinfection that would eliminate the option of adding de-chlorination after the existing chlorination process.

The potential future costs for these programs have yet to be determined. Preliminary compliance costs for TRC control and ammonia control are estimated to be up to $560M (million) and $840M, respectively.

- CSO Best Management Practices Order

On May 8, 2014, DEC and DEP entered into an agreement for the monitoring of CSO compliance, reporting requirements for bypasses, and notification of equipment out of service at the WWTP during rain events. The 2014 CSO BMP Order incorporates, expands, and supersedes the 2010 CSO BMP Order by requiring DEP to install new monitoring equipment at identified key regulators and outfalls and to assess compliance with requirements to "Maximize Flow to the WWTP". The costs for compliance for this Order have not yet been determined, but DEP expects this program to have significant capital costs as well as expense costs.

- Superfund Remediation

There are currently three Superfund sites in NYC, at various stages of investigation. The Gowanus Canal Remedial Investigation/Feasibility Study (RI/FS) is complete, and Remedial Design work will take place in the next three to five years. The Newtown Creek RI/FS completion is anticipated for 2018, and the Former Wolff-Alport Chemical Corporation has only recently been listed as a Superfund site.

DEP's ongoing costs for these projects are estimated at about $50-60M for the next ten years, not including design or construction costs for the Gowanus Canal. EPA's selected remedy for the Gowanus Canal requires that NYC build two combined sewage overflow retention tanks. While the EPA estimated cost is $78M, the DEP estimate based on actual construction experience in NYC is $380-760M for construction, with an additional $40-80M for design. Potential alternatives to the EPA selected remedy will be evaluated during the Gowanus LTCP process. Similar Superfund mandated CSO controls at Newtown Creek could add costs of $1 to 2 billion.

Potential, Unbudgeted Drinking Water Regulation

- Hillview Reservoir Cover

LT2 also mandates that water from uncovered storage facilities (including DEP's Hillview Reservoir) be treated or that the reservoir be covered. DEP has entered into an Administrative Order with the New York State Department of Health (NYSDOH) and an Administrative Order with EPA, which mandate NYC to begin work on a reservoir cover by the end of 2018. In August 2011, EPA announced that it would review LT2 and its requirement to cover uncovered finished storage reservoirs such as Hillview. DEP has spent significant funds analyzing water quality, engineering options, and other matters relating to the Hillview Reservoir. Potential costs affiliated with construction are estimated to be on the order of $1.6 billion.

Other: State of Good Repair Projects and Sustainability/Resiliency Initiatives

Wastewater Projects

- Climate Resiliency

  In October 2013, on the first anniversary of Hurricane Sandy, DEP released the NYC Wastewater Resiliency Plan, the nation's most detailed and comprehensive assessment of the risks that climate change poses to a wastewater collection and treatment system. The groundbreaking study, initiated in 2011 and expanded after Hurricane Sandy, was based on an asset-by-asset analysis of the risks from storm surge under new flood maps at all 14 treatment plants and 58 of NYC's pumping stations, representing more than $1 billion in infrastructure.

  DEP estimates to spend $447M in cost-effective upgrades at these facilities to protect valuable equipment and minimize disruptions to critical services during future storms. It is estimated that investing in these protective measures today will help protect this infrastructure from over $2 billion in repeated flooding losses over the next 50 years. DEP is currently pursuing funding through the EPA State Revolving Fund Storm Mitigation Loan Program.

  DEP will coordinate this work with the broader coastal protection initiatives, such as engineered barriers and wetlands, described in the 2013 report, "A Stronger, More Resilient New York," and continue to implement the energy, drinking water, and drainage strategies identified in the report to mitigate the impacts of future extreme events and climate change. This includes ongoing efforts to reduce CSOs with green infrastructure as part of LTCPs and build-out of high level storm sewers that reduce both flooding and CSOs. It also includes build-out of storm sewers in areas of Queens with limited drainage and continued investments and build-out of the Bluebelt system.

- Energy projects at WWTPs

  The City's blueprint for sustainability, *PlaNYC 2030: A Greener, Greater New York*, set a goal of reducing the City's greenhouse gases (GHG) emissions from 2006 levels by 30 percent by 2017. This goal was codified in 2008 under Local Law 22. In order to meet the PlaNYC goal, DEP is working to reduce energy consumption and GHG emissions through: reduction of fugitive methane emissions, investment in cost-effective, clean energy projects, and energy efficiency improvements.

  Fugitive methane emissions from wastewater treatment plants currently account for approximately 170,000 metric tons (MT) of carbon emissions per year and 30% of DEP's overall emissions. To reduce GHG emissions and to increase on-site, clean energy generation, DEP has set a target of 60 percent beneficial use of the biogas produced by 2017. Recent investments by DEP to repair leaks and upgrade emissions control equipment have already resulted in a 30 percent reduction of methane emissions since a peak in 2009. Going forward, DEP has approximately $500 million allocated in its capital improvement plan to make additional system repairs to flares, digester domes, and digester gas piping, in order to maximize capture of fugitive emissions for beneficial use or flaring.

A 12 megawatt cogeneration system is currently in design for the North River WWTP and estimated to be in operation in Spring 2019. This project will replace 10 direct-drive combustion engines, which are over 25 years old and use fuel oil, with five new gas engines enhancing the plant's operational flexibility, reliability, and resiliency. The cogeneration system will produce enough energy to meet the plant's base electrical demand and the thermal demand from the treatment process and building heat, in addition to meeting all of the plants emergency power requirements. The project is taking a holistic approach and includes: (1) improvements to the solids handling process to increase biogas production and reduce treatment, transportation and disposal costs; (2) optimization of biogas usage through treatment and balancing improvements; and (3) flood proofing the facility to the latest FEMA 100-yr flood elevations plus 32 inches to account for sea level rise. The cogeneration system will double the use of anaerobic digester gas produced on-site; eliminate fuel oil use, and off-set utility electricity use, which will reduce carbon emissions by over 10,000 metric tons per year, the equivalent of removing ~2,000 vehicles from the road. The total project cost is estimated at $212M. DEP is also initiating an investment-grade feasibility study to evaluate the installation of cogeneration at the Wards Island WWTP, the City's second largest treatment plant.

To reduce energy use and increase energy efficiency, DEP has completed energy audits at all 14 in-city wastewater treatment plants (WWTPs). Close to 150 energy conservation measures (ECMs) relating to operational and equipment improvements to aeration, boilers, dewatering, digesters, HVAC, electrical, thickening and main sewage pumping systems have been identified and accepted for implementation. Energy reductions from these ECMs have the potential to reduce greenhouse gas emissions by over 160,000 MT of carbon emissions at an approximate cost of $140M. DEP is developing implementation plans for these measures.

Water Projects

- Water for the Future

In 2011, DEP unveiled Water for the Future: a comprehensive program to permanently repair the leaks in the Delaware Aqueduct, which supplies half of New York's drinking water. Based on a 10-year investigation and more than $200M of preparatory construction work, DEP is currently designing a bypass for a section of the Delaware Aqueduct in Roseton and internal repairs for a tunnel section in Wawarsing. Since DEP must shut down the Aqueduct when it is ready to connect the bypass tunnel, DEP is working on projects that will supplement the City's drinking water supply during the shutdown, such as developing the groundwater aquifers in Jamaica, Queens, and implementing demand reduction initiatives, such as offering a toilet replacement program. Construction of the shafts for the bypass tunnel is underway, and the project will culminate with the connection of the bypass tunnel in 2021. The cost for this project is estimated to be about $1.5 billion.

- Gilboa Dam

DEP is currently investing in a major rehabilitation project at Gilboa Dam at Schoharie Reservoir. Reconstruction of the dam is the largest public works project in Schoharie County, and one of the largest in the entire Catskills and This project is estimated to cost roughly $ 440M.

As shown in Figure 9-2, increases in capital expenditures have resulted in increased debt. While confirmed expenditures may be on the decline over the next few years, debt service continues to be on the rise in future years, occupying a large percentage of DEP's operating budget (approximately 45 percent in FY15).

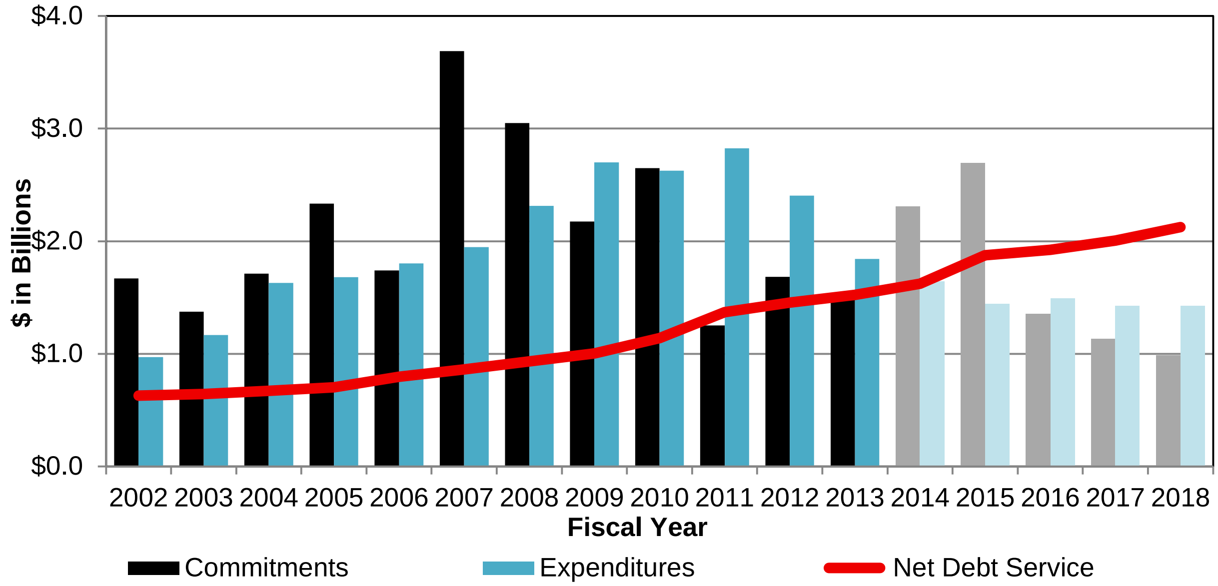


Figure 9-2. Past Costs and Debt Service

9.6.b Background on History of DEP Water and Sewer Rates

The NYC Water Board is responsible for setting water and wastewater rates sufficient to cover the costs of operating NYC's water supply and wastewater systems (the "System"). Water supply costs include those associated with water treatment, transmission, distribution, and maintaining a state of good repair. Wastewater service costs include those associated with wastewater conveyance and treatment, as well as stormwater service, and maintaining a state of good repair. The NYC Municipal Water Finance Authority ("MWFA") issues revenue bonds to finance NYC's water and wastewater capital programs, and the costs associated with debt service consume a significant portion of the System revenues.

For FY15, most customers will be charged a uniform water rate of $0.49 per 100 gallons of water. Wastewater charges are levied at 159 percent of water charges ($0.79 per 100 gallons). There is a small percentage of properties that are billed a fixed rate. Under the Multifamily Conservation Program, some properties are billed at a fixed per-unit rate if they comply with certain conservation measures. Some nonprofit institutions are also granted exemption from water and wastewater charges on the condition that their consumption is metered and their consumption falls within specified consumption threshold levels. Select properties can also be granted exemption from wastewater charges (i.e., pay only for water services) if they can prove that they do not burden the wastewater system (e.g., they recycle wastewater for subsequent use onsite).

There are also currently a few programs that provide support and assistance for customers in financial distress. The Safety Net Referral Program uses an existing network of NYC agency and not-for-profit programs to help customers with financial counseling, low-cost loans, and legal services. The Water Debt Assistance Program (WDAP) provides temporary water debt relief for qualified property owners who are at risk of mortgage foreclosure. While water and wastewater charges are a lien on the property served, and NYC has the authority to sell these liens to a third party, or lienholder, in a process called a lien sale, DEP offers payment plans for customers who may have difficulty paying their entire bill at one time. The agency has undertaken an aggressive communications campaign to ensure customers know about these programs and any exclusions they may be qualified to receive, such as the Senior Citizens Homeowner's Exemption and the Disabled Homeowner's Exemption. DEP also just announced the creation of a Home Water Assistance Program (HWAP) to assist low-income homeowners. In this program, DEP will partner with the NYC Human Resources Administration (HRA), which administers the Federal Home Energy Assistance Program (HEAP), to identify homeowners who would be eligible to receive an annual credit on their DEP bill.

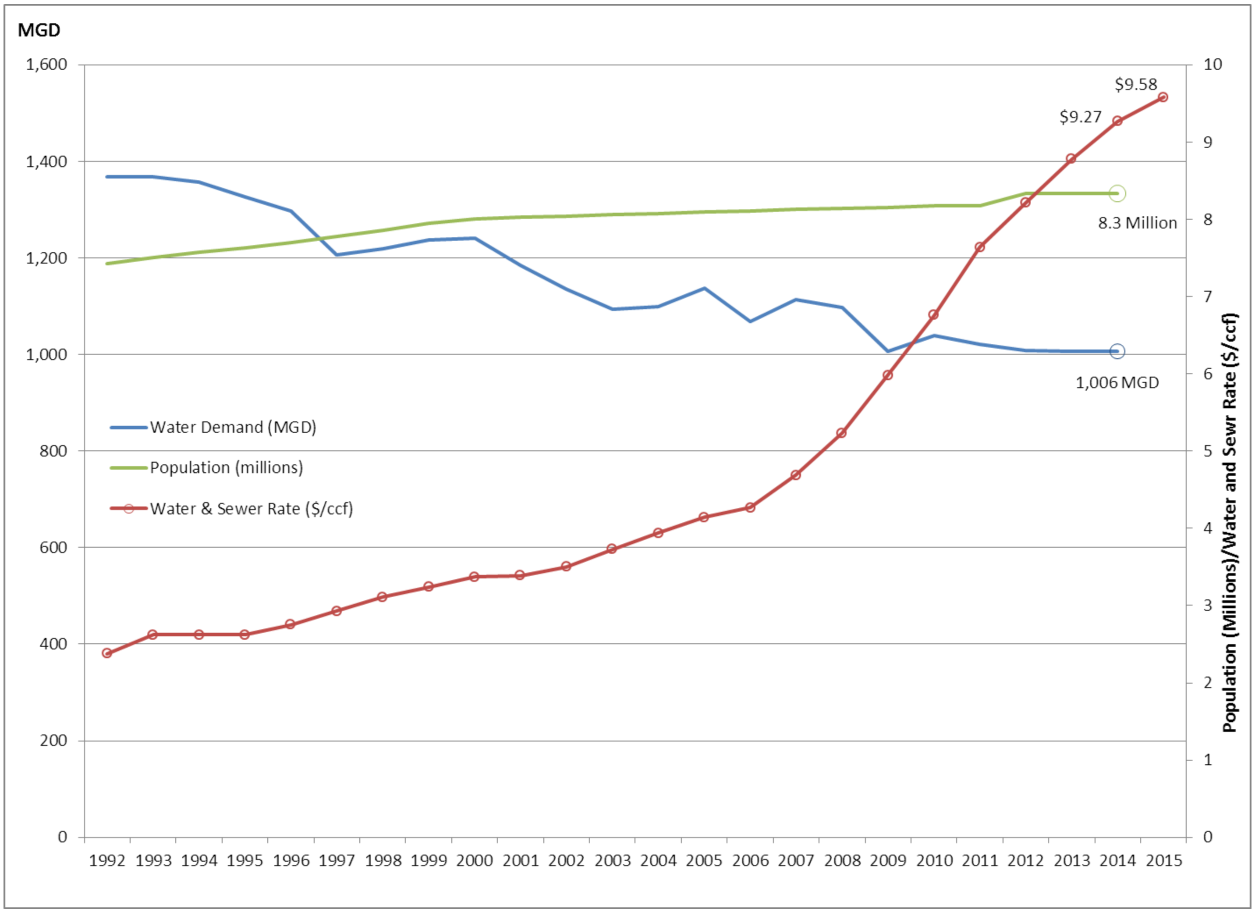


Figure 9-3. Population, Consumption Demand, and Water and Sewer Rates Over Time

Figure 9-3 shows how water and sewer rates have increased over time and how that compares with system demand and population. Despite a modest rise in population, water consumption rates have been falling since the 1990s due to metering and increases in water efficiency measures. At the same time, rates have been rising to meet the cost of service associated with DEP's capital commitments. DEP operations are funded almost entirely through rates paid by our customers with less than 2 percent of spending supported by federal and state assistance over the past 10 years. From FY 2002 to FY 2015, water and sewer rates have risen 173 percent. This is despite the fact that DEP has diligently tried to control operating costs. To mitigate rate increases, DEP has diligently managed operating expenses, and since 2011, the agency has had four budget cuts to be able to self-fund critical agency operating needs. Additionally, DEP has undertaken an agency-wide Operational Excellence (OpX) program to review and improve the efficiency of the agency's operations; to date, initiatives have been implemented that result in a recurring annual benefit of $80M.

9.6.c Residential Indicator

As discussed above, the first economic test as part of EPA's 1997 CSO guidance is the residential indicator (RI), which compares the average annual household water pollution control cost (wastewater and stormwater related charges) to the median household income of the service area. Average household wastewater cost can be estimated by approximating the residential share of wastewater treatment and dividing it by total number of households. Since the wastewater bill in NYC is a function of water consumption, average household costs are estimated based on consumption rates by household type in Table 9-1 below.

Table 9-1: Residential Water and Wastewater Costs Compared to MHI

	Average Annual Wastewater Bill ($/year)	Wastewater RI (Wastewater Bill/MHI*)	Total Water and Wastewater Bill ($/Year)	Water and Wastewater RI (Water and Wastewater Bill/MHI)
Single Family**	629	**1.14%**	1,025	**1.85%**
Multi-family***	409	**0.74%**	666	**1.20%**
Average Household Consumption******	534	**0.97%**	870	**1.57%**
MCP	599	**1.08%**	976	**1.76%**

*Note Latest MHI data is $50,895 based on 2012 ACS data, estimated MHI adjusted to present is $55,308
** Based on 80,000 gallons/year consumption and FY 2015 Rates
*** Based on 52,000 gallons/year consumption and FY 2015 Rates
**** Based on average consumption across all metered residential units of 67,890 gallons/year and FY 2015 rates

As shown in Table 9-1, the RI for wastewater costs varies between 0.74 percent of MHI to 1.14 percent of MHI depending on household type. Since DEP is a water and wastewater utility and the ratepayers receive one bill for both charges, it is also appropriate to look at the total water and wastewater bill in considering the RI, which varies from 1.2 percent to 1.76 percent of MHI.

Based on this initial screen, current wastewater costs pose a low to mid-range economic impact according to the 1997 CSO Guidance. However, there are several limitations to using MHI in the context of a city like New York. NYC has a large population and more than three million households. Even if a relatively small percentage of households were facing unaffordable water and wastewater bills, there would be a significant number of households experiencing this hardship. For example, more than 690,000 households in NYC (about 23 percent of NYC's total) earn less than $20,000 per year and have estimated wastewater costs well above 2 percent of their household income. Therefore, there are several other socioeconomic indicators to consider in assessing residential affordability, as described below.

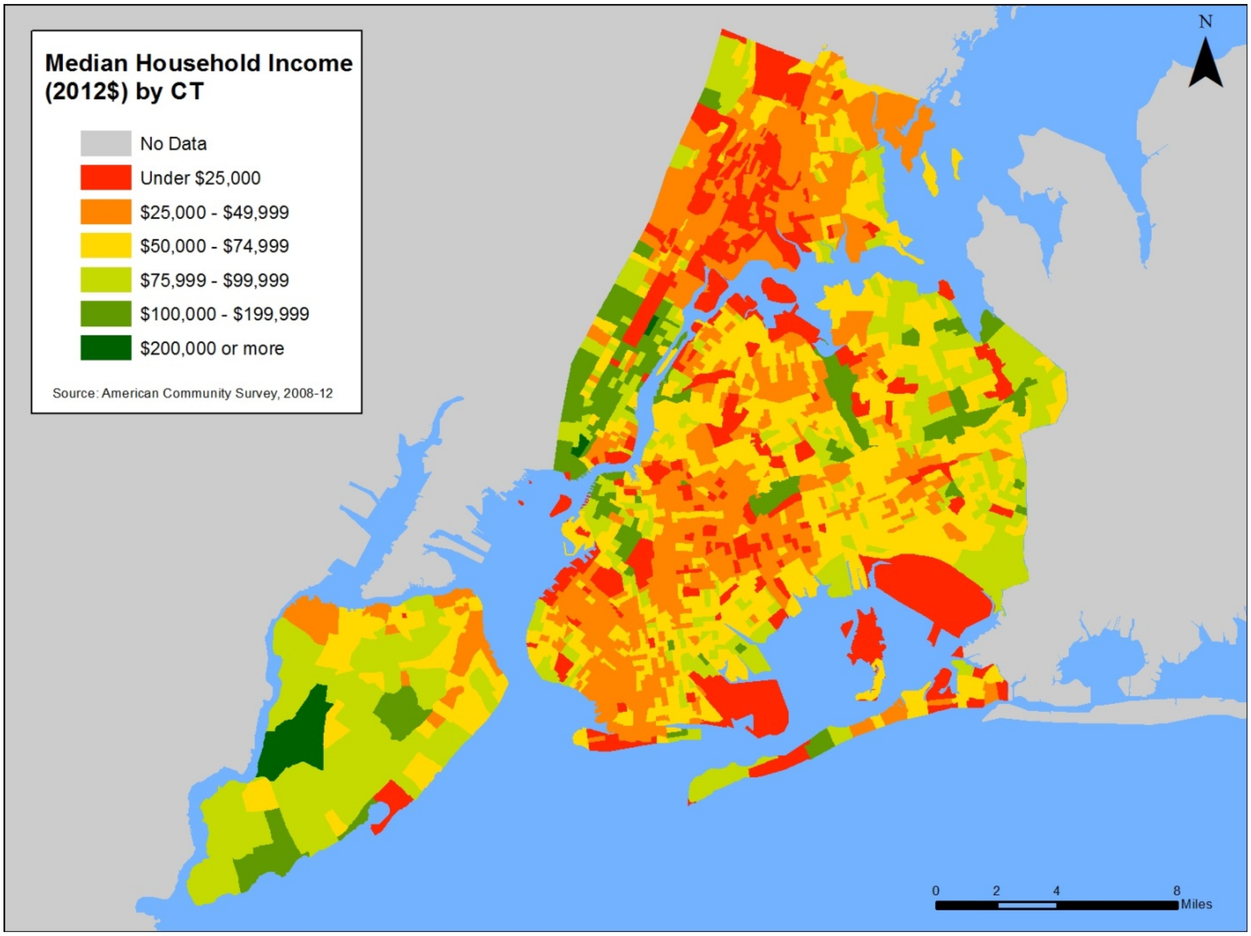
9.6.c.1 Income Levels

In 2012, the latest year for which Census data is available, the MHI in NYC was $50,895. As shown in Table 9-2, across the NYC boroughs, MHI ranged from $32,460 in the Bronx to $70,963 in Staten Island. Figure 9-4 shows that income levels also vary considerably across NYC neighborhoods, and there are several areas in NYC with high concentrations of low-income households.

Table 9-2. Median Household Income

Location	2012 (MHI)
United States	$51,371
New York City	$50,895
Bronx	$32,460
Brooklyn	$45,230
Manhattan	$67,099
Queens	$54,713
Staten Island	$70,963

Source: U.S. Census Bureau 2012 ACS 1-Year Estimates.



Source: U.S. Census Bureau 2008-2012 ACS 5-Year Estimates.

Figure 9-4. Median Household Income by Census Tract

As shown in Figure 9-5 on the following page, after 2008, MHI in NYC actually decreased for several years, and it has just begun to recover to the 2008 level. At this same time, costs continued to increase.

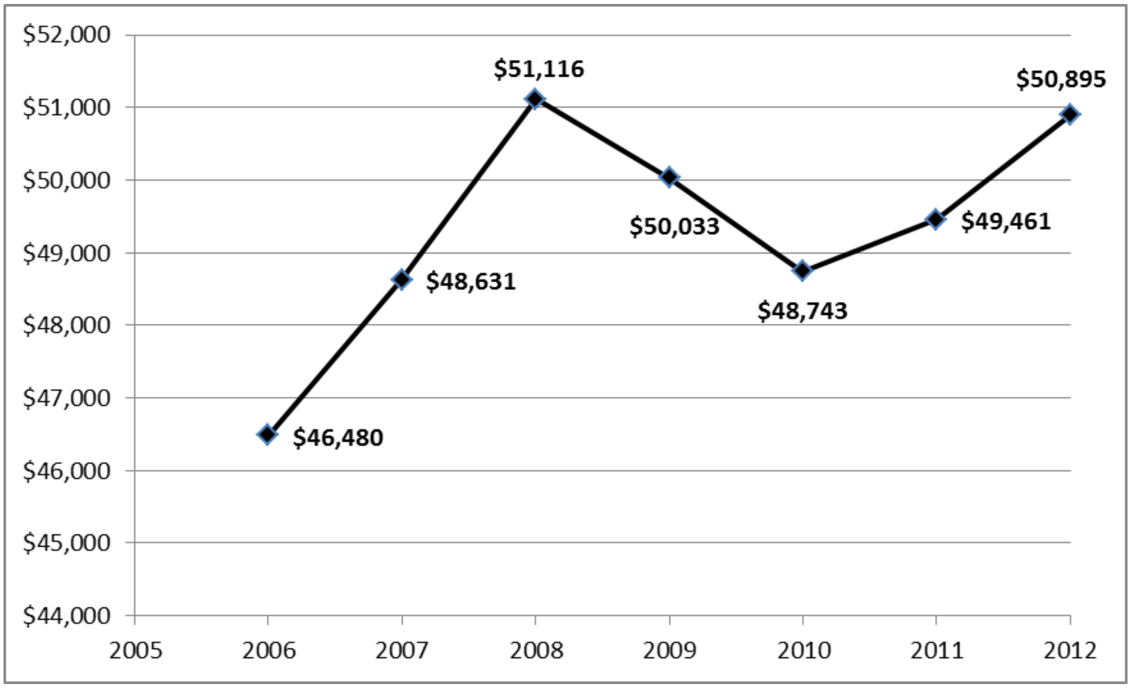


Figure 9-5. NYC Median Household Income Over Time

9.6.c.2 Income Distribution

NYC currently ranks as one of the most unequal cities in the United States in terms of income distribution. NYC's income distribution highlights the need to focus on metrics other than Citywide MHI in order to capture the disproportionate impact on households in the lowest income brackets. It is clear that MHI does not represent "the typical household" in NYC. As shown in Figure 9-6, incomes in NYC are not clustered around the median, but rather there are greater percentages of households at both ends of the economic spectrum. Also, the percentage of the population with middle-class incomes between $20,000 and $100,000 is 11.5 percent less in NYC than in the U.S. generally.

Source: U.S. Census Bureau 2012 ACS 1-Year Estimates.

Figure 9-6. Income Distribution for NYC and U.S.

9.6.c.3 Poverty Rates

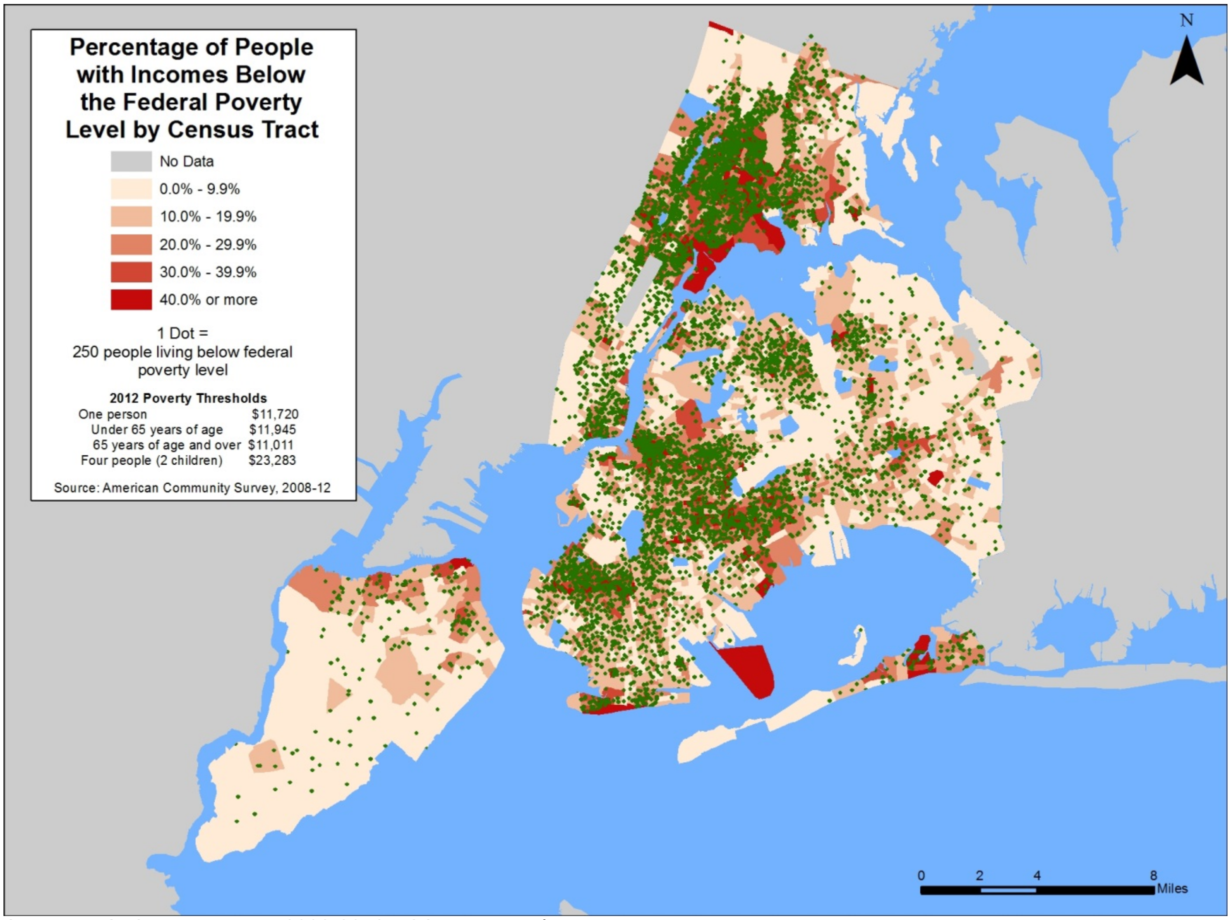
Based on the latest available census data, 21.2 percent of NYC residents are living below the federal poverty level (more than 1.7 million people, which is greater than the entire population of Philadelphia). This compares to a national poverty rate of 15.9 percent despite the similar MHI levels for NYC and the United States as a whole. As shown in Table 9-3, across the NYC boroughs, poverty rates vary from 11.6 percent in Staten Island to 31 percent in the Bronx.

Table 9-3: NYC Poverty Rates

Location	Percentage of Residents Living Below the Federal Poverty Level (%) (ACS 2012)
United States	15.9
New York City	21.2
Bronx	31.0
Brooklyn	24.3
Manhattan	17.8
Queens	16.2
Staten Island	11.6

Figure 9-7 shows that poverty rates also vary across neighborhoods, with several areas in NYC having a relatively high concentration of people living below the federal poverty level. Each green dot represents

250 people living in poverty. While poverty levels are concentrated in some areas, there are pockets of poverty throughout NYC. An RI that relies on MHI alone fails to capture these other indicators of economic distress. Two cities with similar MHI could have varying levels of poverty.



Source: U.S. Census Bureau 2008-2012 ACS 5-Year Estimates.

Figure 9-7. Poverty Clusters and Rates in NYC

The New York City Center for Economic Opportunity (CEO) has reasoned that the official (federal) poverty rate does not provide an accurate measure of the number of households truly living in poverty conditions (CEO, 2011). This is especially relevant in NYC, where the cost of living is among the highest in the nation. According to CEO, federal poverty thresholds do not reflect current spending patterns, differences in the cost of living across the nation, or changes in the American standard of living (CEO, 2011). To provide a more accurate accounting of the percentage of NYC's population living in poverty, CEO developed an alternative poverty measure based on methodology developed by the National Academy of Sciences (NAS).

The NAS-based poverty threshold reflects the need for clothing, shelter, and utilities, as well as food (which is the sole basis for the official poverty threshold). The threshold is established by choosing a point in the distribution of expenditures for these items, plus a small multiplier to account for miscellaneous expenses such as personal care, household supplies, and non-work-related transportation. CEO adjusted the NAS-based threshold to account for the high cost of living in NYC.

In addition, the NAS-based income measure uses a more inclusive definition of resources available to households compared to the federal measure, which is based on pre-tax income. Along with cash income after taxes, it accounts for the cash-equivalent value of nutritional assistance and housing programs (i.e., food stamps and Section 8 housing vouchers). It also recognizes that many families face the costs of commuting to work, child care, and medical out-of-pocket expenses that reduce the income available to meet other needs. This spending is accounted for as deductions from income. Taken together, these adjustments create a level of disposable income that, for some low-income households, can be greater than pre-tax cash income.

CEO's methodology shows that in NYC, poverty-level incomes are actually much higher than those defined at the federal level, which results in a higher percentage of NYC residents living in poverty than is portrayed by national measures. As an example, in 2008, CEO's poverty threshold for a two-adult, two-child household was $30,419. The federal poverty threshold for the same type of household was $21,834. In that year, 22.0 percent of NYC residents (about 1.8 million people) were living below the CEO poverty threshold income; 18.7 percent were living below the federal poverty threshold.

More recently, the U.S. Census Bureau developed a Supplemental Poverty Measure (SPM), reflecting the same general approach as that of CEO. The federal SPM factors in some of the financial and other support offered to low-income households (e.g., housing subsidies, low-income home energy assistance) and also recognizes some nondiscretionary expenses that such households bear (e.g., taxes, out-of-pocket medical expenses, and geographic adjustments for differences in housing costs) (U.S. Census Bureau, 2012).

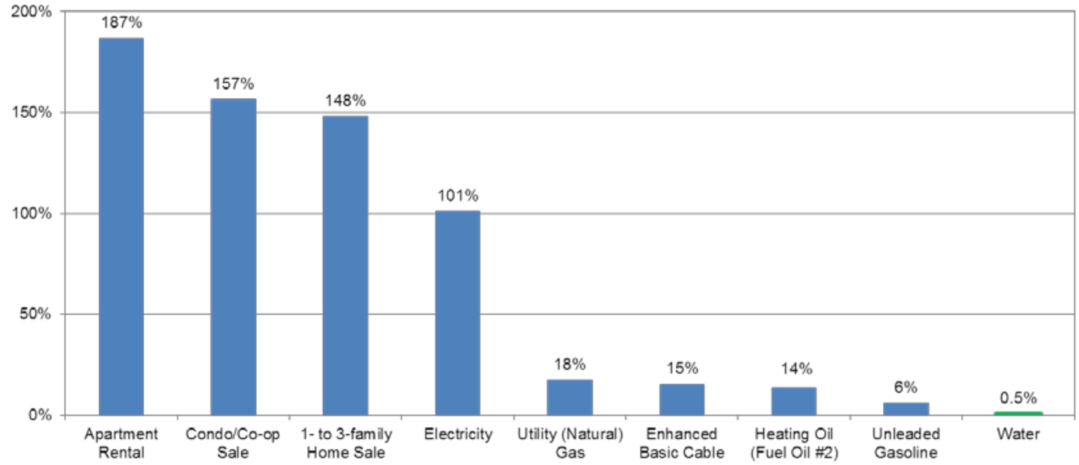
Nationwide, the SPM indicates that there are 5.35 percent more people in poverty than the official poverty threshold would indicate. The SPM also indicates that inside Metropolitan Statistical Areas the difference is 11.2 percent more people in poverty, and within "principal cities," the SPM-implied number of people in poverty is 5.94 percent higher than the official poverty measure indicates.

9.6.c.4 Unemployment Rates

In 2013 the annual average unemployment rate for NYC was 7.7 percent according to NYS Department of Labor, compared to a national average of 7.1 percent. Over the past two decades, NYC's unemployment rate has generally been significantly higher than the national average. Due to the recent recession, the national unemployment rate has increased significantly, moving closer to that of NYC.

9.6.c.5 Cost of Living and Housing Burden

NYC residents face relatively high costs for nondiscretionary items (e.g., housing, utilities) compared to individuals living almost anywhere else in the nation as shown in Figure 9-8. While water costs are comparable to other average of other U.S. cities, the housing burden is substantially higher.



	Apartment Rental	Condo/Co-op Sale	1- to 3-family Home Sale	Electricity	Utility (Natural) Gas	Enhanced Basic Cable	Heating Oil (Fuel Oil #2)	Unleaded Gasoline	Water
	(average monthly rent)	*(median per sale)*	*(median per sale)*	*(average per year; 6,000 kwh)*	*(average per therm)*	*(average per year)*	*(average per gallon)*	*(average per gallon)*	*(average per year; 80,000 gallons)*
NYC	$3,105	$500,000	$490,000	$1,556	$1.222	$854	$4.437	$3.524	$992
U.S. Cities	$1,083	$194,900	$197,400	$774	$1.040	$740	$3.904	$3.320	$987

Source: Wall Street Journal (Apartment Rental); The Real Estate Board of New York and National Association of Realtors (condo/coop and home sales); New York State Energy Research and Development Authority and Bureau of Labor Statistics (electricity and fuel oil #2); U.S. Bureau of Labor Statistics (natural gas and unleaded gasoline); FCC and company websites (enhanced basic cable); NYC FY 2014 Water and Wastewater Rate Survey (water)

Figure 9-8: Comparison of Costs Between NYC and other US Cities

Approximately 67 percent of all households in NYC are renter-occupied, compared to about 35 percent of households nationally. For most renter households in NYC, water and wastewater bills are included in the total rent payment. Rate increases may be passed on to the tenant in the form of a rental increase, or born by the landlord. In recent years, affordability concerns have been compounded by the fact that gross median rents have increased, while median renter income has declined as shown in Figure 9-9 (NYC Housing, 2014).

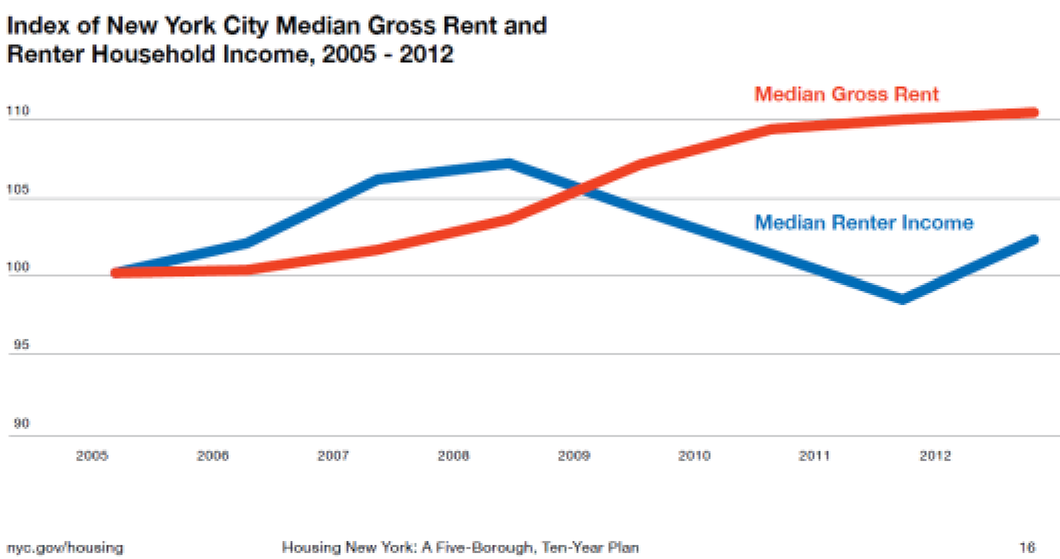


Figure 9-9: Median Gross Rent vs. Median Renter Income

Most government agencies consider housing costs of between 30 percent and 50 percent of household income to be a moderate burden in terms of affordability; costs greater than 50 percent of household income are considered a severe burden.

A review of Census data shows approximately 21 percent of NYC households (close to 645,000 households) spent between 30 percent and 50 percent of their income on housing, while about 25 percent (748,000 households) spent more than 50 percent. This compares to 20.0 percent of households nationally that spent between 30 percent and 50 percent of their income on housing and 16.2 percent of households nationally that spent more than 50 percent. This means that 46 percent of households in NYC versus 36.2 percent of households nationally spent more than 30 percent of their income on housing.

The New York City Housing Authority is responsible for 172,223 affordable housing units (9 percent of the total renter households in NYC). The agency is estimated to pay about $186M for water and wastewater in FY15. This total represents about 5.9 percent of their $3.14 billion operating budget. Even a small increase in rates could potentially impact the agency's ability to provide affordable housing and/or other programs.

9.6.d Financial Capability Indicators

The second phase of the 1997 CSO Guidance develops the Permittee Financial Capability Indicators (FCI), which are compared to national benchmarks and are used to generate a score that is the average of six economic indicators. Lower FCI scores imply weaker economic conditions. Table 9-4 summarizes the FCI scoring as presented in the 1997 CSO Guidance.

Table 9-4. Financial Capability Indicator Scoring

Financial Capability Metric	Strong (Score = 3)	Mid-range (Score = 2)	Weak (Score = 1)
Debt indicator			
Bond rating (GO bonds, revenue bonds)	AAA-A (S&P) Aaa-A (Moody's)	BBB (S&P) Baa (Moody's)	BB-D (S&P) Ba-C (Moody's)
Overall net debt as percentage of full market value	Below 2%	2–5%	Above 5%
Socioeconomic indicator			
Unemployment rate	More than 1 percentage point below the national average	+/- 1 percentage point of national average	More than 1 percentage point of national average
MHI	More than 25% above adjusted national MHI	+/- 25% of adjusted national MHI	More than 25% below adjusted national MHI
Financial management indicator			
Property tax revenues as percentage of FMPV	Below 2%	2–4%	Above 4%
Property tax revenue collection rate	Above 98%	94–98%	Below 94%

Table 9-5: NYC Financial Capability Indicator Score

Financial capability metric	Actual value	Score
Debt indicators		
Bond rating (GO bonds)	AA (S&P) AA (Fitch) Aa2 (Moody's)	Strong/3
Bond rating (Revenue bonds)	AAA (S&P) AA + (Fitch) Aaa-A (Moody's)	
Overall net debt as percentage of FMPV	4.5%	Midrange/2
GO		
Debt	$41.2 billion	
Market value	$917.7 billion	
Socioeconomic indicators		
Unemployment rate (2013 annual average)	0.6 percentage point above the national average	Mid-range/2
NYC unemployment rate	7.7%	
United States unemployment rate	7.1%	
MHI as percentage of national average	99%	Mid-range/2
Financial management indicators		
Property tax revenues as percentage of FMPV	2.2%	Mid-range/2
Property tax revenue collection rate	98.2%	Strong/3
Permittee Indicators Score		2.3

New York City's FCI score based on this test is presented in Table 9-5 and further described below.

9.6.d.1 Bond Rating

The first financial benchmark is NYC's bond rating for both general obligation (G.O.) and revenue bonds. A bond rating performs the isolated function of credit risk evaluation. While many factors go into the investment decision-making process, bond ratings can significantly affect the interest that the issuer is required to pay, and thus the cost of capital projects financed with bonds. According to EPA's criteria – based on the ratings NYC has received from all three rating agencies [Moody's, Standard & Poor's (S&P), and Fitch Ratings] – NYC's financing capability is considered "strong." Specifically, NYC's G.O. bonds are rated AA by S&P and Fitch and Aa2 by Moody's; and MWFA's General Resolution revenue bonds are rated AAA by S&P, AA+ by Fitch, and Aa1 by Moody's, while MWFA's Second General Resolution revenue bonds (under which most of the Authority's recent debt has been issues) are rated AA+ by S&P, AA+ by Fitch, and Aa2 by Moody's. This results in a "strong" rating for this category.

Nonetheless, NYC's G.O. rating and MWFA's revenue bond ratings are high due to prudent fiscal management, the legal structure of the System, and the Water Board's historical ability to raise water and wastewater rates. However, mandates over the last decade have significantly increased the leverage of the System, and future bond ratings could be impacted by further increases to debt beyond what is currently in forecast.

9.6.d.2 Net Debt as a Percentage of FMPV

The second financial benchmark measures NYC's outstanding debt as a percentage of FMPV. Currently NYC has over $41.6 billion in outstanding G.O. debt, and the FMPV within NYC is $917.7 billion. This results in a ratio of outstanding debt to FMPV of 4.5 percent and a "mid-range" rating for this indicator. If $30.6 billion of MWFA revenue bonds that support the System are included, net debt as a percentage of FMPV increases to 7.8 percent, which results in a "weak" rating for this indicator. Furthermore, if NYC's $37.5M of additional debt that is related to other services and infrastructure is included, the resulting ratio is 8.6 percent net debt as a percentage of FMPV.

9.6.d.3 Unemployment rate

For the unemployment benchmark, the 2013 annual average unemployment rates for NYC were compared to those for the United States. NYC's 2013 unemployment rate of 7.7 percent is 0.6 basis points (or 8.5 percent) higher than the national average of 7.1 percent. Based on EPA guidance, NYC's unemployment benchmark would be classified as "mid-range". However, it is important to note that over the past two decades, NYC's unemployment rate has generally been significantly higher than the national average. Due to the recession, the national unemployment is much closer to NYC's unemployment rate. Additionally, the unemployment rate measure identified in the 1997 financial guidance sets a relative comparison at a snapshot in time. It is difficult to predict whether the unemployment gap between the U.S. and NYC will once again widen, and it may be more relevant to look at longer term historical trends, of the service area.

9.6.d.4 MHI

The MHI benchmark compares the community's MHI to the national average. Using ACS 2012 single-year estimates, NYC's MHI is $50,895 and the nation's MHI is $51,371. Thus, NYC's MHI is 99 percent of the national MHI, resulting in a "mid-range" rating for this indicator. However, as discussed above in this section, MHI does not provide an adequate measure of affordability or financial capability. MHI is a poor indicator of economic distress and bears little relationship to poverty or other measures of economic need. In addition, reliance on MHI alone can be a very misleading indicator of the affordability impacts in a large and diverse city such as NYC.

9.6.d.5 Tax Revenues as a Percentage of Full Market Property Value

This indicator, which EPA also refers to as the "property tax burden", attempts to measure "the funding capacity available to support debt based on the wealth of the community," as well as "the effectiveness of management in providing community services". According to the New York City Property Tax Annual report issued in FY13, NYC had collected $20.1 billion in real property taxes against a $917.7 billion FMPV, which amounts to 2.2 percent of FMPV. For this benchmark, NYC received a "mid-range" score. Also, this figure does not include water and wastewater revenues. Including $3.5 billion of FY13 System revenues increases the ratio to 2.6 percent of FMPV.

However, this indicator (including or excluding water and wastewater revenues) is misleading because NYC obtains a relatively low percentage of its tax revenues from property taxes. In 2007, property taxes accounted for less than 41 percent of NYC's total non-exported taxes, meaning that taxes other than property taxes (e.g., income taxes, sales taxes) account for nearly 60 percent of the locally borne NYC tax burden.

9.6.d.6 Property Tax Collection Rate

The property tax collection rate is a measure of "the efficiency of the tax collection system and the acceptability of tax levels to residents". This New York City Property Tax Annual report issued in FY13 indicates NYC's total property tax levy was $20.1 billion, of which 98.2 percent was collected, resulting in a "mid-range" rating for this indicator.

It should be noted, however, that the processes used to collect water and wastewater charges and the enforcement tools available to water and wastewater agencies differ from those used to collect and enforce real property taxes. The New York City Department of Finance, for example, can sell real property tax liens on all types of non-exempt properties to third parties, who can then take action against the delinquent property-owners. DEP, in contrast, can sell liens on multi-family residential and commercial buildings whose owners have been delinquent on water bills for more than one year, but it cannot sell liens on single-family homes. The real property tax collection rate thus may not accurately reflect the local agency's ability to collect the revenues used to support water supply and wastewater capital spending.

9.6.e Future Household Costs

For illustration purposes, Figure 9-10 shows the average estimated household cost for wastewater services compared to household income versus the percentage of households in various income brackets for the years 2015 and 2022. As shown, 50 percent of households are estimated to pay more than 1 percent of their income on wastewater service in 2015. Roughly 30 percent of households are estimated to pay 2 percent or more of their income on wastewater service alone in 2015. Estimating modest future rate and income increases (based on costs in the CIP and historic Consumer Price Index data, respectively), up to 37 percent of households could be paying more than 2 percent of their income on wastewater services by 2022. These projections are preliminary and do not include additional future wastewater spending associated with the programs outlined in Section 1.1.2 Future System Investment. When accounting for these additional costs, it is likely that an even greater percentage of households could be paying well above 2 percent of their income on wastewater services in the future.

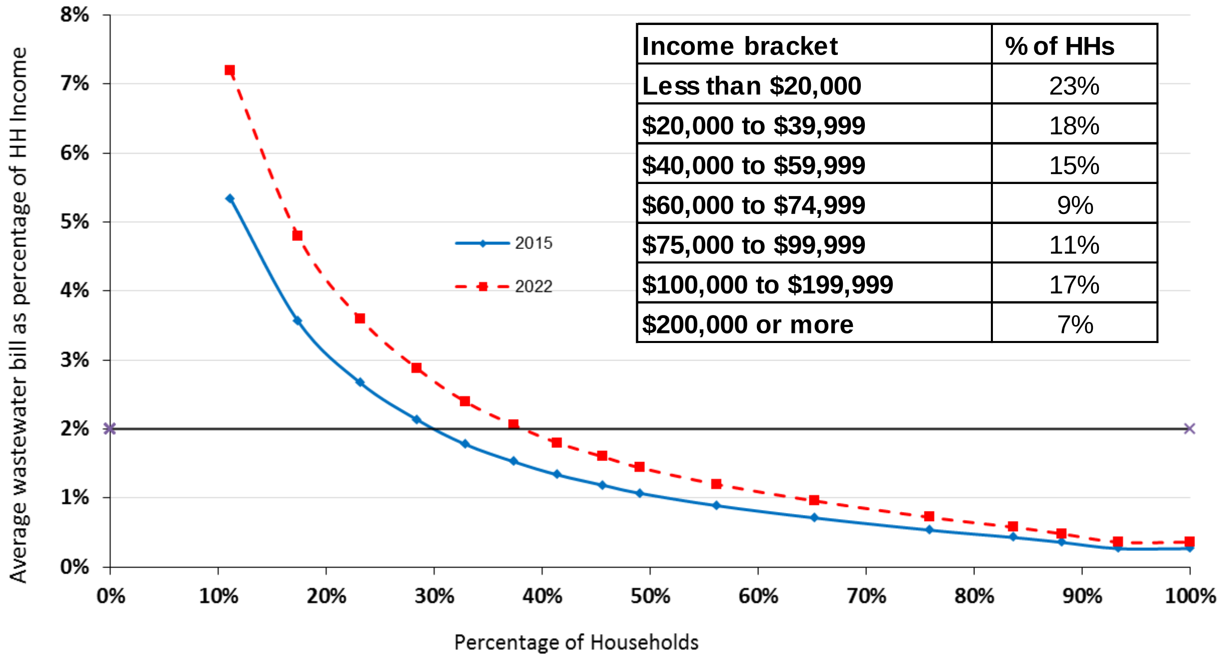
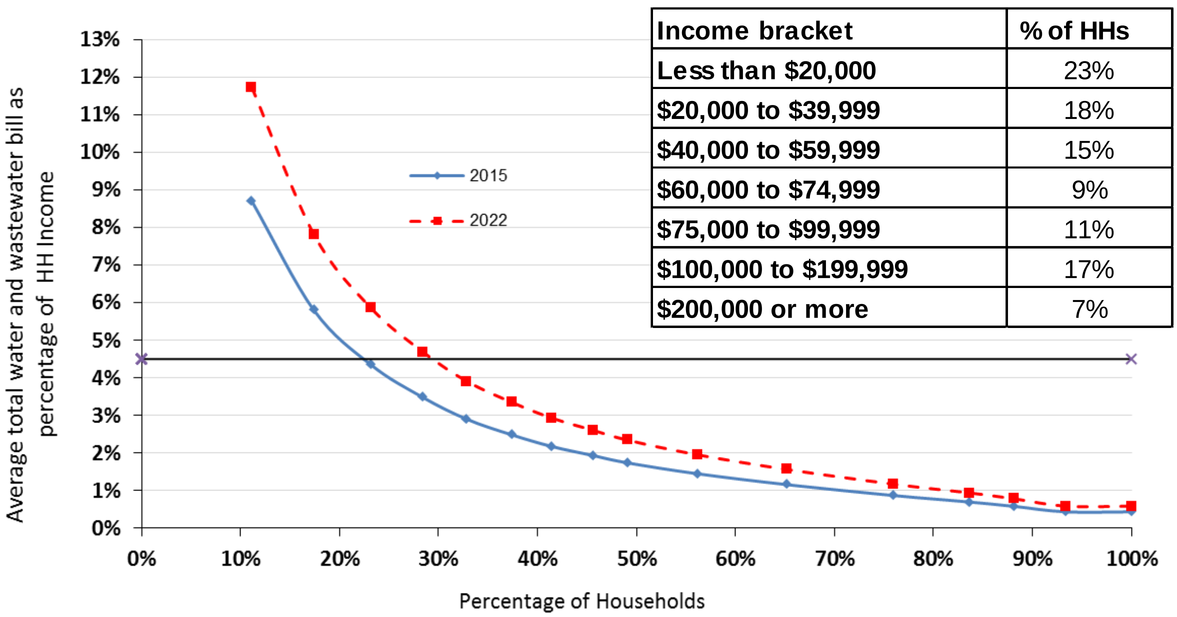


Figure 9-10: Estimated Average Wastewater Household Cost Compared to Household Income (FY15 & FY22)

DEP, like many utilities in the nation, provides both water and wastewater service, and its rate payers see one bill. Currently the average combined water and sewer bill is around 1.6 percent of MHI, but 23 percent of households are estimated to be currently paying more than 4.5 percent of their income, and that could increase to about 30 percent of households in future years as shown in Figure 9-11. Again, this estimate does not include additional spending for the additional water and wastewater programs outlined in Section 9.6.a.2 - Future System Investment.



Income bracket	% of HHs
Less than $20,000	23%
$20,000 to $39,999	18%
$40,000 to $59,999	15%
$60,000 to $74,999	9%
$75,000 to $99,999	11%
$100,000 to $199,999	17%
$200,000 or more	7%

Figure 9-11: Estimated Average Total Water and Wastewater Cost as a Percentage of Household Income (FY15 and FY22)

9.6.f Potential Impacts of CSO LTCPs to Future Household Costs

As previously discussed, DEP is facing significant future wastewater spending commitments associated with several regulatory compliance programs. This section presents the potential range of CSO LTCP implementation costs for NYC and describes the potential resulting impacts to future household costs for wastewater service. The information in this section reflects a simplified household impact analysis that will be refined in future LTCP waterbody submittals. All referenced Waterbody / Watershed Facility Plan (WWFP) costs presented in this section have been escalated to June 2014 dollars using the Engineering News-Record City Cost Index (ENRCCI) for New York for comparison purposes.

9.6.f.1 Estimated Costs for Waterbody CSO Recommended Alternative

As discussed in Section 8.8, recommendations in the Westchester Creek LTCP include completing the construction of the facilities recommended in the 2011 Westchester Creek WWFP, including regulator modifications at CSO-29 and CSO-29A and a parallel sewer for Pugsley Creek. When the WWFP construction is completed, CSO volumes are projected to be reduced from over 800 MG to 290 MG for the 2008 typical year (used for the baseline condition and for alternative evaluations).

The recommended LTCP alternative also includes implementation of 348 acres of green structure bioswales, 122 acres of onsite private properties and 17 acres onsite public properties for green infrastructure in the Westchester Creek watershed by 2030. This acreage represents 14 percent of the total combined sewer impervious area in the watershed.

To date, approximately $96.2 million has been committed to grey CSO control infrastructure, and $66 million has been committed for green infrastructure projects. Future costs for the recommended LTCP alternative have not yet been determined but will include the cost to implement the remaining proposed green infrastructure, as well as additional recommendations to be included in the Bronx River LTCP include evaluating floatables control at HP-011 and investigating a new siphon at HP-011. Additional costs may also be incurred following the monitoring of pathogen levels, through post construction monitoring and other ongoing programs, to determine the effectiveness of recommended WWFP facilities and green infrastructure.

9.6.f.2 Overall Estimated Citywide CSO Program Costs

DEP's LTCP planning process was initiated in 2012 and will extend until the end of 2017 per the Consent Order schedule. Overall anticipated CSO program costs for NYC will not be known until all of the LTCPs have been developed and approved. However, DEP did develop CSO control costs as part of a previous WWFP effort. These costs are presented in Table 9-6, and they will be supplemented by LTCP recommended alternative costs in future waterbody LTCP affordability sections as new costs become available.

Costs for the recommended alternatives as well as 25 percent, 50 percent, and 100 percent CSO control are included in Table 9-6 to provide a possible range of future CSO control costs. Also, green infrastructure is a major component of the CSO Consent Order. The overall green infrastructure program cost is estimated at $2.4 billion, of which $1.5 billion will be spent by DEP. The green infrastructure program costs are in addition to the grey CSO control costs and are therefore presented as a separate line item. As shown in Table 9-6, overall future CSO control costs could range from $4.1 billion to $85.6 billion.

Table 9-6 also presents CSO control costs that have been committed from FY 2002 through FY 2013 and in DEP's FY2014-2024 CIP. When excluding these committed costs, the range of possible future CSO control costs is $1.1 billion to $82.7 billion.

9.6.f.3 Potential Impacts to Future Household Costs

To estimate the impact of the possible range of future CSO control costs to ratepayers, the annual household cost impact of the future Citywide CSO control costs was calculated for the CSO spending scenarios. The cost estimates presented will evolve over the next few years as the LTCPs are completed for the 10 waterbodies. The cost estimates will be updated as the LTCPs are completed.

A 4.75 percent interest rate was used to determine the estimated annual interest cost associated with the capital costs, and the annual debt service was divided by the FY 2015 Revenue Plan value to determine the resulting percent rate increase. This also assumes bonds are structured for a level debt service amortization over 32 years. Note that interest rates on debt could be significantly higher in the future. As Table 9-7 shows, the Recommended CSO Control and 25 percent CSO Control scenarios would result in a 2 percent rate increase. The 50 percent CSO Control scenario would result in a double-digit rate increase of 15 percent, and the 100 percent CSO Control scenario would result in a substantial 118 percent rate increase. These rate increases translate into additional annual household costs of up to $1,207. Both the 50 percent and 100 percent CSO control scenarios represent a substantial increase in annual household costs, which only reflects possible future CSO control program costs. The cost of the additional future mandated and non-mandated programs discussed in Section 9.6.a.2 - Future System Investment would further increase the annual burden to ratepayers. For illustrative purposes, estimates for future spending on TRC, Ammonia, MS4, Superfund and Hillview Cover have been assumed in Table 9-7 and Table 9-8, and these are subject to change.

Table 9-6: Range of Potential Future CSO Costs

Waterbody / Watershed[1]	Historical and Current CIP Commitments	Baseline Committed Grey Infrastructure Costs: Committed FY2002-FY2013	Baseline Committed Grey Infrastructure Costs: Committed in 2014-2024 CIP	Baseline Committed Grey Infrastructure Costs: Total Existing Committed	Additional LTCP Recommended Alternative	LTCP Recommended Alternative Cost	25% CSO Control Cost[2]	50% CSO Control Cost[2]	100% CSO Control Cost[2]
Alley Creek and Little Neck Bay	CSO Abatement Facilities and East River CSO	$141,916,025	$ (3,085,000)[3]	$138,831,025	Disinfection in Existing CSO Retention Facility	$11,300,000	$113,000,000	$173,000,000	$569,000,000
Westchester Creek	Hunts Point WPCP Headworks	$7,800,000	$88,425,000	$96,225,000	Green Infrastructure Implementation and Post Construction Monitoring	TBD	$200,000,000	$420,000,000	$731,400,000
Hutchinson River	*Hunts Point WPCP Headworks*	*$3,000,000*	*$0*	*$3,000,000*	*TBD*	*TBD*	*$173,849,412*	*$427,937,014*	*$830,465,268*
Flushing Creek	*Flushing Bay Corona Avenue Vortex Facility, Flushing Bay CSO Retention, Flushing Bay CSO Storage*	*$360,348,471*	*$46,334,000*	*$406,682,471*	*TBD*	*TBD*	*$169,672,037*	*$339,344,073*	*$6,628,747,129*
Bronx River	*Installation of Floatable Control Facilities, Hunts Point Headworks*	*$46,989,901*	*$106,000*	*$47,095,901*	*TBD*	*TBD*	*$36,165,246*	*$90,413,115*	*$1,218,286,583*
Gowanus Canal	*Gowanus Flushing Tunnel Reactivation, Gowanus Facilities Upgrade*	*$174,828,480*	*$3,139,000*	*$177,967,480*	*TBD*	*TBD*	*$249,182,401*	*$529,512,603*	*$1,148,481,688*
Coney Island Creek	*Avenue V Pumping Station, Force Main Upgrade*	*$199,749,241*	*$2,485,000*	*$202,234,241*	*TBD*	*TBD*	*$59,646,395*	*$119,292,789*	*$1,163,462,575*

Waterbody / Watershed[1]	Historical and Current CIP Commitments	Baseline Committed Grey Infrastructure Costs			Additional LTCP Recommended Alternative	LTCP Recommended Alternative Cost	25% CSO Control Cost[2]	50% CSO Control Cost[2]	100% CSO Control Cost[2]
		Committed FY2002-FY2013	Committed in 2014-2024 CIP	Total Existing Committed					
Jamaica Bay	*Improvements of Flow Capacity to Fresh Creek-26th Ward Drainage Area, Hendrix Creek Canal Dredging, Shellbank Destratification, Spring Creek AWCP Upgrade*	*$141,135,131*	*$323,733,000*	*$464,868,131*	*TBD*	*TBD*	*$180,881,883*	*$367,416,325*	*$4,142,534,281*
Flushing Bay[4]	*See Flushing Creek*	*$0*	*$0*	*$0*	*TBD*	*TBD*	*$222,270,368*	*$791,802,838*	*$4,787,918,645*
Newtown Creek	*English Kills Aeration, Newtown Creek Water Quality Facility, Newtown Creek Headworks*	*$160,099,445*	*$91,312,000*	*$251,411,445*	*TBD*	*TBD*	*$566,569,452*	*$1,586,394,467*	*$3,421,512,923*
East River and Open Waters	*Bowery Bay Headworks, Inner Harbor In-Harbor Storage Facilities, Reconstruction of the Port Richmond East Interceptor Throttling Facility, Outer Harbor CSO Regulator Improvements, Hutchinson River CSO*	*$153,145,476*	*$43,131,000*	*$196,276,476*	*TBD*	*TBD*	*$534,921,268*	*$7,016,829,726*	*$59,488,594,159*
Bergen and Thurston Basins[5]	Pumping Station and Force Main Warnerville	*$41,876,325*	$ (180,000)[3]	*$41,696,325*	NA	NA	NA	NA	NA
Paerdegat Basin[5]	Retention Tanks, Paerdegat Basin Water Quality Facility	*$397,605,260*	$ (4,609,000)[3]	*$392,996,260*	NA	NA	NA	NA	NA

Waterbody / Watershed[1]	Historical and Current CIP Commitments	Baseline Committed Grey Infrastructure Costs			Additional LTCP Recommended Alternative	LTCP Recommended Alternative Cost	25% CSO Control Cost[2]	50% CSO Control Cost[2]	100% CSO Control Cost[2]
		Committed FY2002-FY2013	Committed in 2014-2024 CIP	Total Existing Committed					
Green Infrastructure Program[6]	Miscellaneous Projects Associated with City-wide Green Infrastructure Program	$24,200,000	$907,005,000	$931,205,000	Full Implementation of Green Infrastructure Program	$1,500,000,000	$1,500,000,000	$1,500,000,000	$1,500,000,000
TOTAL		*$1,852,693,755*	*$ 1,497,796,000*	*$3,350,489,755*		*$1,511,300,000*	*$4,006,158,462*	*$13,361,942,951*	*$85,630,403,250*

Notes:

1. The shaded waterbody rows include current LTCP alternative and cost information. Other waterbody rows are presented in italics and will be updated in future waterbody LTCP affordability chapters as new alternatives and costs become available.
2. 25%, 50%, and 100% CSO costs are estimated using knee of the curve / cost vs. CSO control plots from WWFPs and LTCPs and do not subtract historic and currently committed costs, which are presented separately. All costs taken from the WWFPs have been escalated to June 2014 dollars for comparison purposes using the ENRCCI for New York.
3. Negative values for Alley Creek and Little Neck Bay, Bergen and Thurston Basins, and Paerdegat Basin reflect a de-registration of committed funds.
4. Committed costs for Flushing Bay are captured in the committed costs reported for Flushing Creek.
5. Bergen and Thurston Basins and Paerdegat Basin are not part of the current LTCP effort; thus, no LTCP detail is provided for them.
6. DEP's green infrastructure program costs are assumed to be the same regardless of the CSO control level.

Table 9-7: CSO Control Program Household Cost Impact

Capital Spending Scenario	Projected Capital Cost ($M)[1]	Annual Debt Service ($M)[2]	% Rate Increase from FY 2015 Rates	Additional Annual Household Cost	
				Single-Family Home	Multi-Family Unit
Current CIP	13,664	839	24	$245	$159
Future Potential Mandated Program Costs for MS4, TRC, Ammonia, Superfund, and Hillview Cover[3]	7,000	430	12	$125	$82
100% CSO Control	82,715	5,079	145	$1,483	$964
50% CSO Control	10,446	641	18	$187	$122
25% CSO Control	1,090	67	2	$20	$13
Citywide LTCP CSO Control Alternatives[4]	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*

Notes:
1. CSO Capital costs have been reduced to reflect historic and currently committed costs for CSO control projects (see Table 9-6).
2. Assumes bonds are structured for a level debt service amortization over 32 years at a 4.75% interest rate.
3. DEP will face additional future wastewater mandated program costs. While these costs have not been finalized, the following estimated costs for select programs are included for planning purposes to represent potential future annual household cost on top of costs for the CSO control program: MS4 Permit Compliance - $2.5 billion, TRC - $560 million, Ammonia $840 million Superfund Remediation - $1.5 billion million, and $1.6 billion for Hillview Cover.
4. Projected capital cost for the City-wide recommended LTCP CSO control alternatives is not currently available. This information will be included in the City-wide LTCP following completion of the individual waterbody LTCPs.

Table 9-8. Total Estimated Cumulative Future HH Costs/MHI

Capital Spending Scenario	Total Projected Annual Household Cost[1]		Total Water and Wastewater HH Cost / MHI[2]		Total Wastewater HH Cost / MHI[2]	
	Single-family Home	Multi-family Unit	Single-family Home	Multi-family Unit	Single-family Home	Multi-family Unit
FY 2015 Rates	$1,025	$666	1.9%	1.2%	1.1%	0.74%
Current CIP	$1,270	$825	2.0%	1.3%	1.2%	0.81%
Other Future Potential Mandated Program Costs for MS4, TRC, Ammonia, Superfund, and Hillview Cover	$1,395	$907	2.2%	1.5%	1.4%	0.89%
100% CSO Control +CIP +Other	$2,878	$1,871	4.6%	3.0%	2.8%	1.84%
50% CSO Control+CIP+Other	$1,582	$1,029	2.5%	1.6%	1.6%	1.01%
25% CSO Control+CIP+Other	$1,415	$920	2.3%	1.5%	1.4%	0.90%
Citywide LTCP CSO Control Alternatives	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*

Notes:
1. Projected household costs are estimated from rate increases presented in Table 9-7.
2. Future costs were compared to assumed 2020 MHI projection.

Table 9-8 shows the potential range of future spending and its impact on household cost and compared to MHI. While these estimates are preliminary, it should be noted (as discussed in detail earlier in this section) that comparing household cost to MHI alone does not tell the full story since a large percentage of households below the median could be paying a larger percentage of their income on these costs.

9.6.g Benefits of Program Investments

DEP has been in the midst of an unprecedented period of investment to improve water quality in New York Harbor. Projects worth $9.9 billion have been completed or are under way since 2002 alone, including projects for nutrient removal, CSO abatement, marshland restoration in Jamaica Bay, and hundreds of other projects. In-City investments are improving water quality in New York Harbor and restoring a world-class estuary while creating new public recreation opportunities and inviting people to return to NYC's 578 miles of waterfront. A description of Citywide water quality benefits resulting from previous and ongoing programs is provided below, followed by the anticipated benefits of water quality improvements to Westchester Creek resulting from implementation of the recommended CSO control alternative.

9.6.g.1 Citywide Water Quality Benefits from Previous and Ongoing Programs and Anticipated Westchester Creek Water Quality Benefits

Water quality benefits have been documented in New York Harbor and its tributaries from the almost $10 billion investment that NYC has already made in both grey and green infrastructure. Approximately 95 percent of New York Harbor is available for boating and kayaking and 14 of NYC's beaches provide access to swimmable waters in the Bronx, Brooklyn, Queens and Staten Island.

Of the $9.9 billion already invested, almost 20 percent has been dedicated to controlling CSOs and stormwater. That investment has resulted in NYC capturing and treating over 70 percent of the combined stormwater and wastewater that otherwise would be directly discharged to our waterways during periods of heavy rain or runoff. Projects that have already been completed include Green Infrastructure projects in 26th Ward, Hutchinson River and Newtown Creek watersheds; area wide green infrastructure contracts; Avenue V Pump Station and Force Main; and the Bronx River Floatables Control. Several other major projects are in active construction or design. The water quality improvements already achieved have allowed greater access of the waterways and shorelines for recreation as well as enhanced environmental habitat and aesthetic conditions in many of NYC's neighborhoods.

More work is needed, and DEP has committed to working with DEC to further reduce CSOs and make other infrastructure improvements to gain additional water quality improvements. The consent order signed in 2012 between DEP and DEC outlines a combined grey and green approach to reduce CSOs. This LTCP for Westchester Creek is just one of the detailed plans that DEP is preparing by the year 2017 to evaluate and recommend additional control measures for reducing CSO and improving water quality in New York Harbor (the "Harbor"). DEP is also committed to extensive water quality monitoring throughout the Harbor which will allow better assessment of the effectiveness of the controls implemented.

As noted above, a major component of the Consent Order that DEP and NYSDEC developed is green infrastructure stormwater control measures. DEP is targeting a 10 percent application rate for implementing green infrastructure in combined sewer areas. The green infrastructure will take multiple forms including green or blue roofs, bioinfiltration systems, right of way bioswales, rain barrels, and porous pavement. These measures provide benefits beyond the associated water quality improvements. Depending on the measure installed, they can recharge groundwater, provide localized flood attenuation, provide sources of water for non-potable use such as watering lawns or gardens, reduce heat island effects on streets and sidewalks, improve air quality, enhance aesthetic quality, and provide recreational opportunities. These are all benefits that contribute to the overall quality of life for residents of NYC.

A detailed discussion of anticipated water quality improvements to Westchester Creek is included in Section 8.0, and a copy of the UAA submitted as part of the LTCP is included in Appendix D.

9.6.h Conclusions

As part of the LTCP process, DEP will continue to develop and refine the affordability and financial capability assessments for each individual waterbody as it works toward an expanded analysis for the Citywide LTCP. In addition to what is outlined in the federal CSO guidance on financial capability, DEP has presented in this section a number of additional socioeconomic factors for consideration in the context of affordability and assessing potential impacts to our ratepayers. Furthermore, DEP feels it is important to include a fuller range of future spending obligations and has sought to present an initial picture of that here. Ultimately the environmental, social, and financial benefits of all water-related obligations should be considered when priorities for spending are developed and implementation of mandates are scheduled, so that resources can be focused where the community will get the most environmental benefit.

9.7 Compliance with Water Quality Goals

Westchester Creek is currently attaining the Class I bacteria criterion. The assessment of the waterbody indicates that Westchester Creek cannot support bathing water quality (Class SC) within its full extension, nor is it suitable for that use because of natural and manmade features, such as lack of access, marshy tidal flat conditions, etc. The UAA, described above and attached in Appendix D, is submitted in further support of this LTCP. DEP has identified site-specific targets to provide for and monitor the continual improvement of water quality in Westchester Creek. These site specific targets are presented for DEC's consideration in in Section 8.

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11.0 GLOSSARY

1.5xDDWF:	One and One-half Times Design Dry Weather Flow
2xDDWF:	Two Times Design Dry Weather Flow
AACE	Advancement of Cost Engineering
AAOV:	Annual Average Overflow Volumes
AC	Acre
BEACH:	Beaches Environmental Assessment and Coastal Health
BEPA	Bureau of Environmental Planning and Analysis
BGY:	Billon Gallons Per Year
BMP:	Best Management Practice
BNR:	Biological Nutrient Removal
BODR	Basis of Design Report
BWSO:	Bureau of Water and Sewer Operations
CAC:	Citizens Advisory Committee
$CBOD_5$:	Carbonaceous Biochemical Oxygen Demand
CEO:	New York City Center for Economic Opportunity
CFR:	Code of Federal Regulation
CFS	Cubic Feet Per Second
CFU	Colony-Forming Unit
Conc:	Abbreviation for "Concentration".
CSO:	Combined Sewer Overflow
CSS:	Combined Sewer System
CWA:	Clean Water Act
DCIA:	Directly Connected Impervious Areas
DCP:	New York City Department of City Planning

DDC	New York City Department of Design and Construction
DDWF:	Design Dry Weather Flow
DEC:	New York State Department of Environmental Conservation
DEP:	New York City Department of Environmental Protection
DO:	Dissolved Oxygen
DOB:	New York City Department of Buildings
DOF:	New York City Department of Finance
DOH:	New York State Department of Health
DOHMH:	New York City Department of Health and Mental Hygiene
DOT:	New York City Department of Transportation
DPR:	New York City Department of Parks and Recreation
DWF:	Dry Weather Flow
E. Coli:	Escherichia Coli.
EBP:	Environmental Benefit Project
ECL	New York State Environmental Conservation Law
ECM:	Energy Conservation Measure
EDC	New York City Economic Development Corporation
EMC:	Event Mean Concentration
ENRCCI:	Engineering News-Record City Cost Index
EPA:	United States Environmental Protection Agency
ERTM:	East River Tributaries Model
ET:	Evapotranspiration
EWR	Newark Liberty International Airport
FAD:	Filtration Avoidance Determination
FCI:	Financial Capability Indicators

FEMA:	Federal Emergency Management Agency
FM	Force Main
FMPV:	Full Market Property Value
FOIA:	Freedom of Information Act
FT	Abbreviation for "Feet"
FY:	Fiscal Year
GHG:	Greenhouse Gases
GI:	Green Infrastructure
GIS:	Geographical Information System
GM:	Geometric Mean
G.O.:	General Obligation
GRTA:	NYC Green Roof Tax Abatement
HEAP:	Home Energy Assistance Program
HGL:	Hydraulic Gradient Line
HLSS:	High Level Sewer Separation
HP	Hunts Point
HRA:	New York City Human Resources Administration
HSM	Harbor Survey Monitoring Program
HWAP:	Home Water Assistance Program
IEC:	Interstate Environmental Commission
in.:	Abbreviation for "Inches".
IW:	InfoWorks CS™
JFK:	John F. Kennedy International Airport
KOTC:	Knee-of-the-Curve
lbs/day:	pounds per day

LGA:	LaGuardia Airport
LT2	Long Term 2
LTCP:	Long Term Control Plan
MCP:	Multifamily Conservation Program
mg/L:	milligrams per liter
MG:	Million Gallons
MGD:	Million Gallons Per Day
MHI:	Median Household Income
MOU:	Memorandum of Understanding
MPN:	Most probable number
MS4:	Municipal separate storm sewer systems
MSS:	Marine Sciences Section
MT:	Metric Ton
MWFA:	New York City Municipal Water Finance Authority
NAS:	National Academy of Sciences
NEIWPCC:	New England Interstate Water Pollution Control Commission
NMC:	Nine Minimum Control
NMFS:	National Marine Fisheries Service
NOAA:	National Oceanic and Atmospheric Administration
NPDES:	National Pollutant Discharge Elimination System
NPW	Net Present Worth
NYC:	New York City
NYCDOB:	New York City Department of Buildings
NYCDPR	New York City Department of Parks and Recreation
NYCRR:	New York State Code of Rules and Regulations

NYMTC	New York Metropolitan Transportation Council
NYSDOS:	New York State Department of State
NYTA	New York Transit Authority
O&M:	Operation and Maintenance
OGI:	Office of Green Infrastructure
OLTPS	Mayor's Office of Long Term Planning and Sustainability
OMB:	Office of Management and Budget
ONRW:	Outstanding National Resource Waters
OpX:	Operational Excellence
Org.	Organism
PBC	Probable Bid Cost
PCM:	Post Construction Monitoring
POTW:	Publicly Owned Treatment Plant
PS:	Pump Station or Pumping Station
Q:	Symbol for Flow (designation when used in equations)
RI:	Residential Indicator
RI/FS:	Remedial Investigation/Feasibility Study
ROWB:	Right-of-way bioswales
RTC:	Real-Time Control
RWQC:	Recreational Water Quality Criteria
SCADA:	Supervisory Control and Data Acquisition
SIU:	Significant Industrial User
SPDES:	State Pollutant Discharge Elimination System
SPM:	Supplemental Poverty Measure
STV:	Statistical Threshold Value

TAZ	Transportation Analysis Zone
TBD:	To Be Determined
TMDL:	Total Maximum Daily Load
TPL	Trust for Public Load
TRC:	Total Residual Chlorine
TSS:	Total Suspended Solids
UAA:	Use Attainability Analysis
UER-WLIS:	Upper East River – Western Long Island Sound
USACE:	United States Army Corps of Engineers
USEPA:	United States Environmental Protection Agency
USFWS:	United States Fish and Wildlife Service
USGS:	United States Geological Survey
UV:	Ultraviolet Light
WDAP:	Water Debt Assistance Program
WQS:	Water Quality Standards
WWFP:	Waterbody/Watershed Facility Plan
WWOP:	Wet Weather Operating Plan
WWTP:	Wastewater Treatment Plant

Appendix A: Supplemental Tables

Annual CSO and Stormwater Baseline Volumes (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total MG/Yr**
Westchester Creek	HP-012	CSO-23A	63
Pugsley Creek	HP-013	CSO-24	3
Westchester Creek	HP-014	CSO-29, CSO-29A	127
Westchester Creek	HP-015	CSO-22	16
Westchester Creek	HP-016	Regulator 4	63
Westchester Creek	HP-033	CSO-23	33
		Total CSO Volume	**289**

Stormwater Outfalls and Direct Drainage			
Waterbody	**Outfall**	**Regulator**	**Total MG/Yr**
Pugsley Creek	HP-504	NA	9
Westchester Creek	HP-602	NA	18
Pugsley Creek	HP-623	NA	27
Pugsley Creek	HP-625	NA	1
Westchester Creek	HP-635	NA	51
Westchester Creek	HP-839	NA	55
Direct Drainage	NA	NA	164
		Total Stormwater Volume	**327**

Totals by Waterbody			
Waterbody	**Outfall**	**Regulator**	**Total MG/Yr**
Westchester Creek	-	-	575
Pugsley Creek	-	-	40

Totals by Source			
Source	**Outfall**	**Regulator**	**Total MG/Yr**
CSO	-	-	289
Stormwater/Direct Drainage	-	-	327

Totals by Source by Waterbody			
Waterbody	**Source**	**Percent**	**Total MG/Yr**
Westchester Creek	CSO	50%	286
	Stormwater/Direct Drainage	50%	289
	Total to Westchester Creek		**575**
Pugsley Creek	CSO	6%	3
	Stormwater/Direct Drainage	94%	37
	Total Volume to Pugsley Creek		**40**
		Total	**615**

Annual CSO and Stormwater Enterococci Baseline Loads (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org. x10^{12}**
Westchester Creek	HP-012	CSO-23A	399
Pugsley Creek	HP-013	CSO-24	16
Westchester Creek	HP-014	CSO-29, CSO-29A	729
Westchester Creek	HP-015	CSO-22	2
Westchester Creek	HP-016	Regulator 4	323
Westchester Creek	HP-033	CSO-23	191
		Total CSO Load	**1,660**

Stormwater Outfalls and Direct Drainage			
Waterbody	**Outfall**	**Regulator**	**Total Org. x10^{12}**
Pugsley Creek	HP-504	NA	18
Westchester Creek	HP-602	NA	35
Pugsley Creek	HP-623	NA	51
Pugsley Creek	HP-625	NA	2
Westchester Creek	HP-635	NA	97
Westchester Creek	HP-839	NA	105
Direct Drainage	NA	NA	40
		Total Stormwater Load	**348**

Totals by Waterbody			
Waterbody	**Outfall**	**Regulator**	**Total Org. x10^{12}**
Westchester Creek	-	-	1,920
Pugsley Creek	-	-	87

Totals by Source			
Source	**Outfall**	**Regulator**	**Total Org. x10^{12}**
CSO	-	-	1,660
Stormwater	-	-	348

Totals by Source by Waterbody			
Waterbody	**Source**	**Percent**	**Total Org. $x10^{12}$**
Westchester Creek	CSO	74	1,644
	Stormwater/Direct Drainage	26	227
	Total Load to Westchester Creek		**1,920**
Pugsley Creek	CSO	18	16
	Stormwater/Direct Drainage	82	71
	Total Load to Pugsley Creek		**87**
		Total	**2,007**

Annual CSO and Stormwater Fecal Coliform Baseline Loads (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org. $x10^{12}$**
Westchester Creek	HP-012	CSO-23A	1,428
Pugsley Creek	HP-013	CSO-24	56
Westchester Creek	HP-014	CSO-29, CSO-29A	2,572
Westchester Creek	HP-015	CSO-22	6
Westchester Creek	HP-016	Regulator 4	1,119
Westchester Creek	HP-033	CSO-23	676
		Total CSO Load	**5,857**

Stormwater Outfalls and Direct Drainage			
Waterbody	**Outfall**	**Regulator**	**Total Org. $x10^{12}$**
Pugsley Creek	HP-504	NA	43
Westchester Creek	HP-602	NA	83
Pugsley Creek	HP-623	NA	123
Pugsley Creek	HP-625	NA	5
Westchester Creek	HP-635	NA	233
Westchester Creek	HP-839	NA	252
Direct Drainage	NA	NA	27
		Total Stormwater Load	**766**

Totals by Waterbody			
Waterbody	**Outfall**	**Regulator**	**Total Org. $x10^{12}$**
Westchester Creek	-	-	6,396
Pugsley Creek	-	-	227

Totals by Source			
Source	**Outfall**	**Regulator**	**Total Org. $x10^{12}$**
CSO	-	-	5857
Stormwater	-	-	766

Totals by Source by Waterbody			
Waterbody	**Source**	**Percent**	**Total Org. x10^{12}**
Westchester Creek	CSO	81	5801
	Stormwater/Direct Drainage	19	595
	Total Load to Westchester Creek		**6,396**
Pugsley Creek	CSO	25	56
	Stormwater/Direct Drainage	75	171
	Total Load to Pugsley Creek		**227**
		Total	**6,623**

Annual CSO and Stormwater BOD_5 Baseline Loads (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Westchester Creek	HP-012	CSO-23A	15,019
Pugsley Creek	HP-013	CSO-24	644
Westchester Creek	HP-014	CSO-29, CSO-29A	29,572
Westchester Creek	HP-015	CSO-22	2,483
Westchester Creek	HP-016	Regulator 4	16,866
Westchester Creek	HP-033	CSO-23	7,292
		Total CSO BOD_5 Load	**71.876**

Stormwater Outfalls and Direct Drainage			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Pugsley Creek	HP-504	NA	1,126
Westchester Creek	HP-602	NA	2,252
Pugsley Creek	HP-623	NA	3,378
Pugsley Creek	HP-625	NA	125
Westchester Creek	HP-635	NA	6,380
Westchester Creek	HP-839	NA	6,881
Direct Drainage	NA	NA	20,516
		Total Stormwater Load	**40,658**

Totals by Waterbody			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Westchester Creek	-	-	107,261
Pugsley Creek	-	-	5,273

Totals by Source			
Source	**Outfall**	**Regulator**	**Total Lbs**
CSO	-	-	71,876
Stormwater	-	-	40,658

Totals by Source by Waterbody			
Waterbody	**Source**	**Percent**	**Total Lbs**
Westchester Creek	CSO		71,232
	Stormwater/Direct Drainage		36,029
	Total Load to Westchester Creek		**107,261**
Pugsley Creek	CSO		644
	Stormwater/Direct Drainage		4,629
	Total Load to Pugsley Creek		**5,273**
		Total	**112,534**

Appendix B: Long Term Control Plan (LTCP) Westchester Creek Kickoff Meeting – Summary of Meeting and Public Comments Received

On February 26, 2014 DEP hosted a kick off public meeting for the water quality planning process for long term control of combined sewer overflows in the Westchester Creek and Pugsley Creek waterbody. The two-hour event, held at the JHS 125 Henry Hudson School in the Bronx provided information about DEP's Long Term Control Plan (LTCP) development for Westchester Creek. DEP presented information on the Westchester Creek watershed characteristics and status of waterbody improvement projects, obtained public information on waterbody uses in Westchester Creek, and provided opportunities for public input. The presentation can be found at http://www.nyc.gov/dep/ltcp.

Approximately ten people from the public attended the event as well as representatives from the Department of Environmental Protection and New York State Department of Environmental Conservation The following summarizes the questions and comments from attendees as well as responses given.

- One attendee asked DEP to look into whether the marina on Westchester Creek might be contributing to a water quality problem because the boats are occupied full-time and they might be discharging sewage into the creek.
- Another attendee intended to solicit comments from the marina occupants to encourage further public participation in the LTCP process.
- An attendee estimated that 5,000 to 8,000 people use the soccer fields on Ferry Point Park and there are no toilets at the facility, the implication being that at least some of these people may be contributing to water quality issues due to inadequate sanitation. She also noted that the Parks Department has millions of dollars they received as part of the Croton water treatment work (which Shane reminded her came from DEP) but Parks has been resistant to installing restroom facilities at the park.
- An attendee noted that the Schildwachter facility at the head end of Westchester Creek has a SPDES permit of some kind. DEP was unaware of such a permit, but agreed that they would look into it and incorporate it into the LTCP as a water quality influence if appropriate.
- An attendee asked whether the sewage from Co-Op City influences Westchester Creek and DEP stated that all Co-Op City runoff and sanitary sewage that is not discharged as CSO passes through the Hutchinson River watershed on its way to the Hunts Point WWTP for treatment. The attendee noted that her question stemmed from the poor water quality in the vicinity after Hurricane Sandy, which she characterized as the worst in the city related to that surge. DEP noted that Sandy is not the design condition for the sewer system, and that no municipality sizes their sewers to accommodate such a relatively rare occurrence.
- An attendee noted that DEP was talking a great deal about rainfall but did not seem concerned about addressing increased sanitary flows related to economic development. Keith from DEP explained that the city is using sanitary flows based on a 2040 population projection that includes all known planned developments, changes to zoning, etc. The questioner added that there were several new malls, a hotel, and other new development that would seem to increase the CSO problems. DEP responded that, although this might seem to be the case, in actuality the stormwater flows are a large percentage of the flow, so even large increases in sanitary flow have only a marginal effect on CSO.

- An attendee asked whether DEP was working on green infrastructure projects to capture the runoff from the Bruckner cloverleaf that sits on top of Westchester Creek. It was noted that the runoff from large highways usually doesn't go into the sewer system; more often there are dedicated stormwater outfalls or the stormwater drains directly to the waterbody. DEP responded that this will be addressed in the near future when DEC begins issuing MS4 (stormwater) permits. The LTCP process is concerned with CSO areas only.

Appendix C: Long Term Control Plan (LTCP) Westchester Creek Public Meeting #2 – Summary of Meeting and Public Comments Received

The second of three planned public meetings related to the Westchester Creek Long-Term Control Plan (LTCP) development was held at Herbert Lehman High School, 3000 East Tremont Avenue in the Westchester Square neighborhood in the Bronx. The meeting included posterboards, handouts, and a presentation focusing on alternatives evaluations for Westchester Creek Combined Sewer Overflows control. Representatives from the Department of Environmental Protection (DEP) included the Bureau of Public Affairs (BPA), the Bureau of Environmental Planning and Analysis (BEPA), the Office of Green Infrastructure (OGI), the Bureau of Wastewater Treatment (BWT), and representatives from the LTCP consulting team. One representative from New York State Department of Environmental Conservation (DEC) Region 2 was also in attendance. Approximately ten people from the public attended the event, most of whom had not attended the first meeting.

- After a half-hour meet-and-greet, Shane Ojar (BPA) started the proceedings. Each of the various state and city representatives introduced themselves. Shane asked participants to consider how Westchester Creek is used and how it might be used in the future, noting that DEP's goal is to improve water quality to support those uses to the extent limited resources will allow. He explained that the goal of meeting water quality standards and public input will feed into what actually gets built.

- Lily Lee (BWT) presented the technical substance of the presentation. She started by noting that the Long Term Control Plan (LTCP) is required by New York State Department of Environmental Conservation and US Environmental Protection Agency (EPA), and that the LTCP process requires evaluating attainment of the current standards set by DEC. She reminded the audience that uses were solicited from the group at the kickoff meeting, and that the goal is to align the Water Quality Standards (WQS), the uses, and the CSO reduction strategies.

- Lily presented recent data collected by an enhanced (weekly) sampling by the Harbor Survey program. The fecal coliform data show that the existing Class I Water Quality Standard as set by DEC is being fully attained. She also presented this past winter's dissolved oxygen measurements, which show full attainment of the existing Water Quality Standard as well. She explained that the data are used to improve water quality models, and although the pathogen modeling is complete, Dissolved Oxygen (DO) modeling is ongoing.

- Lily pointed out the combined sewer overflow (CSO) areas and stormwater outfalls on the maps provided. She explained that the Long Term Control Plan builds on the Waterbody/Watershed Facility Plan (WWFP) developed in Westchester Creek. She highlighted the meaning of the Water Quality Standard Class I, designated for boating and fishing, in which only fecal coliform limits are applicable and not entero which is applicable to other Water Quality Standards. She showed uses that were marked with dots on a map during the last meeting, which showed lots of kayaking and fishing.

- Lily then explained the WWFP commitments of raising weirs at CSO-29 and 29A along Eastchester Road, and the parallel sewer being built that would substantially reduce CSOs discharging into Westchester Creek. Altogether these projects are expected to cost about $160 million and are targeted for completion by 2019. The green infrastructure (GI) commitment is starting this summer under the area-wide contract. Combined the impact of the planned WWFP projects and GI is projected to reduce CSO volume by 64%, from nearly 800 MG/year down to approximately 300 MG/year.

- Lily presented information that showed that, for the currently applicable water quality standards, Westchester Creek is in 100% attainment throughout the year. She then showed attainment levels for the next highest class (SB) taking into account the WWFP projects and green infrastructure, noting that very high to full attainment in summer months, but less attainment when considered on an annual basis. Even if all CSO is eliminated, there would be an improvement but not full attainment.

- The explanation provided for this is in the consideration of all pollutant sources to Westchester Creek. The East River boundary is a limiting factor, as is stormwater. With the WWFP fully implemented, stormwater contributes more than half of entero concentration. Closer to the East River, entero goes down, but stormwater still contributes a large portion of that concentration. Even at the East River entero concentrations were shown to be higher than the Water Quality Standard. Lastly, most of the CSO discharges at the head end, where it is narrow and there is not a lot of mixing.

- With the very narrow performance gap in mind, Lily then presented several alternatives that DEP is considering to reduce CSO. The first presented was an in-line storage concept for the long outfall of HP-014. There were many challenges presented to building and operating this. Among the most significant is that the pipes are largely underneath active tracks within the NYTA rail yard. DEP would need access 24/7, and to accomplish this would probably be disruptive to the rail yard and therefore subway passengers. In comparison to the disruption, the water quality improvement is slight.

- The next alternative showed disinfection as a means of reducing pathogens, a process that would be added to in-line storage. Lily stated that dechlorination would also be necessary because the impact of chlorine on the waterbody. This alternative would reduce the pathogen load by 44% but would only increase attainment by 5 percentage points. Lily noted the challenges of controlling residual chlorine in a highly varying flow environment like a CSO discharge.

- After disinfection, consideration was given to expanding the Throgs Neck Pump Station to pump more flow to the sewage treatment plant. Several sizes and discharge relocation options were considered, but the best of these reduced CSO up to 19%, which did not improve water quality that much. The cost may vary a lot as well, and the CSO discharges may increase in another waterbody because of the large, interconnected nature of the collection system.

- CSO storage was presented next. Storage tunnels of different sizes were shown to capture a range of CSO. Tunnels were presented as very disruptive, requiring drop shafts, a pump station to drain the tunnel, and a lot of additional infrastructure related to this approach.

- Floatables was presented as an alternative to control CSO impact although it would not reduce CSO volume. It would improve the aesthetics in the waterbody, but would not improve attainment of the Water Quality Standard.

- Green infrastructure is already planned for the area, targeting 14% of the combined area tributary to Westchester Creek. This target is embedded in the Baseline, but DEP is considering an additional 10% buildout as an alternative. Still single digit improvement in attainment, and the existing target is already high, so finding additional sites would be a challenge. In addition, there is shallow bedrock in this area of the Bronx, which could reduce DEP's ability to implement green infrastructure in the area.

- The final alternative presented was dredging, which was included at the expressed interest of one attendee of the first public meeting. DEP's approach to this is to remove any exposed sediment mounds to below 3 feet below mean lower low water (MLLW). Lily explained that in the case of Westchester Creek there is no basis for doing this kind of environmental dredging because there are no exposed sediment mounds at low tide. Also it does not improve attainment. She noted that USACE is responsible for navigational dredging.

- Lily explained that none of these alternatives are jumping out at DEP as being cost-effective and/or affordable, properties that are considered in the alternatives evaluations. She then showed a curve comparing the CSO reduction versus cost of each alternative which showed that the "knee-of-the-curve" might be at over $200 million, the scale of which is in itself not cost-effective.

- Shane Ojar then closed the presentation by encouraging attendees to revisit the considerable information provided in this meeting by accessing it on the website, and to provide responses to the original request for guidance as to what the long-term uses should be so that the community drives the project. He closed by informing everyone that this was the alternatives meeting and that DEP would be back near the end of the summer. He welcomed questions, and directed thoughts from after the meeting to be emailed to DEP's dedicated LTCP email address.

Following the presentation, there was a Question and Answer forum. The following summarizes the questions and comments from attendees as well as responses given.

1. **COMMUNITY CHARACTER**. An attendee noted an inordinate amount of brick and mortar alternatives in comparison to green infrastructure. Some of the other alternatives sitting next to a high school and on the edge of residential community and people in the community probably would not want that type of heavy infrastructure. He also noted the high concentration of institutional facilities along Eastchester Road, including a special education school, the psych center, and multiple hospitals. He was concerned that construction in this area would not be possible.

2. **INDUSTRIAL POLLUTION**. One attendee wondered where NYTA wastewater went after they washed down the rail cars, and suggested it discharged at the head end of Westchester Creek. He also wondered why city planners were not making sure polluters like this are held responsible. DEP explained how the CSO system works, and mentioned their industrial pretreatment program (IPP) which requires industrial sewer users to be permitted by DEP and to be subject to permit stipulations, including retaining their runoff during storms to maximize available capacity, and providing a level of pretreatment specifically to reduce pollution through CSOs. Regardless, DEP noted that the flow from the rail yard is small in comparison to the sewage and the stormwater, and probably does not contain pathogens like sewage does.

3. **BRUSH AVENUE**. Brush Avenue, a private road, was discussed at length by the community as having unacceptably poor drainage, few sidewalks, no curbs, and is hugely rutted. There were no catch basins from Wenner Place to Jay Place until Pepsi installed 2 around 2000 when they moved in. One attendee recalled how the community used their own money to address "underground streams" and in 1990 they got a sewer. One attendee expressed disappointment that large acreage properties that were generally natural were being sold for and large impervious surfaces were being allowed to be built. DEP noted that this is no longer allowed: a 2012 building code update requires runoff to not exceed the lesser of 0.25 cfs and the pre-construction runoff condition.

4. **COORDINATION**. It was suggested by several attendees that DEP, DDC, and DOT do not coordinate well when it should be possible for a resident to call 311 and a member of each department would come and investigate the complaint. One example cited was the Waterbury Avenue project, which DEP explained that they decided not to wait for DOT funding issues to be resolved.

5. **COMMUNITY OUTREACH**. There were several questions related to how DEP goes about community outreach. It was suggested that green infrastructure is a good avenue through which to engage the community because people can relate to it and enjoy it. DEP noted that they would come and talk to people, but that they would greatly benefit from the help of those in attendance who would gather groups and disseminate information. Another avenue of engagement suggested was the Westchester Industrial Business Zone (IBZ) along the western shoreline, which is filled with large, flat roofs. It was suggested that DEP reach out to SOBRO to see if there are opportunities there. DEP responded that they have worked with SOBRO but not in this particular IBZ. Another attendee recalled a “stellar” committee under CB10 related to the Pelham Bay landfill, and suggested that CB10 should have an environmental committed (they currently have a public services committee).

6. **SCHEDULE**. Several attendees expressed frustration with the overall timeline, having attended public meetings decades ago and still not seeing progress. It appeared to one attendee to be a lot of study and not much is happening. DEP noted that there is an enforceable Consent Order and that DEP has been investing in the waterbodies as demonstrated with the current improvement projects in Westchester Creek.

7. **GREEN INFRASTRUCTURE**. Green infrastructure was met enthusiastically by the attendees. One attendee asked whether the GI budget could be larger. DEP agreed, noting that GI is cheaper than grey infrastructure and less disruptive. They also noted that DEP works within the street rights-of-way (ROW) and city-owned properties, employing green roofs, rain gardens, permeable pavement, and other technologies, along with its ongoing grant program. The last of these funded projects at Albert Einstein and Montefiore along Eastchester Road, among many other projects citywide. One attendee observed that the siting process seeks opportunities, but wondered at what point it is known to be practicable, so that you avoid the risk of making a commitment in the LTCP that cannot be accomplished. DEP acknowledged that this is a known risk, but they have a standard that they have to meet. There are already GI milestones in a Consent Order that phase to the ultimate endpoint of buildout, so it is in DEP’s interest to do as much GI as they can once they have identified a site.

8. **GI MAINTENANCE**. The attendees recognized the need for maintenance of GI systems. The local community installed tree pits along Brush Ave that took a very long time to water, leading them to seek assurances that these sites would be maintained once installed. DEP responded that, when they build something in the street, the city is responsible for maintenance. From the beginning they have sought to ensure maintenance, instituting funding of Parks Department crews dedicated to this who visit sites twice a week generally. They also visit more frequently at sites located within commercial areas or other neighborhoods where there is a higher risk of damage or need for maintenance. One attendee asked about maintenance of green roofs or green farms on private property. DEP responded that the property owner is responsible for the maintenance.

9. **WATER QUALITY**. Westchester Creek is holding its own. They are catching 4-foot fish mussels, people eating what they catch. This is true throughout the city. The WWTPs are constantly being upgraded. NYC harbor is the cleanest it has been for more than a century of testing.

OTHER IDEAS. It was noted that in Gowanus Canal DEP has a propeller to encourage circulation in the waterbody. DEP responded that this brings in water from another waterbody through an existing tunnel, and so could not be implemented in Westchester Creek. An attendee suggested that there are acres of land along I-95 that could be used for managing stormwater in the area.

Appendix D: Westchester Creek Use Attainability Analysis

EXECUTIVE SUMMARY

The New York City Department of Environmental Protection (DEP) has performed a Use Attainability Analysis (UAA) in accordance with the 2012 CSO Order on Consent for Westchester Creek; a tributary of the Upper East River, currently designated as a Class I waterbody. Westchester Creek originates as a headwall at CSO outfall HP-014 and flows in a southerly direction toward the East River (Figure 1). There is no natural base flow in the creek since any natural flow has been incorporated into the NYC municipal drainage system.

Figure 1. Aerial View of Westchester Creek

Detailed analyses performed during the Westchester Creek Long Term Control Plan (LTCP) concluded that the designated Class I secondary contact recreational uses in Westchester Creek are in full attainment (100 percent) for the fecal coliform criterion. However, based on this technical assessment, it was found that Westchester Creek would be unable to attain Primary Contact Water Quality (WQ) Criteria 100 percent of the time throughout its full extension. The inability to meet a primary contact standard is primarily due to direct drainage, CSO and urban runoff. Based upon modeling, DEP projects that with the completion of the projects listed in this LTCP, there will be some improvement in water quality in Westchester Creek. On the basis of these findings, DEP is requesting, through the UAA process, that the

New York State Department of Environmental Conservation (DEC) consider site-specific water quality targets for Westchester Creek, and recommend that a portion of the creek be upgraded to SC/SB on a recreational season basis.

INTRODUCTION

Regulatory Considerations

DEC has designated Westchester Creek as a Class I waterbody. The Class I classification does not provide for primary contact. The best usages of Class I waters are "secondary contact recreation and fishing" (6 NYCRR 701.13). The next higher classification is Class SC. The best usages of Class SC waters are "limited primary and secondary contact recreation and fishing" (6 NYCRR 701.11). The SC classification is presumed by DEC to be equivalent to attaining the fishable and swimmable goals of the CWA.

Figure 2 - Westchester Creek Shoreline

Federal policy recognizes that the uses designated for a waterbody may not be attainable, and the UAA has been established as the mechanism to modify the WQS in such a case. Here, Westchester Creek meets the existing designated use classification. However, elimination of all CSOs will not result in attainment of the next higher classification of SC or SB (note that the bacteria criteria for both of these classifications are the same).

This UAA identifies the attainable and existing uses of Westchester Creek and compares them to those designated by DEC, in order to provide data to establish appropriate WQS for these waterways. An examination of several factors related to the physical condition of the waterbody and the actual and possible uses suggests that the uses listed in the SC classification may not be attainable.

Under federal regulations (40 CFR 131.10), six factors may be considered in conducting a UAA:

1. Naturally occurring pollutant concentrations prevent the attainment of the use; or

2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or

3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or

4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original conditions or to operate such modification in a way that would result in the attainment of the use; or

5. Physical conditions related to the natural features of the waterbody, such as the lack of proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or

6. Controls more stringent than those required by Sections 301(b) and 306 of the Act [CWA] would result in substantial and widespread economic and social impact.

Identification of Existing Uses

Although the Westchester Creek watershed is primarily residential with some commercial, industrial and open space uses, the bulk of those commercial and industrial uses are concentrated along the immediate shorelines of the Creek. This limits direct shoreline access to Westchester Creek by the public to the parkland areas near the mouth (Figure 2). The eastern shoreline is bordered by the Hutchinson River Parkway and commercial properties along its entire length. The head end of the creek is inaccessible from the Lehman High School athletic fields that occupy the property to the north, and the western shoreline is characterized by large commercial and industrial uses (Figure 3). The limited residential areas in the vicinity of Westchester Creek do not have direct access other than the parkland areas near the mouth. One of the southern parkland access ways to the shoreline is at Pugsley Creek, where the NYC Parks Department has provided a walking platform along a portion of its shore. Pugsley Creek is tributary to Westchester Creek at the very downstream end of Westchester Creek, where it joins the East River (Figure 5). Access is possible from Ferry Point Park on the eastern shore near the mouth, and at Castle Hill Park between Pugsley and Westchester Creeks.

Figure 3. Head End of Westchester Creek Showing Outfall HP-014, Lehman H.S. and Fuel Barging Operation

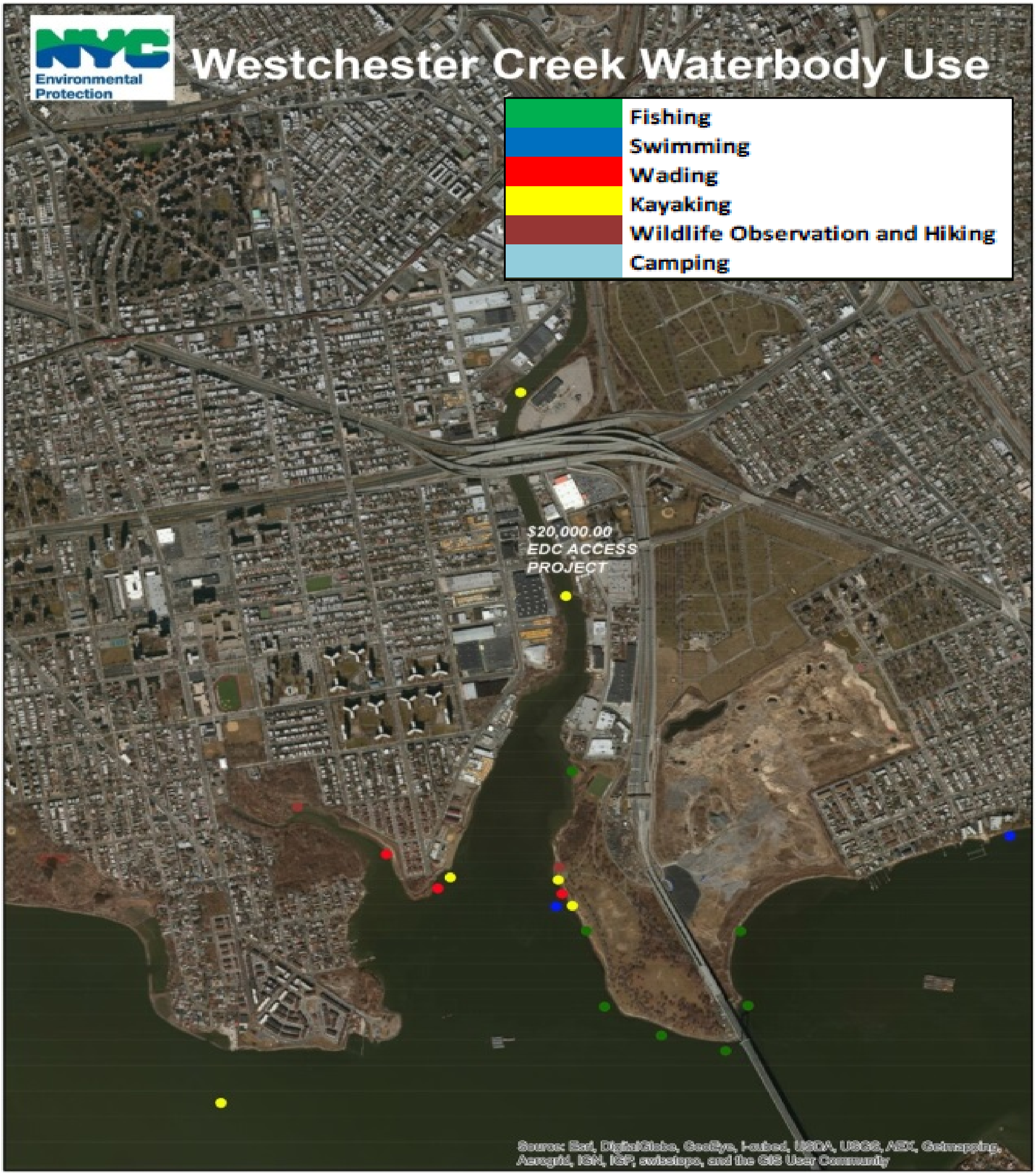

Figure 4. Uses Identified by the Public

Figure 5. Puglsey Creek Shoreline

With no access to the shoreline, Westchester Creek is not suitable for bathing and as such there are no NYC DOHMH certified bathing beaches anywhere within the waterbody. Furthermore, because of the industrial nature of the waterbody, there are limited opportunities for kayaking, although that is an existing use. There are no areas suitable for wading or bathing, although, at a public meeting, comment was provided that at an area near the mouth of the creek there have been instances of body immersion (Figure 4). Other uses identified by the public included fishing and wading. Notwithstanding this input, the bulk of the waterbody is unsuitable for primary contact uses.

ATTAINMENT OF DESIGNATED USES

Westchester Creek is a Class I waterbody, suitable for secondary contact recreation and aquatic life propagation and survival. As noted previously, Westchester Creek is used infrequently for secondary contact recreation, and although the public noted evidence of limited full body immersion, primary contact is not an existing use. However, as part of the LTCP, an analysis was performed to assess the level of attainment if DEC were to reclassify Westchester Creek to Class SC (limited primary contact recreation).

Water quality modeling and observed data indicate that the existing Class I (secondary contact) bacteria criterion is being achieved. With respect to the Class SC WQS, the attainment of the fecal coliform numeric criteria throughout the entirety of Westchester Creek is not possible 100 percent of the time due to CSOs as well as additional pollutant sources other than CSO (namely, direct drainage and urban stormwater). With complete removal of CSOs, attainment is still not possible due to other sources. However, the analyses indicate that the waterbody would attain the SC/SB fecal coliform (monthly median) numeric criteria during the recreational season.

An analysis was also conducted during the development of the LTCP using 10 years of water quality model projections from 2001 through 2011 to predict the time to recover in Westchester Creek following a rain event. As primary contact uses could be attained in Westchester Creek during the recreational season a high percent of the time, DEP used the primary contact fecal coliform recreation criterion of 1,000 counts/100 ml from the NYS DOH guidelines and 130 counts/100 ml from the 2012 Recreational Water Quality Criteria (RWQC) recommendations in this analysis. The result of the analysis is summarized in Section 8 of the Westchester Creek LTCP report. As noted, the duration of time within which bacteria concentrations are expected to be higher than NYS DOH considers safe for primary contact varies based on rainfall event size. Generally, a value of around 48 hours appears to be reasonable for the Inner Area of Westchester Creek. Figure 6 shows the delineation of the inner and outer areas of Westchester Creek.

DEP has been using model projections in various waterbodies and near beaches to assist with advisories that are typically issued twice a day. The recovery time is essentially the timeline that the waterbody will not support primary contact and is intended to advise the water users of the potential health risk associated with this use during this time period.

Figure 6. Inner and Outer Areas of Westchester Creek

CONCLUSIONS

Westchester Creek attains the existing Class I WQS but cannot fully achieve the primary contact water quality criteria of Class SC, based on fecal coliform on an annual basis. However, the analyses show, that primary contact water quality criteria can be attained throughout the recreational season a high percent of the time with the caveat that during and after rain events, bacteria levels will be elevated. Westchester Creek is not used for primary contact recreation, so the non-attainment of fishable/swimmable standards during and after rainfall or during the non-recreational season would not impact existing waterbody uses. Non-attainment of primary contact water quality criteria are attributable to the following UAA factors:

- Human caused conditions (direct drainage and urban runoff) create high bacteria levels that prevent the attainment of the use and that cannot be fully remedied for large storms (UAA factor #3).

- Changes to the shoreline to channelize it and create bulkheads have modified the water such that access to the Creek is limited [See UAA factor #4 (40 CFR 131.10(g)(2)]

It should be emphasized that the Westchester Creek watershed is an industrial waterway with no shoreline access points for recreation and very limited known recreational uses of the waterway.

RECOMMENDATIONS

Westchester Creek attains the current Class I criterion for bacteria. Adopting primary contact water quality criteria in Westchester Creek is possible on a limited basis although it may not result in increased uses given the existing industrial uses and the lack of adequate access points. DEP has identified seasonal site-specific water quality targets.

DEP believes DEC could adopt site-specific bacteria targets for the creek during the recreational season to advance the Creek towards the numerical limits established, or under consideration by DEC, including SC bacteria standards and Future Primary Contact WQ Criteria consistent with the 2012 EPA RWQC. DEP notes that these targets are based on projections and may require adjustment based upon post-construction monitoring results. DEP has identified the following site-specific bacteria targets:

Recreational Season Site-Specific Targets: Uses of Westchester Creek generally oriented around the recreational season (May 1st – October 31st). DEP has identified that the following numerical site-specific targets be established for the creek for recreational season against which continual water quality improvements be measured:

Maximum rolling 30-day GM enterococci value of 300 cfu /100mL

Monthly fecal coliform GM concentration of 600 cfu/100mL

With anticipated reductions in CSO overflows resulting from grey and green infrastructure, the Creek could be protective of limited primary contact should it occur, as long as it did not occur during and following rainfall events. Toward that end, DEP believes that a wet weather advisory would be appropriate for that area of the waterbody and should be implemented if DEC were to upgrade the area to a primary contact classification.