Development and Evaluation of Alternatives Report

Borough of Fort Lee

June 2019
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Certification

Fort Lee Development and Evaluation of Alternatives Report

Submitted on behalf of the following participating Permittee

by the Borough of Fort Lee

NJPDES Number NJ0034517 (Borough of Fort Lee)

NJPDES Certification:

"I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted; or (b) as part of a cooperative effort by members of a hydraulically connected system, as is required under the NJPDES Permit, to provide the information requested. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: ____________________

Alfred R. Restaino, Borough Administrator

Date: 6/26/19
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Executive Summary

This report is being provided as one of several reports required for the Fort Lee Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) under NJPDES Permit No. NJ0034517. It evaluates control alternatives but makes no claims as to the ultimate control that will be selected. Costs are also developed for some control alternatives but these are comparative costs developed solely for making comparisons of the capital and operating costs of the alternatives. Fort Lee has not yet committed to providing for the costs associated with control of their CSOs.

The borough of Fort Lee was issued a Combined Sewer Overflow (CSO) permit (NJPDES Permit No. NJ0034517) by the New Jersey Department of Protection in 2015. The permit requires the development of a Long Term Control Plan for reducing CSO’s by June 1, 2020. There are several requirements for reports and other actions. This report, Development and Evaluation of Alternatives Report, discusses all the alternatives available for CSO reduction and selects alternatives that could be used to reduce CSOs in Fort Lee.

The Borough of Fort Lee comprises approximately 1,600 acres which is serviced by combined and separately sewer areas. The combined sewer system consists of approximately 640 acres discharging to three pump stations and two CSO outfalls. The CSO outfalls are activated in rain storms.

One significant improvement was made in 2016 to the combined collection system that impacts CSOs. In 2016 a sewer infrastructure project servicing the new Hudson Lights project revised the sewer collection system. Before 2016, the Lower Main Pump Station sent pumped flow to a 12 inch pipe by gravity to the Palisade Terrace Pump Station which would then pump to the interceptor. After 2016, the flow from the Palisade Terrace Pump Station was rerouted to a new 12 inch pipe that discharges directly to the BCUA interceptor. In addition to the rerouting the flow, the pump station capacity was upgraded from 2 MGD to 5 MGD. This change in the combined sewer system reduced annual CSOs at the Palisade Terrace outfall from 11.73 MGD to 4.17 MGD. This reduction in CSOs corresponds to 84.7% CSO capture which almost achieves EPA’s CSO control policy objective of 85% capture.

The CSO outfalls are in a neighboring town, Edgewater, on the Hudson River. The Hudson River is an SE2 water body in the vicinity of Fort Lee with a fecal coliform criteria (geometric mean) of 770 cfu/100 mL. Currently, sampling programs show the water quality to be in compliance with this criteria; therefore, water quality is not a driver for CSO control.

If Fort Lee is required to reduce CSOs further, the alternatives that they could use to reduce or eliminate CSOs are gray infrastructure alternatives such as disinfection, high rate filtration with disinfection and storage tanks. Peracetic Acid (PAA) would be the likely disinfection process selected because of the long shelf life of PAA and the non-toxic nature of any residual concentration. Testing of the
PAA disinfection process with and without high rate filtration would likely be performed to gather design data.

Control alternatives that could reduce but not eliminate CSOs are sewer separation and green infrastructure. Fort Lee may use sewer separation or green infrastructure to increase CSO capture to 85%. If more CSO capture is required by NJDEP then we will consider the gray infrastructure alternatives of disinfection, high rate filtration with disinfection and storage tanks.

The lifecycle cost for achieving 85% capture by sewer separation or GI ranges from $6,250,000 to $10,000,000. For tank storage, the most expensive CSO control alternative considered, the range is $47,000,000 to $167,000,000. For filtration with disinfection the cost range from $36,000,000 to $85,000,000. If disinfection alone proves to be a viable option then costs may range from $3,720,000 to $7,270,000. These evaluations of alternatives will serve as a base for the consideration and development of final selected CSO control plan in Fort Lee. We believe the most cost effective solution for meeting water quality objectives and complying with the EPA CSO control policy will be GI, sewer separation or disinfection with PAA.
1 Introduction

This report is being provided as one of several reports required for the Fort Lee Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) under NJPDES Permit No. NJ0034517. It evaluates control alternatives but makes no claims as to the ultimate control that will be selected. Costs are also developed for some control alternatives but these are comparative costs developed solely for making comparisons of the capital and operating costs of the alternatives. Fort Lee has not yet committed to providing for the costs associated with control of their CSOs.

1.1 Sewage System Description

Fort Lee’s wastewater services spreads to over 1,600 acres of which 640 acres are serviced by a combined system. The service area extends along the Palisade Ridge adjacent to the Hudson River. The Fort Lee CSS includes three (3) pump stations, their regulators, and two (2) discharge points. The three (3) pump stations are Palisade Terrace Pumping Station (PTPS), Lower Main Pumping Station (LMPS), and Bluff Road Pumping Station (BRPM). During the 2017 flow metering, flows at these pump stations were metered. The tributaries to these pumping stations are described in the following sections.

1.2 Service Area Land Use Data

The sanitary flow in Fort Lee is primarily residential with some commercial flow. Figure 1-1 displays the various land use types in Fort Lee. There are no planned changes to land use type in the future.

![Figure 1-1. Land Use Type in Fort Lee](image-url)
1.2.1 Palisade Terrace Pumping Station (PTPS)

The PTPS collects dry weather flows from the north-western portion of the Borough that has an area of about 340 acres. The land use in the drainage area is mostly residential. The PTPS drainage area has the population of approximately 9,100 people who contribute on average of 1.23 million gallons per day of dry weather flow.

Most of this area is separately sewered with the exception of McCloud Drive. Additional Inflow and Infiltration (I&I) sources (e.g., sump pumps, groundwater infiltration, etc.) contribute flows to the pump station during wet weather periods. The PTPS pumped flows discharge to the BCUA interceptor starting at the intersection of Route 4 and Edwin Avenue.

1.2.2 Lower Main Pumping Station (LMPS)

The LMPS collects flows from the north-eastern portion of the Borough and has a drainage area of about 167 acres. The drainage area is primarily residential. The LMPS has approximately 2,500 people who contribute on average 0.64 million gallons per day of dry weather flow. This drainage area is separately sewered with the exception of English and Cedar Street. I&I is also prevalent in this drainage area. Before 2016 the LMPS sent pumped flow to a 12 inch pipe on Parking Avenue, from which the flow traveled by gravity to the PTPS. After 2016, the flow from the pump station was rerouted to a 12 inch pipe that discharges to the BCUA interceptor. In addition to the rerouting the flow, the pump station capacity was upgraded from 2 MGD to 5 MGD.

1.2.3 Bluff Road Pumping Station (BRPS)

The BRPS collects dry weather flow from about 493 acres from the southern portion of the Borough. This drainage area is primarily residential. The BRPS has approximately 12,100 people who contribute on average 1.83 dry weather flow.

Unlike the other drainage areas, this area is serviced mostly by combined sewers with the exception of Anderson Avenue and the areas north of the street. The pump station can pump 6 MGD of flow.

1.2.4 Direct Drainage to BCUA Interceptor

Within the Borough of Fort Lee there are two drainage areas that drain directly to the BCUA interceptor Sewer. BCUA-1 combines with the Bluff Road Pumping Station and drains downstream of the Overpeck Valley Sewer. BCUA-1 has an approximate population of 3,500 with an average flow of 0.5 MGD. BCUA-2 directs to the Fort Lee East Interceptor Sewer and combines with both Lower Main and Palisades Pumping Station upstream of the Overpeck Valley Trunk.
Sewer. BCUA-2 drainage area contains approximately 7,800 people with an average flow of 2 MGD. Both areas are separated and primarily residential.

1.2.5 Combined Sewer System Characteristics

Prior to 2016 the Fort Lee model discharged flow from the Lower Main pump station to the Palisades regulator. In 2016 this was revised with the construction of the Hudson Lights project. Lower Main Pump Station was upsized and a new 10” line was installed connecting it directly to the BCUA Interceptor. The overflow from the Lower Main Pump Station still combines with the overflow from the Palisades Pump Station and discharges to Outfall 2. The new pumps at Lower Main were built to handle additional flows from new housing development, Hudson Lights, in the Lower Main drainage area.

The changes to the Fort Lee model include the following:

1. Population and landuse updates.
2. Increased capacity of the Lower Main Station.
3. Redirection of the Lower Main Pump Station discharge from the Palisade Pump Station directly to the BCUA Interceptor.
4. Incorporation the Hudson Lights 16 acre redevelopment project.
5. Addition of seasonal variability to infiltration and inflow flows.

After these changes were made the model was recalibrated to flow data collected during October to December 2017 and validated to BCUA flow metering data from March 1, 2017 to August 27, 2017. Once the model was calibrated and validated a one year simulation was performed using the rainfall design year of 2004. The simulation was performed before and after the redirection of the Lower Main Pump Station discharge to the BCUA Interceptor to see the effect of this change. Overflows for both conditions are summarized below. Before the Lower Main flow was redirected to the interceptor the simulation resulted in 38 overflows totaling 11.73 MGD at the Palisade netting facility. By redirecting the discharge directly to the interceptor, overflows were reduced to 22 and total volume was reduced to 4.17 MGD. This is a 42% reduction in overflows and a 64.5% reduction in overflow volume. This model revision simulates how the collection system currently works.

| Table 1-1. Comparison of Model Results Before and After Revising the Operation of the Lower Main Pump Station |
|---------------------------------------------------------------|---------------------------------------------------------------|
| **Condition** | **Outfall 001 (Bluff Road)** | **Outfall 002 (Palisade Terrace)** |
| | Overflows | Volume | Overflows | Volume |
| 2004 before redirection of Lower Main | 60 | 77.20 | 38 | 11.73 |
| 2004 after redirection of Lower Main | 60 | 77.20 | 22 | 4.17 |
Netting systems are utilized by Fort Lee to remove floatables from the CSOs and meet USEPA “Nine Minimum Controls” and the Long Term Control Plan requirements. The netting systems were installed in 1998. The netting systems are inspected at least monthly by DPW personnel. Inspections are undertaken prior to anticipated storm events, and after significant storm events.

The netting systems are in-line TrashTrap systems manufactured by Fresh Creek Technologies, Inc. who is currently owned by Storm Trap. Each netting facility contains two nets. The netting units are installed in in-line chambers and are installed in line with the combined sewer system pipe. A fixed hydraulic relief
screen located upstream of the nets assures screening of the flow under all conditions and provides additional system capacity. The screen is inclined in the direction of flow so that any debris caught on this screen falls into the nets as the water level in the chamber recedes. The screen will also work as a weighted relief valve, if required, to reduce back pressure. Grating under the nets allows them to drain dry. Debris is captured and contained in disposable nets. The disposable nets and support frame are housed in a rack assembly installed in the chamber.

Net maintenance and change outs are scheduled based on periodic visual inspection. The system is maintained by Fresh Creek/Storm Trap through ground-level lockable access doors on the top of the netting chamber. There is no confined-space entry required during routine service because the disposable nets and frames are lifted from the chamber to perform the net change-out above ground. A hoist truck for changing the nets and a container for holding the full nets are used for maintenance. A crew of two typically accomplishes the net change-out. The full nets are disposed of at an approved facility.

1.4 Recent Reports or Plans

The 2004 NJPDES permit for Fort Lee required the Borough to develop a Long Term Control Plan (LTCP) in accordance with the National CSO Control Policy. This phase of the CSO program required development and evaluation of the feasibility of a range of control alternatives to reduce CSO frequency and pollutant loadings pursuant to the Federal Clean Water Act (CWA) goals and consistency with EPA’s CSO Control Policy. It resulted in the following studies and reports:

- Interim Service Area and Land Use Report for Fort Lee, March 2007;
- Rainfall Monitoring Study Report for Borough of Fort Lee, March 2007;
- Interim System Inventory and Assessment Report for Borough of Fort Lee, March 2007;
- Interim Combined Sewer System Modeling Report for Borough of Fort Lee, March 2007;
- Combined Sewer Overflow Interim Monitoring Report for Fort Lee, March 2007; and

These reports presented the development of the Long Term Control Plan in 2007.

Two subsequent reports were used to define the reconfiguration for the combined sewer system:
• Engineer’s Design Report For Lower Main Pumping Station and Force Main, March 2013; and
• Calculations Report for Flow Reduction to Lower Main Pump Station Due to Sewer-Storm Separation at Fort Lee Redevelopment Projects, April 2013.

The following reports were prepared for the development of the 2020 LTCP:

• New Jersey CSO Group Baseline Compliance Monitoring Program Report, June 30, 2018;
• Identification Of Sensitive Areas Report, May 2018;
• BCUA CSO Group Public Participation Program Report, June 27, 2018 revised January 4, 2019;
• Public Participation Program Report for the Borough of Fort Lee, January 18, 2019; and

1.5 Approach to Development and Evaluation of Alternative Controls

The USEPA recommends a three-step sequence for the development of alternatives:

1. Definition of water quality objectives.
2. Definition of a range of CSO control goals to meet the CSO component of the water quality goals.
3. Development of alternatives to meet the CSO control goals.
2 General Information

2.1 Public Participation Process

According to the NJPDES permit, each permittee is required to establish a Supplemental CSO team comprised of members of the public and other stakeholders. The Supplemental CSO Team works with the permittee’s consultants and assigned staff to act as a liaison between the general public and the decision makers for the permittee. The Borough also created a local CSO Team to carry out the same functions. The goals of the Supplemental and Local CSO Teams consists of the following elements:

- Meet periodically to assist in the sharing of information and to provide input to the planning process;
- Review the proposed nature and extent of data and information to be collected during LTCP development;
- Provide input for consideration in the evaluation of CSO control alternatives; and
- Provide input for consideration in the selection of those CSO controls that will cost effectively meet the Clean Water Act requirements.

The BCUA CSO Group established a Supplemental CSO Team by posting an invitation on its website providing notification of the project and inviting individual members, or interest groups with the community to join. The website invitation was posted for approximately a one-month period, but there was no public response.

In an effort to obtain regional input the BCUA extended a personal invitation to the Hackensack River Keeper, who accepted. In addition, each member of the BCUA CSO Group was invited to designate two members of their municipality or supplemental team to join the Regional Team. The members identified by Fort Lee are:

- Jan Goldberg;
- Bob Applebaum; and
- Sal Pagano.

Meetings for the BCUA CSO Group were scheduled on a roughly quarterly basis. Attendance at each meeting was good, with most of the members attending each meeting. The CSO treatment objectives, and alternatives have been discussed at these meetings.

Mr. Goldberg, Mr. Applebaum, and Mr. Pagano are also on the Local CSO Team. Three local team meetings were held with all members in attendance at each. In
addition to the team members, the Mayor, Council members, Borough Engineer and Department of Public Works members also attend some meetings.

2.2 Approximated Future Conditions

One large redevelopment project in Fort Lee is The Modern and Hudson Lights complex which have been under construction since 2013. The Modern is a residential skyscraper complex with two buildings near the western end of the George Washington Bridge. The towers are part of a larger 16 acre urban renewal project for the long vacant parcel. They are separated by a 1.75-acre public park. An adjacent project called Hudson Lights will feature retail, including a three-screen movie theater, as well as a hotel and office space. The complex will contain approximately 1400 residential units.

![Figure 2-1. Photo of the Modern A and B and Hudson Lights](image)

2.2.1 Projections of Population Growth

The population growth was estimated for 2045 and was based on the New Jersey Transportation Planning Authority. The population for Fort Lee is projected to be 43,747.
3 Water Quality Objectives

The New Jersey CSO Group submitted a report to NJDEP presenting the results of the Baseline Compliance Monitoring Program that was conducted in 2016 and 2017. These efforts are described in Baseline Compliance Monitoring Program Quality Assurance Project Plan, 2016 and in NJCSO Group Compliance Monitoring Program Report, 2018.

3.1 Applicable Water Quality Standards

The sampling program was not designed to provide an adequate data volume for assessing attainment of water quality standards, which would have required five samples per month at each sampling location to compute monthly geometric means. However, a review of the data collected can indicate the likelihood of attainment in the Hudson River in the vicinity of Fort Lee.

Figure 3-1 presents the data that was collected during the sampling program for the Hudson River at Fort Lee. This location is a classified as a SE2 water body with a fecal coliform standard of 770 cfu/100 mL as a geometric mean. Data are presented as open circles for surface data, filled gray circles for mid-depth data, and filled black circles for bottom data. Secchi depth does not fall into a specific depth category, but is plotted with filled black circles. Turbidity is shown on the same panel as Secchi depth and is presented with filled green circles. All samples collected in this program were in compliance with fecal coliform standard of 770 CFU/100 mL.

3.2 Range of CSO Goals Being Evaluated

Fort Lee will specify its intention to comply with the Presumptive or Demonstration Approaches in its final LTCP. The Presumptive Approach implies compliance with the CSO treatment goals if one of three conditions are met. The Demonstration Approach allows a municipality to demonstrate compliance without meeting the criteria.

The preliminary indication is that it will comply with the Presumptive Approach with the understanding that capturing 85% of the CSO will be deemed to be in compliance with the NJPDES permit and EPA CSO Policy. The Policy states:

A program that meets any of the criteria listed below would be presumed to provide an adequate level of control to meet the water quality-based requirements of the CWA, provided the permitting authority determines that such presumption is reasonable in light of the data and analysis conducted in the characterization, monitoring, and modeling of the system and the consideration of sensitive areas described above. These criteria are provided because data and modeling of wet weather events
often do not give a clear picture of the level of CSO controls necessary to protect WQS.

i. No more than an average of four overflow events per year...

ii. The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis...

iii. The elimination or removal of no less than the mass of pollutants, identified as causing water quality impairment..., for the volumes that would be eliminated or captured for treatment under paragraph ii... " (Section II.C.4.a.)

Fort Lee will need to understand NJDEP’s thoughts on the Presumptive Approach criteria and if they are receptive to 85% CSO capture as being in compliance. It is understood that the post construction compliance sampling program, subsequent to the LTCP, will also have to demonstrate compliance.
Figure 3-1. Water Quality Results for the Hudson River in Fort Lee near George Washington Bridge
4 Screening of CSO Control Technologies

4.1 Introduction

This section of the report focuses on the technology screening process and the evaluation of CSO control alternatives as per the requirements of the NJPDES Permit. In order to determine the appropriate CSO control technologies, a preliminary comprehensive review of combined sewer overflow technologies was completed to determine those technologies that have the greatest potential to meet the requirements of the NJPDES Permit. This screening of technologies complies with the requirements of the Combined Sewer Overflows (CSOs) Control Policy Section II.C.4 and is consistent with the EPA’s “Guidance for Long Term Control Plan.” The Alternatives Evaluation shall consist of:

- Technology Screening Process; and
- Identification and Evaluation of Specific CSO Control Alternatives.

This screening of technologies does not consider cost or the cost effectiveness, and is only meant to exclude those CSO control technologies not technically or physically applicable to the service area. The results of this screening have brought several CSO control technologies forward for more detailed consideration in the development of the LTCP. These control technologies are further discussed in Section D of this report.

4.1.1 Water Quality and CSO Control Goals

With respect to water quality, control technologies are screened for their effectiveness on addressing pollutants of concern and CSO control goals to achieve compliance with the CWA, including:

- Reducing the count of fecal coliform colonies;
- Reducing the count of Enterococcus colonies;
- Reducing the count of Escherichia coli colonies; and
- CSO discharge volume reduction.

4.1.2 Evaluation Methodology Used for This Study

The CSO control technologies evaluated in this section have been assigned a value based on their effectiveness at reaching primary and secondary CSO control goals. Descriptions of the goal effectiveness categories are detailed below:

- High: The CSO control technology will have a significant impact on this CSO control goal and is among the best technologies available to achieve
that goal. These technologies may be considered for further evaluation for this reason.

- **Medium:** This technology is effective at achieving the CSO control goal, but is not considered among the most effective technologies to achieve that goal.
- **Low:** This technology will have a minor impact on this CSO control goal. These technologies will need other positive attributes to be considered for further evaluation.
- **None:** The CSO control technology will have zero or negative effect on the CSO control goals.

CSO control technologies will be recommended for further evaluation based on multiple factors. The first factor will be the goals effectiveness value that generally quantifies the impact a technology will have towards achieving a water quality goal. These goal-effectiveness values are described above. The second factor is whether or not the NJPDES Permit requires further investigation of a technology. The permit identifies certain technologies that must be evaluated further. The third and final factor in determining whether a technology will be evaluated further is the current or future implementation and operation of that technology. If the technology is currently in place, will be implemented, or is mandated by the Nine Minimum Controls, then an evaluation is unnecessary.

Potential CSO control technologies generally fall into the following broad categories:

- **Source Controls:** Green infrastructure; public and private infiltration and inflow (I/I) reduction and removal; sewer separation; and best management practices (BMPs)/Nine Minimum Controls, including floatables control.
- **Collection System Controls:** Gravity sewers; pump stations; hydraulic relief structures; in-line storage; outfall relocation/consolidation; and regulator/diversion structure modification.
- **Storage Technologies:** Above and below ground tanks; and tunnels.
- **Treatment Technologies:** Screening and disinfection; vortex separation; retention/treatment basins; high rate clarification; and satellite sewage treatment.

A CSO technology that is highly effective in one or all evaluation factors will likely be recommended for further investigation. A CSO technology that does not reach a “medium” effectiveness water quality goals will not be recommended for further evaluation.

The following discussion is structured to closely follow the order of CSO technologies listed in the NJPDES Permit. A summary of technologies
recommended for further investigation is provided in Section C.9 Screening of Control Technologies of this report.

4.2 Source Control

The EPA defines source controls as those that impact the quality or quantity of runoff entering the combined sewer system. Source control measures can reduce volumes, peak flows, or pollutant discharges that may decrease the need for more capital-intensive technologies downstream in the CSS. However, source controls typically require a high level of effort to implement on a scale that can achieve a measurable impact. Source controls discussed in the following section will include both quantity control and quality control measures.

4.2.1 Stormwater Management

Stormwater management controls consist of measures designed to capture, treat, or delay stormwater prior to entering the CSS.

4.2.1.1 Street/Parking Lot Storage (Catch Basin Control)

Street and parking lot storage can be accomplished by modifying catch basins to restrict the rate of stormwater runoff that enters the CSS. A portion of the stormwater runoff that would otherwise immediately enter the CSS is allowed to pond on streets or parking lots for a period of time before entering the CSS. This control measure can be very effective at reducing peak flows during wet weather events, when most CSOs occur. However, this practice typically faces strong public opposition and can lead to hazardous road conditions if not managed properly (e.g., hydroplaning, ice formation during winter months, etc.).

4.2.1.2 Catch Basin Modification (Floatables Control)

Catch basin modifications consist of various devices that prevent floatables from entering the CSS. Inlet grates can reduce the amount of street litter and debris that enters the catch basin. Other modifications such as hoods, submerged outlets and vortex valves alter the outlet pipe hydraulics and keep floatables from exiting the catch basin and continuing downstream. These devices also provide a water seal for containing sewer gas. The success of a catch basin modification program is dependent on having catch basins with sumps deep enough to install hood-type devices. A potential disadvantage of catch basin outlet modifications and other insert-type devices is the fact that retained materials could clog the outlet if cleaning is not performed regularly.

4.2.1.3 Catch Basin Modification (Leaching)

Catch basin modifications for leaching consist of catch basin base and riser sections that permit infiltration of stormwater into the ground. Leaching catch basins are generally installed in a geotextile and crushed stone lined excavation.
Leaching catch basin installations are limited to highly permeable soils and should not be installed in series with other drainage structures. Leaching catch basins can be installed with or without an outflow pipe. Basins without an outflow can overflow into streets and parking lots and then freeze under excessive storm events or if soils decrease permeability over time. These control measures function much like an infiltration basin without an emergency overflow pipe. In order to avoid this adverse feature, an outflow pipe should be necessary in all leaching modified catch basins unless there is minimal flow to the basin, and a low overflow damage risk to the surrounding area.

4.2.2 Public Outreach Program

Public education and outreach is a non-structural control measure aimed at limiting the negative effects of certain human behavior on the CSS. Promoting certain human actions and discouraging others can impact the quality and quantity of water discharged to the CSS. A collaboration of entities who own and operate combined sewer systems within the Passaic Valley Sewerage Commission (PVSC) and North Bergen Municipal Utilities Authority (NBMUA) services areas have established the Clean Waterways, Healthy Neighborhoods initiative. The initiative aims to foster public awareness by keeping the public informed of the efforts being taken to reduce the water quality impact of CSOs on the receiving waters in the area. Additional information is available on the following website: https://www.nicleanwaterways.com/.

4.2.2.1 Water Conservation

Water conservation in CSS areas can reduce the volume of direct discharges to the system. Water conservation measures include the installation of low-flow fixtures, education to reduce water waste, leak detection and correction, and other programs. Although this measure has the potential to decrease CSS flows, it has very little impact on peak flows, which cause most CSOs.

4.2.2.2 Catch Basin Stenciling

Stenciling consists of marking catch basins with symbols and text such as, “Drains to the River” or “Only Rain Down the Storm Drain”. This measure can help increase public awareness of the sewer system and discourage the public from dumping trash into the CSS, which can cause blockages and lead to CSOs.

Catch basin stenciling is only as effective as the public’s understanding and acceptance of the program. Catch basin inlet grates have the equivalent effect while not relying on public cooperation.

4.2.2.3 Community Cleanup Programs

Community cleanup programs are an inexpensive and effective way to reduce floatables entering the CSS and provided educational benefits to the community.
Cleanup activities can be organized by local businesses, non-profit organizations, and student chapters at all levels. It is a great way to raise the sense of community spirit and environmental awareness.

4.2.2.4 Public Outreach Programs

Public outreach programs help raise citizens’ awareness of water quality and other environmental issues. Programs educate citizens about CSS's and encourage people to do their part to reduce the grease, toxic chemicals, and floatables from entering local waterways. These items are currently discussed during the project Supplemental CSO Team Meetings (public meetings) and information presented in meetings is available as handouts.

4.2.2.5 FOG Program

Fats, oils and grease (FOG) are not water soluble and will buildup and clog sewer and drainage pipes, resulting in messy, costly sanitary sewer overflows. These overflows are bad for commercial and retail businesses, the environment, and public health. FOG programs often consist of food service establishment inspection, installation of Grease Removal Devices (GRDs) and development of a preferred pumper program for proper maintenance of GRDs. However, FOG programs have little effect on the amount of bacteria in the collection system and do not provide any flow reductions.

4.2.2.6 Garbage Disposal Restrictions

Garbage disposals provide a convenient means for residences and businesses to dispose of food waste. However, the use of garbage disposals increases the amount of food scrap entering the sewer system and is known to cause blockages and decrease the flow capacity in the CSS. Restricting garbage disposal usage has the potential to decrease the number of blockages that occur each year. Garbage disposal restrictions require an increased allocation of resources for enforcement and can face considerable public resistance. Furthermore, this practice does very little to reduce wet weather CSO events or decrease bacteria loads.

4.2.2.7 Pet Waste Management

When pet waste is not properly disposed of, it can be carried away by stormwater runoff and washed into storm drains or nearby streams. Since storm drains do not always connect to treatment facilities, untreated animal feces often end up in waterways, causing significant water pollution. An effective pet waste management program can help increase public awareness and encourage proper waste disposal. This is a low cost, long term program that has the potential to reduce bacteria loads to both the CSS and directly to local streams.
4.2.2.8 Lawn and Garden Maintenance

Failure to apply chemical treatments to lawns or gardens per USEPA guidelines may lead to ineffective treatment and contamination of the waterways through runoff or groundwater. A public outreach program that explains the guidelines and the reasons they exist may help reduce waterway contamination. This information is currently available to the public on the following USEPA website: https://www.epa.gov/safepestcontrol/lawn-and-garden. Runoff that contains chemical treatments can contribute to decreased water quality downstream of the CSS in the receiving waters.

4.2.2.9 Hazardous Waste Collection

Improperly disposed hazardous waste can find its way into stormwater runoff and into storm drains and waterways. Hazardous waste that ends up in waterways does not necessarily end up in a treatment facility and can cause significant surface water pollution. To prevent this, household hazardous waste collection events can be scheduled a few times every year to allow the community to properly dispose of any hazardous waste.

4.2.3 Ordinance Enforcement

4.2.3.1 Construction Site Erosion & Sediment Control

Construction site erosion and sediment control involves management practices aimed at controlling the transport of sediment and silt by stormwater from disturbed land. Erosion and sediment control has the potential to reduce sediment loads to both the CSS and directly to streams, and can help reduce server cleanout Operation and Maintenance (O&M) costs. The N.J.S.A. 4:24-39, NJ Soil Erosion and Sediment Control Act, requires all construction activities greater than 5,000 square feet to complete an application for certification of an erosion and sediment control plan for activities during construction.

4.2.3.2 Illegal Dumping Control

Illegal dumping is the disposal of trash or garbage by dumping, burying, scattering, or unloading trash in an unauthorized place, such as public or private property, streets or alleys, or directly into the CSS. When it occurs, illegal dumping contributes a considerable amount of floatables to stormwater runoff, as well as a moderate amount of bacteria, settleable solids, and other pollutants. Enforcement of illegal dumping regulations is being led by State Park Police & Conservation Officers and the NJDEP Department of Compliance & Enforcement.
4.2.3.3 Pet Waste Control

As described in the previous section, pet waste can be a significant contributor of bacteria to stormwater. Public education and outreach programs can help raise public awareness and reduce the level of improper waste disposal. Additional gains can be made through enforcement of the pet waste ordinances, which can be an effective tool in achieving public compliance. Significant resources would need to be devoted to enforcement to achieve similar improvements to Pet Waste Management, which requires very few resources to implement.

4.2.3.4 Litter Control

Litter consists of waste products that have been disposed of improperly in an inappropriate area. Litter is easily washed into the collection system during wet weather events, which increases the amount of floatables in the system. Strict enforcement of the litter control ordinances can help to curb violations and decrease the amount of floatables that make their way into the CSS. Similar to Pet Waste Control, public outreach and education is a more effective use of resources to achieve similar water quality improvements.

4.2.3.5 Illicit Connection Control

An illicit discharge is any discharge to the municipal separate storm sewer system (MS4) that is not composed entirely of storm water, except for discharges allowed under a NPDES permit or waters used for firefighting operations. Illicit connections can contribute polluted water, solids, and trash to the stormwater system, where it is eventually discharged to the environment without receiving proper treatment. These connections can be reduced through the implementation of an illicit discharge detection and elimination (IDDE) program. Although this measure does not directly target the CSS, it can have significant impacts on local water quality that can help to address Total Maximum Daily Loads (TMDLs). Illicit connection control is not particularly effective at achieving any of the primary goals of the LTCP.

4.2.4 Good Housekeeping

4.2.4.1 Street Sweeping/Flushing

Municipal street cleaning enhances the aesthetic appearance of streets by periodically removing the surface accumulation of litter, debris, dust and dirt, which prevents these pollutants from entering storm or combined sewers. Common methods of street cleaning are manual, mechanical and vacuum sweepers, and street flushing. However, the total public area accessible to street sweepers is limited, and generally does not include sidewalks, traffic islands, and congested street parking areas. Although street sweeping/flushing can reduce the concentration of floatables and pollutants in storm runoff that originate from the street, the measure has minimal impact on bacteria or CSO volume reduction.
4.2.4.2 Leaf Collection

Leaf collection is an important part of stormwater management because it not only keeps leaves out of the stormwater system to maintain its maximum flow capacity, but also benefits water quality by reducing nutrients such as phosphorous and nitrogen that can originate from the decomposition of leaves. In most municipalities, this long term stormwater management measure is scheduled based on seasonal patterns, and is an effective tool to maintain capacity in both the separate storm sewer and the CSS.

4.2.4.3 Recycling Programs

Recycling programs provide a means for the public to properly dispose of items that may otherwise end up entering the CSS, such as motor oil, anti-freeze, pesticides, animal waste, fertilizers, chemicals, and litter. These programs are usually effective in reducing floatables and toxins.

4.2.4.4 Storage/Loading/Unloading Areas

Industrial and commercial users would be required to designate and use specific areas for loading and unloading operations. This would concentrate the potential for loading and unloading related waste to a few locations on site, making it easier to manage waste. The effectiveness of this technology is limited to the number of industrial users upstream of CSO regulators. If there are no industrial users in the CSS, then this is technology is not applicable.

4.2.4.5 Industrial Spill Control

Industrial users would be required to utilize spill control technologies like containment berms and absorbent booms to mitigate the risk of contaminants entering the waterway or collection system. Similar to Storage/Loading/Unloading Areas, the effectiveness of this technology is limited to the number of industrial users upstream of CSO regulators.

4.2.5 Green Infrastructure

Green infrastructure is a source control that reduces runoff volumes, peak flows, and/or pollutant loads. GI utilizes the processes of infiltration, evapotranspiration, and capture for re-use to reduce the amount of runoff volume (USEPA, 2014). It is effective at increasing the time of concentration of remaining runoff and reducing pollutant loads through sedimentation and filtration. This technology can be used alone in a scalable manner, or it can be used in conjunction with gray infrastructure to reduce its size and cost.

GI's benefits extend beyond reducing the flow of water into CSSs during wet weather events. Through mimicking a more naturalized system, GI can deliver a broad range of ecosystem services or benefits to people, some of which include:
improved community livability (aesthetics and property values), human health, air quality, water quality, groundwater recharge, wildlife habitats and connectivity, reduced heat island effects, reduced energy use, green jobs, and recreational opportunities (USEPA, 2014). It can also help reduce flooding and is flexible for addressing climate change (droughts or increased precipitation). As described in Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control (USEPA, 2014), the EPA requires that any incorporation of GI into a LTCP include analysis in two areas:

1. Community and political support for GI; and
2. Realistic potential for GI implementation.

PVSC and the Permittees will assess the public support from stakeholders in the community and government for the GI alternatives through the implementation of the LTCP Public Participation Plan. The realistic potential for the implementation will first be screened within this memorandum and refined further in the alternatives evaluation.

There are a wide range of potential GI technologies currently in use throughout the country, and many of these include numerous design variations incorporated into a variety of documents and design manuals. The intent of this section is to summarize important aspects of the relevant practices, rather than to provide a comprehensive catalog or detailed design documents.

In addition, there are watershed-scale GI options that are not appropriate for PVSC Service Area due to highly urbanized nature of the CSS area or improper resources to maintain the technology. These include land conservation efforts and creation, preservation, or restoration of riparian buffers, flood plains, wetlands, open space, and forests. These GI options should be encouraged when land use can easily be converted for this intention with minimal upkeep, but this report will not consider these technologies to reduce runoff volume and bacterial loading. With the above considerations in mind, feasible and appropriate GI technologies were evaluated for implementation in buildings, impervious areas, and pervious areas in PVSC Service Area publically-owned property.

### 4.2.5.1 Green Roofs

Green roofs have bioretention media that collect runoff to promote evapotranspiration and achieve water quality through soil media filtration. They are typically shallow in depth (4-8") based on the ability of the building to support the weight of the media, plantings, and captured rainfall. Green roofs may be built in layers on a roof or installed as cells in crates. An example green roof section can be found in Figure 4-1.

Green roofs are recommended for use on buildings with flat roofs (recommended 1-2% slope) that have the structural capacity to support the weight of the media, plantings and water. Structural improvements to an existing building to support
the additional weight associated with a green roof are not typically recommended; therefore this technology is more feasible on new construction. Green roofs can be installed in a section or across an entire roof. An overflow system is typically installed. The vegetation may require irrigation during the first 1-2 years to establish growth. Recommended maintenance for green roofs includes semi-annual maintenance of vegetation.

**Figure 4-1. Example Green Roof Section**

Many rooftop retrofits are required for this GI technology to have measureable impact. Most of the buildings in the CSS are privately owned. Implementing this technology on a scale that would have a measureable impact would require retrofits on private property.

### 4.2.5.2 Blue Roofs

Blue roofs collect runoff to promote evaporation (they do not have plantings) through detention. They are typically shallow in depth (4-8”) based on the ability of the building to support the weight of the media and captured rainfall. Blue roofs may be built in layers on a roof or installed as cells in crates.

Unlike green roofs, a blue roof may not provide any water quality benefits, unless filters or storage media are used specifically for this purpose. The water detained from blue roofs may be used on-site instead of being released with the appropriate modifications.

Blue roofs are recommended for use on buildings with flat roofs (recommended 1-2% slope) that have the structural capacity to support the weight of the media and water. Structural improvements to an existing building to support the additional weight associated with a blue roof are not typically recommended; therefore this option is more feasible on new construction. Blue roofs can be installed in a section or across an entire roof. An overflow system is typically installed to direct the detained water off of the roof. Recommended maintenance for blue roofs includes semi-annual maintenance for clearing of debris.

Similar to green roofs, blue roofs would require implementation on private property to have a measureable impact.
4.2.5.3 Rainwater Harvesting

Rainwater harvesting is the collection and storage of rainfall from buildings to delay or eliminate runoff. The reduction in runoff volume varies based on the size of the rain barrel or cistern storage unit, and the reuse of the stored rainfall. A few typical reuse options are irrigation and vehicle washing. Indoor reuse options, such as toilet flushing and heating and cooling, may be possible if coordinated with building policies.

Rainwater harvesting is applicable to all types of buildings with gutters and downspouts but may be reserved for buildings where green or blue roofs are not appropriate (roof slopes greater than 2%). Storage units may be sized and installed for each downspout or for the building as a whole. Rain barrels, such as those in Figure 4-2, are typically used for residential installations and larger cisterns are typically used for non-residential applications. They are typically placed at grade but can be buried below grade if a pumping system for water reuse is provided. An overflow system is typically installed. Recommended maintenance for rainwater harvesting includes semi-annual maintenance for clearing of debris in the piping or storage unit.

Similar to green and blue roofs, this technology is limited by the number of available roofs, most of which are private. Private residential uses of cisterns are much less common than on private commercial properties, but are encouraged to help reduce combined sewer overflows.

![Figure 4-2. Rain Barrels](image)
4.2.5.4 Permeable Pavements

Permeable pavements promote runoff infiltration and rely on a permeable substrate (engineered soils) to store runoff and remove pollutants. There are different types of permeable pavements, most commonly constructed with asphalt, concrete, or pavers. Permeable asphalt and concrete are similar to traditional mixes except that the amount of fine aggregates is reduced or eliminated. Permeable pavers are individual paver units laid together to create a paved surface. The depth of the permeable substrate, anywhere from 3-10 feet, will have the largest impact on runoff volume reduction. Substrate design may incorporate stormwater retention chambers to increase storage volume. Underdrains may be necessary depending on the local soil types, depth of substrate, and groundwater elevation.

Permeable pavements are recommended for low traffic and low speed traffic areas such as sidewalks, parking lanes, parking lots, driveways, and alleys. Figures 4-3, 4-4, and 4-5 show slightly different pavement includes semi-annual inspection and vacuuming. Preventative maintenance is also necessary to minimize the introduction of soil and other fine particles that could clog the pavement pores.

This GI technology can be very effective when implemented in parking lots, parking lanes, and narrow sidewalks where planter boxes cannot be implemented.

Figure 4-3. Example Permeable Sidewalk Section
Planter Boxes

Planter boxes are bioretention cells that collect runoff and promote runoff infiltration. These walled units are similar to free-form rain gardens as vegetated depressions (12-24") that rely on ponding and a permeable substrate (engineered soils) to store runoff and remove pollutants. The depth of the permeable substrate, anywhere from 3-10 feet, will have the largest impact on runoff volume reduction. An Example Planter Bumpout Section can be found in Figure 4-6. Substrate design may incorporate stormwater retention chambers to increase storage volume. Properly designed planter boxes limit ponding to 3-6 hours after a storm. Ponding overflow pipes and/or underdrains may be necessary depending on the local soil types, depth of substrate, and groundwater elevation. The vegetation promotes evapotranspiration to reduce the volume of the stored runoff.
There are two primary sizes of planter boxes for use based on the drainage pattern in developed areas: sidewalk planter boxes and bumpout planter boxes. Sidewalk planter boxes may also be more specifically referred to as a Tree Well Best Management Practice (BMP), a Tree Well with Soil Panels, a Continuous Planting Strip, Mid-Sidewalk BMP, or a Back of Sidewalk BMP. Sidewalk planter boxes are depressed below the elevation of the existing sidewalk. Bumpout planter boxes are larger units that extend from the sidewalk curb into an area of a parking lane. An example of this design can be found in Figure 4-6. Curb cuts into planter boxes allow roadway runoff to enter the cells and overflow to street inlets once the maximum ponding depth has been reached. Planter boxes are recommended for use in regularly spaced intervals in the downstream drainage path in areas of impervious cover.

Recommended maintenance for planter boxes includes semi-annual inspections and improvements to vegetation and mulch, and annual inspection of overflow pipes and underdrains, if applicable. Inspection after a large storm is also recommended. If there is evidence of ponding after 48 hours, mulch replacement or overflow pipe cleaning may be necessary.

Planter boxes are well suited for highly developed areas where space allows. They can be installed block by-block to contain, infiltrate, and evapotranspirate stormwater runoff.

![Figure 4-6. Example Planter Bumpout Section](image-url)
4.2.5.6 Bioswales

Bioswales are vegetated channels that reduce runoff velocity and promote runoff infiltration. These are linear channels with shallow depressions (6-12”) that incorporate vegetation and a permeable substrate (engineered soils). As a channel, runoff not infiltrated does not pond, but flows through the swale and is conveyed elsewhere. The channels, especially those with slopes greater than 6%, may incorporate check dams to assist in reducing runoff velocity and promote infiltration and pollutant removal. A design example for a bioswale is found in Figure 4-7.

![Figure 4-7. Example Bioswale Detail](image)

Bioswales are recommended for use in parks and areas of natural cover since they primarily reduce runoff velocity and have a low volume reduction per square foot. Due to their linear nature, bioswales may also be effective in the buffer between open space areas and impervious areas with high volumes of runoff such as roads and parking lots. Recommended maintenance for bioswales includes semi-annual inspections and improvements to vegetation and mulch.

This technology incorporates both stormwater treatment and stormwater conveyance. While not as flexible as planter boxes, there may be locations in within the community where a bioswale could be effective.

4.2.5.7 Free-Form Rain Gardens

Rain gardens are bioretention basins that collect runoff and promote runoff infiltration. These are vegetated depressions (12-24”) that rely on ponding and a permeable substrate (engineered soils) to store runoff and remove pollutants. The size and shape of rain gardens can be tailored to site-specific needs, but the depth of the permeable substrate (anywhere from 3-10 feet) will have the largest impact on runoff volume reduction. Substrate design may incorporate
stormwater retention chambers to increase storage volume. Properly designed rain gardens limit ponding to 3-6 hours after a storm. Ponding overflow pipes and/or underdrains may be necessary depending on the local soil types, depth of substrate, and groundwater elevation. The vegetation promotes evapotranspiration to reduce the volume of the stored runoff, and infiltration helps improve water quality. An example of a rain garden is found in Figure 4-8.

Rain gardens are recommended for use in low points in parks and areas of natural cover so they can blend in seamlessly with a grassed buffer and enhance the vegetation without appearing to be a stormwater control mechanism. Locations near the transition from pervious to impervious cover can provide runoff reduction for nearby impervious areas.

Recommended maintenance for rain gardens includes semi-annual inspections and improvements to vegetation and mulch and annual inspection of overflow pipes and underdrains, if applicable.

Annual inspection after a large storm is also recommended. If evidence of ponding exists after 48 hours, mulch and/or soil replacement or overflow pipe cleaning may be necessary.

**Figure 4-8. Example Rain Garden Section**

Rain gardens are very effective at capturing and treating stormwater and have versatile footprints that make them advantageous for use in highly developed urban environments.
4.3 Infiltration and Inflow Control

4.3.1 Infiltration/Inflow (I/I) Reduction

Excessive infiltration and inflow can consume the hydraulic capacity of a collection system and increase overall operations and maintenance costs. Inflow comes from sources such as roof drains, manhole covers, cross connections from storm sewers, catch basins, and surface runoff. Within a CSS, surface drainage is the primary source of inflow. Infiltration comes from groundwater that seeps in through leaking pipe joints, cracked pipes, manholes, and other similar sources. The flow from infiltration tends to be constant, but at a lower volume than that of inflow.

Identifying I/I sources is labor intensive and requires specialized equipment. Significant I/I reductions can also be difficult and expensive to achieve. However, the benefit of a good I/I control program is that it can save money by extending the life of the system, reducing the need for expansion, and lowering treatment costs. I/I reduction for combined sewers provides limited gains, since water tends to find another way into the system. However, I/I reductions in sanitary sewers can have significant impacts on increasing the available capacity in the downstream CSS.

4.3.2 Advanced System Inspection & Maintenance

System inspection and maintenance programs can provide valuable knowledge about the condition of the CSS infrastructure, which is beneficial for planning, inspection, and maintenance activities. This can help ensure design flow capacity is consistently available to prevent CSO events. This technology offers relatively minor advances towards meeting the primary and secondary goals of the LTCP.

4.3.3 Combined Sewer Flushing

This type of operation and maintenance (O&M) practice re-suspends solids that have settled in the CSS and flushes them downstream. This practice consists of introducing a controlled volume of water over a short duration at key points in the collection system using external water from a tank truck, pressurized feed, or by detaining the CSS flow for a period, and then releasing it. Overall, this practice helps reduce the amount of settled solids that are resuspended and discharged during significant wet weather events. This measure is most effective when applied to flat collection systems since solids are more likely to become deposited on flat grades.

4.3.4 Catch Basin Cleaning

Catch basin cleaning reduces the transport of solids and floatables to the CSS by regularly removing accumulated catch basin deposits. Methods to clean catch
basins include manual, bucket, and vacuum removal. Catch basin cleaning can be effective in reducing floatables in combined sewer; however, it is not effective at bacteria reduction or volume reduction, nor is it particularly effective at BOD reduction.

4.4 Sewer System Optimization

Sewer system optimization involves collection system controls and modifications that affect CSO flows and loads once the runoff has entered the collection system. Options for system optimization include measures that maximize the volume of flow stored in the collection system or maximize the capacity of the system to convey flow to the treatment plant. Sewer system optimization techniques have no impact on water quality, but do have the potential to reduce the volume of CSO events.

4.4.1 Increased Storage Capacity in the Collection System

Options for increased storage capacity rely on maximizing the volume of flow stored in the collection system or increasing the conveyance capacity of the system. Maximizing the use of the existing system involves ongoing maintenance and inspection of the collection system, and can include minor modifications/repairs to existing structures to increase the volume of flow retained in the system. Increasing conveyance capacity is typically achieved by providing additional conveyance pipes or upsizing the existing conveyance system to handle a greater capacity.

4.4.1.1 Additional Conveyance

Conveyance is a technology that transports the combined sewage out of a particular area to a location where the flow can be stored, treated, or discharged where direct public contact with the water is less likely. Conveyance is accomplished by providing additional conveyance pipes or upsizing the existing conveyance pipe to a greater capacity. This practice can effectively reduce overflow volume and frequency in the affected areas. Large conveyance projects can be expensive and may require a lengthy permitting process.

4.4.1.2 Regulator Modifications

A CSO regulator can be uniquely configured to control combined sewer overflow frequency and volume. The existing overflow control structures may be modified based on site-specific conditions. For example, regulator modifications may include increasing the overflow weir height and length or raising the overflow pipe elevation. This technology is especially effective for CSO outfalls with high overflow frequency and low overflow volume, because the additional volume held back in the system is small and less likely to have negative impacts on upstream conditions.
4.4.1.3 Outfall Consolidation/Relocation

Consolidation of one or multiple outfalls can help eliminate CSO discharges in sensitive areas. Outfall consolidation may require modification or relocation of an outfall, the installation of additional conveyance to accommodate new flow configurations, and may also require additional permitting with government agencies. This practice typically lowers O&M requirements for the CSS by limiting the number of outfall structures that need to be monitored. Outfall consolidation works best in areas where outfalls are located in close proximity to each other and require limited additional conveyance. Similar to regulator modifications, outfall consolidation is especially effective at reducing high frequency, low volume CSOs. This practice typically doesn’t add a significant amount of extra capacity to the CSS (depending on the amount of conveyance pipe associated with the consolidation project), so its impact on infrequent, large volume CSO events can be limited. The Hydrologic and Hydraulic (H&H) Model can determine the level of impact that outfall consolidation will have in terms of reducing the number of CSO events.

4.4.1.4 Real Time Control

Real Time Control (RTC) is a highly automated system in which sewer level and flow data are measured at key points in the sewer system and used to operate systems controls to maximize the storage capacity of the CSS and limit overflows. The collected data is typically transferred to a control device where program logic is used to operate gates, pump stations, inflatable dams and other control components. Local dynamic controls are used to control regulators to prevent flooding and system wide dynamic controls are used to implement control objectives, such as maximizing flow to the treatment plant or transferring flows from one portion of the CSS to another to fully utilize the system. Predicative control, which incorporates use of weather forecast data, is an optional feature, but it should be noted that it is complex and requires sophisticated operational capabilities. Additionally, it is important to note that RTC involves the installation of numerous mechanical control, which require upkeep and maintenance, and can only reduce CSO volumes where in-system storage capacity is available.

4.5 Storage

The objective of storage is to reduce overflows by capturing and storing wet weather flows, greater than CSS conveyance/treatment plant capacity, for controlled release back into the system once treatment and conveyance capacity have been restored. A storage facility can attenuate peak flows in the CSS and provide a relatively constant flow into the treatment plant after peak events. Storage technologies do not prevent water from entering the CSS or treat bacterial loads in CSO discharge, but are very effective at reducing or eliminating CSO events. Storage technologies typically have fairly high construction and O&M costs compared to other CSO control technologies, but are a very reliable means of achieving CSO control goals.
4.5.1 Linear Storage

Linear storage is provided by underground storage facilities that are sized to detain peak flows during wet weather events for controlled release back into the system after the event. In-line linear storage (storage in series with the CSS) can be provided by over-sizing the existing interceptors for conveyance, as described in the previous section, whereas off-line linear storage (storage parallel to the CSS) can be provided by installing new facilities such as tunnels and pipelines.

4.5.1.1 Pipelines

Large diameter parallel pipelines or conduits can provide significant storage in addition to the ability to convey flow. Pipelines are typically constructed between an overflow point and a pump station or treatment facility. The pipelines include discharge controls to allow flow to be stored within the pipeline during wet weather events, and slowly released by gravity following the event. The pipelines’ conveyance to the desired endpoint depends on the additional capacity necessary to handle the increased flow and is developed concurrently with the pipeline. A force main pipeline constructed from a pump station relies heavily on the increased flow capacity as the storage benefits are negligible. Pipelines have the advantage of requiring less area for construction compared to point storage. If trenchless technologies can be utilized, such as horizontal directional drilling (HDD), land requirements can be reduced even further.

One disadvantage of pipelines is that a larger volume is typically required to accommodate combined sewer storage needs. The installation of large diameter pipelines is typically less cost effective than tunneling, and the installation of smaller diameter pipes typically requires a significant length in order to provide adequate storage. Additionally, the installation of pipelines is very disruptive, typically requiring open trenches and the temporary closure of public streets.

4.5.1.2 Tunnels

Tunnels provide more storage volume than pipelines, while maintaining the ability to convey flow. Tunnel excavation is accomplished completely underground, and therefore results in minimal surface disruption and requires little right-of-way, outside of drop shafts and conveyance piping to the drop shafts. Overall costs for tunnels can be high, but their cost per million gallons of storage is fairly reasonable compared to other storage technologies, depending on local geology. Tunnels are typically used in congested urban areas where available land is scarce and connections to most, if not all, of the CSO regulators can be made.

4.5.2 Point Storage

Point storage can be provided by above-ground or underground storage facilities such as tanks and equalization basins. These off-line facilities are placed at
specific points in the system to detain peak flows for controlled return back to the system, reducing CSO discharge volume and bacterial loading.

4.5.2.1 Tanks

This technology reduces overflow quantity and frequency by storing all or a portion of diverted wet weather combined flows in off-line storage tanks. Stored flows are returned to the interceptor for conveyance to the treatment plant once system capacity becomes available. Storage tanks are generally fed by gravity and the stored flow is typically pumped back to the interceptor the storm. The benefit of off-line storage tanks is that they are well suited for early action projects at critical CSO outfalls. Storage tanks capture the most concentrated first flush portion wet weather peak flow and help to reduce the downstream capacity needs for conveyance and treatment.

A disadvantage of off-line storage tanks is that they typically require large land area for installation, which may not be available in congested urban areas. Off-line storage tanks typically have higher costs per volume captured compared to other technologies. Additionally, if the existing sewers are deep, then the storage tank must also be deep, which results in additional construction costs. Operation and maintenance costs can also be high, especially if the application includes provisions for partial treatment and discharge, rather than simple storage and bleed-back to the sewer. Depending on the application, odor problems may also be an Issue. However, storage tanks can be a very effective means of CSO control.

4.5.2.2 Industrial Discharge Detention

This technology would require industrial users to build and maintain storage basins to hold industrial discharge during wet weather events and subsequently release it back to the CSS. This would limit the peak wet weather flow to the WRTP. The effectiveness of this technology is limited to the number of industrial users upstream of CSO regulators. If there are no industrial users in the CSS, then this is technology is not applicable.

4.6 STP Expansion or Storage at the Plant

4.6.1 Additional Treatment Capacity

CSOs can potentially be reduced by increasing the treatment capacity of plant. Other technologies can make use of this increased treatment capacity by providing more flow to the plant instead of CSO outfalls.

4.6.2 Wet Weather Blending

Blending is the practice of allowing portions of the wet weather peak flow to bypass certain treatment facilities at the plant. In blending, wet weather flows are
typically routed through primary treatment, allowed to bypass secondary and tertiary treatment, and then recombined with effluent from all processes prior to disinfection and discharge to the environment. This practice may require increasing the capacity of primary treatment and disinfection facilities, but doesn’t require the upsizing of secondary treatment facilities, which can be the more costly components. Other technologies can make use of the increased wet weather peak flow capacity by providing more flow to the plant instead of CSO outfalls.

4.7 Sewer Separation

4.7.1 Roof Leader Disconnection

Roof leaders may directly be connected to the CSS. Roof leaders can be disconnected in order to divert stormwater elsewhere and/or to delay its entry into the CSS. Depending on the neighborhood, roof leaders may be run to dry well, vegetation bed, lawn, storm sewer, or street. This technology typically has limited benefits in dense urban areas due to the lack of pervious areas available to divert flow for infiltration. Unfortunately, the most feasible rain leader disconnection scheme in these areas is usually diversion to the street. In this case, disconnection can lead to nuisance street flooding and is only able to briefly delay the water from entering the CSS through catch basins. Roof leader disconnection is typically much more effective in areas with separate sewers where the roof leader was previously connected to a sanitary sewer, since the diverted rainwater does not have a direct path back into the system. Roof leader disconnection can be effective for both sanitary and storm sewers; however, the effect of this measure is highly contingent upon the extent of roof leaders in the system, site specific conditions, and the ability to find an adequate location to divert stormwater flow from the roof leader.

4.7.2 Sump Pump Disconnection

Buildings with basements below the ground water table sometimes are kept dry by using dewatering pumps. In many cases, these pumps discharge to the CSS or sanitary sewers. Sump pump disconnection diverts this pumped groundwater flow to a location other than these sewers. Sump pump disconnection programs are typically more effective in separate sewer areas and are subject to the same limitations as roof leader disconnection programs (extent, site conditions, diversion options, etc.). There are many limitations to the effectiveness of this approach in terms of the resources, impact on the public and difficulties implementing.

4.7.3 Combined Sewer Separation

Sewer separation is the conversion of a CSS into a system of separate storm sewers and sanitary sewers. This can be accomplished by installing a new
sanitary sewer and using the existing combined sewer as a storm sewer or vice versa. This practice can be very expensive, disruptive to the public, and difficult to implement, especially in downtown areas or other densely developed urban environments. It typically requires closure of public streets for construction while the new pipes are installed and the sewer is separated.

4.8 Treatment of CSO Discharge

Treatment technologies are intended to reduce the pollutant loads to receiving waters by treating wet weather flows prior to discharging to the environment. Specific technologies can address different pollutant constituents, such as settleable solids, floatables, or bacteria.

4.8.1 Treatment — CSO Facility

4.8.1.1 Vortex Separators

Vortex separation is a process that removes floatables and settleable solids from a wastewater stream by directing influent flow tangentially into a cylindrical tank, thereby creating a vortex. The vortex action causes settleable solids to move toward the center of the tank where they are concentrated with a fraction of the influent flow and directed to the underflow at the bottom of the tank. The underflow is then conveyed downstream to the treatment plant. The remaining influent flow travels under a baffle plate, which traps any floatables, and then over a circular baffle located in the center of the tank. It is then discharged to receiving waters or conveyed to storage or treatment devices for further processing. This technology does not address CSO volume or bacteria reduction, and would only help meet water quality and CSO control goals only if used in combination with other technologies.

4.8.1.2 Screens and Trash Racks

Screens and trash racks consist of a series of vertical and horizontal bars or wires that trap floatables while allowing water to pass through the openings between the bars or wires. They can be installed at select points within a CSS to capture floatables and prevent their discharge during CSO events. Due to limited hydraulic capacity, screens are most suitable for small outfalls. Trash racks or static screens can be located on top of an overflow weir or near the outfall. These devices are inexpensive but usually incur high maintenance costs due to their tendency to become clogged. Frequent cleaning (after every storm) is usually required to prevent clogging, which can cause serious flooding and sewer backups.

Mechanical screens can remove floatables and some solids without frequent manual cleaning. This can be a significant advantage when compared to the maintenance requirements and the potential for flooding caused by a clogged static screen. However, most mechanical screens (climber screens, cog screens,
or rake screens) require structural modifications to the outfall chamber to house and protect the screens. If weir-mounted mechanical screens are used instead, they require much less headroom and can be retrofitted into an existing overflow chamber with little to no structural modifications.

As this technology does not address CSO volume or bacteria reduction, it would do little to meet Water quality and CSO control goals.

4.8.1.3 Netting

Netting systems involve mesh nets that are attached to a CSO outfall to capture floatable material as the CSO discharges into the receiving water. The nets are nylon mesh bags that can be concealed inside the CSO outfall until an overflow occurs. The advantage of this technology is that it captures floatables inexpensively, and can provide a base level of control at some CSO sites.

However the operation and maintenance requirements are high and it has some negative aesthetic impacts associated with the visibility of collected trash in the waterbody. This technology is strictly for floatables control and will not address water quality and CSO control goals alone.

4.8.1.4 Containment Booms

A containment boom is a temporary floating barrier used to contain floatables entering into the waterway from a CSO outfall. Containment booms are used to reduce the spread of floatables and reduce the level of effort for post-storm cleanup. These devices are very simple to install, but can be difficult to maintain. Also, there are some negative aesthetic impacts associated with visibility of collected trash in a waterbody. This technology is strictly for floatables control and will not address water quality and CSO control goals alone.

4.8.1.5 Baffles

Baffles are simple floatables control devices that are typically installed at flow regulators within the CSS. They consist of vertical steel plates or concrete beams that extend from the top of the sewer to just below the top of the regulating weir. During an overflow event, floatables are retained by the baffles while water passes under the baffles, over the regulator, and into the receiving water body. When the flow recedes below the bottom of the baffle, floatable material is carried downstream to the treatment plant. Baffles are easy to install and require little maintenance, but do require proper hydraulic configuration. This technology is strictly for floatables control and will not address water quality and CSO control goals alone.
4.8.1.6 Disinfection and Satellite Treatment

This technology consists of disinfecting and treating sewer overflows at a local facility near the CSO outfall. Disinfection is very effective at reducing bacteria through inactivation, but provides only limited opportunities for volume reduction. Disinfection alone cannot provide reductions in TSS, floatables, and nutrient loads unless other processes (e.g., screening, high-rate clarification, etc.) are provided upstream of the disinfection facility. The combination of these other processes with disinfection can provide a satellite location that helps reduce pollutants of concern.

Disinfection of wet weather flow is more challenging to design and control than traditional disinfection at a treatment plant, because of the complex characteristics of the flow. Intermittent occurrences and highly variable flowrates make it more challenging to regulate the addition of disinfectant. One way to address the variable flow issue is to provide flow retention facilities that provide for disinfectant contact time and capture through storage of the first flush of TSS, floatables and nutrients.

Wet weather flows can vary widely in temperature, suspended solids concentrations, and bacterial composition. Therefore, pilot studies are usually needed to characterize the range of conditions that exist for a particular area and the design criteria that need to be considered. Experience has shown that the long contact time required for conventional wastewater treatment is not appropriate for the treatment of wet weather flows. Disinfection can be achieved by providing an increased disinfection dosage and intense mixing to ensure disinfectant contact with the maximum number of microorganisms.

Various disinfection technologies are available, both with and without chlorine compounds. In addition to disinfection effectiveness, many factors should be considered when selecting a disinfectant, including potential toxic effects to the environment, regulations for residuals, safety precautions, and ease of operation and maintenance. Ultraviolet (UV) light and peracetic acid (PAA) are two alternatives to chlorine compounds for wet weather disinfection.

- **Ultraviolet Light** - The main advantages of UV include its ability to quickly respond to flow variation and the absence of a disinfectant residual, among others. The size of the UV system mainly depends on the UV transmittance (i.e., the ability of wastewater to transmit UV light) and TSS concentrations in the wastewater. One of the challenges for UV disinfection is determining how to manage the disinfection of effluent during a power outage. In addition, UV typically has higher capital cost compared to chlorine disinfection systems.

- **Peracetic Acid** - The main advantage of PAA over sodium hypochlorite is its long “shelf life” without product deterioration. Due to the intermittent nature of CSO flows, stored sodium hypochlorite may degrade over time.
if not used. However, PAA systems generally have higher operating costs than chlorine systems.

4.8.1.7 High Rate Physical/Chemical Treatment (ActiFlo)

High rate physical/chemical processes, such as Veolia’s Actiflo or Infilco-Degremont’s DENSADEG, are treatment facilities that require a much smaller footprint than conventional processes. These two competing products have very similar applications, but have processes that differ from each other considerably. For brevity, only one of these processes (Actiflo) is described in detail below and shown in Figure 4-9.

Figure 4-9. Actiflo Process

Fundamentally, the Actiflo process is very similar to conventional coagulation, flocculation, and sedimentation water treatment technology. Both processes use coagulant for suspended solid destabilization and flocculent aid (polymer) for the aggregation of suspended materials. The primary difference between Actiflo and conventional processes is the addition of microsand for the formation of high-density flocs that have a higher-density nucleus and thus settle more rapidly.

Clarified water exits the process by flowing over a weir in the settling tank. The sand and sludge mixture that remains is collected at the bottom of the settling tank and pumped to a hydrocyclone which separates the sludge from the microsand. Sludge is discharged out of the top of the hydrocyclone while the sand is recycled back into the Actiflo process for further use. This process requires upstream screening to ensure that particles larger than 3 to 6 mm do not clog the hydrocyclone.
Actiflo performance varies, but in general removal rates of 80 - 95% for TSS and 30 - 60% for BOD are typical. Phosphorous and nitrogen are also removable with this process, although the removal efficiencies are dependent on the solubility of these compounds present in the wastewater.

Phosphorous removal is typically between 60-90%, and nitrogen removal is typically between 15-35%. Removal efficiencies are also dependent on start-up time. Typically the Actiflo process takes about 15 minutes before optimum removal rates are achieved.

The LTCP primary goals are bacteria reduction and CSO volume reduction. While high rate physical/chemical treatment reduces bacteria somewhat, its principal purpose is TSS reduction. Disinfection would be required downstream for bacteria inactivation. Additionally, while disinfection can be enhanced with upstream treatment, it can be adequately accomplished without high rate physical/chemical treatment. As such, these processes do not add significant value compared to disinfection alone. Furthermore, while technologies such as Actiflo or DENSADEG reduce the footprint of conventional treatment, they still require a significant amount of available space for implementation.

4.8.1.8 High Rate Physical Treatment (FlexFilter)

The FlexFilter by Schreiber or the WesTech WWETCO FlexFilter shown in Figure 4-10 is an innovative filtration technology that used a compressible filter media that allows for a much smaller footprint than conventional filtration (footprint reductions of nearly 90%). Both technologies use a synthetic fiber media, as opposed to granular media such as sand, which can handle increased flux rates (up to 30-40 gpm/sf). Additionally, the process uses compressed air scour with influent flow for filter backwashing which eliminates the need for storage tanks. The filter removes up to 80% of influent particles down to 4 microns in diameter. Overall, this is a relatively low maintenance process, which requires periodic lubrication and detergent addition for media washing.

![Figure 4-10. WWETCO FlexFilter](image-url)
This technology is designed for TSS reduction and does not address the primary goals of the LTCP (bacteria reduction and overflow volume reduction). Since downstream disinfection would be required for bacteria inactivation, this technology provides little benefit compared to disinfection alone. Additionally, although this technology decreases the footprint of conventional filtration, it still requires a substantial footprint for implementation.

4.9 Screening of Control Technologies

The tables below summarize the preceding controls technologies and identify what technologies are being considered in Fort Lee. Those technologies that are not being considered in this report may still be considered in local ordinance’s and Best Practices.
### Table 4-1. Source Control Technologies

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<thead>
<tr>
<th>Technology Group</th>
<th>Practice</th>
<th>Primary Goals</th>
<th>Implementation &amp; Operation Factors</th>
<th>Consider Combining w/ Other Technologies</th>
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<th>Evaluated in this Report</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stormwater Management</strong></td>
<td>Street/Parking Lot Storage (Catch Basin Control)</td>
<td>Low Low</td>
<td>Flow restrictions to the CSS can cause flooding in lots, yards and buildings; potential for freezing in lots; low operational cost. Effective at reducing peak flows during wet weather events but can cause dangerous conditions for the public if pedestrian areas freeze during flooding.</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Catch Basin Modification (for Floatables Control)</td>
<td>Low None</td>
<td>Requires periodic catch basin cleaning; requires suitable catch basin configuration; potential for street flooding and increased maintenance efforts. Reduces debris and floatables that can cause operational problems with the mechanical regulators.</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Catch Basin Modification (Leaching)</td>
<td>Low Low</td>
<td>Can be installed in new developments or used as replacements for existing catch basins. Require similar maintenance as traditional catch basins. Leaching catch basins have minor effects on the primary CSO control goals.</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Public Education and Outreach</strong></td>
<td>Water Conservation</td>
<td>None Low</td>
<td>Water purveyor is responsible for the water system and all related programs in the respective City. However, water conservation is a common topic for public education programs. Water conservation can reduce CSO discharge volume, but would have little impact on peak flows.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Catch Basin Stenciling</td>
<td>None None</td>
<td>Inexpensive; easy to implement; public education. Is only as effective as the public’s acceptance and understanding of the message. Public outreach programs would have a more effective result.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Community Cleanup Programs</td>
<td>None None</td>
<td>Inexpensive; sense of community ownership; educational BMP; aesthetic enhancement. Community cleanups are inexpensive and build ownership in the city.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Public Outreach Programs</td>
<td>Low None</td>
<td>Public education program is ongoing. Permittee should continue its public education program as control measures demonstrate implementation of the NMC.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>FOG Program</td>
<td>Low None</td>
<td>Requires communication with business owners; Permittee may not have enforcement authority. Reduces buildup and maintains flow capacity. Only as effective as business owner cooperation.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Garbage Disposal Restriction</td>
<td>Low None</td>
<td>Permittee may not be responsible for Garbage Disposal. This requires an increased allocation of resources for enforcement while providing very little reduction to wet weather CSO events.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Pet Waste Management</td>
<td>Medium None</td>
<td>Low cost of implementation and little to no maintenance. This is a low cost technology that can significantly reduce bacteria loading in wet weather CSO's.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
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<tr>
<td><strong>Bacteria Reduction</strong></td>
<td><strong>Volume Reduction</strong></td>
<td></td>
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<tr>
<td><strong>Ordinance Enforcement</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lawn and Garden Maintenance</td>
<td>Low</td>
<td>Low</td>
<td>Requires communication with business and homeowners. Guidelines are already established per USEPA. Educating the public on proper lawn and garden treatment protocols developed by USEPA will reduce waterway contamination. Since this information is already available to the public it is unlikely to have a significant effect on improving water quality.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Hazardous Waste Collection</td>
<td>Low</td>
<td>None</td>
<td>The N.J.A.C prohibits the discharge of hazardous waste to the collection system.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Construction Site Erosion &amp; Sediment Control</td>
<td>None</td>
<td>None</td>
<td>In building code; reduces sediment and silt loads to waterways; reduces clogging of catch basins; little O&amp;M required; contractor or owner pays for erosion control. A Soil Erosion &amp; Sediment Control Plan Application or 14-day notification (if Permitee covered under permit-by-rule) will be required by NJDEP per the N.J.A.C.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Illegal Dumping Control</td>
<td>Low</td>
<td>None</td>
<td>Enforcement of current law requires large number of code enforcement personnel; recycling sites maintained. Local ordinances already in place can be used as needed to address illegal dumping complaints.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Pet Waste Control</td>
<td>Medium</td>
<td>None</td>
<td>Requires resources to enforce pet waste ordinances. Public education and outreach is a more efficient use of resources, but this may also provide an alternative to reducing bacterial loads.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Litter Control</td>
<td>None</td>
<td>None</td>
<td>Aesthetic enhancement; labor intensive; City function. Litter control provides an aesthetic and water quality enhancement. It will require city resources to enforce. Public education and outreach is a more efficient use of resources.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Illicit Connection Control</td>
<td>Low</td>
<td>Low</td>
<td>Site specific; more applicable to separate sanitary system; new storm sewers may be required; interaction with homeowners required. The primary goal of the LTCP is to meet the NJPDES Permit requirements relative to POCs. Illicit connection control is not particularly effective at any of these goals and is not recommended for further evaluation unless separate sewers are in place.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Good Housekeeping</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Street Sweeping/Flushing</td>
<td>Low</td>
<td>None</td>
<td>Labor intensive; specialized equipment; doesn't address flow or bacteria; City function. Street sweeping and flushing primarily addresses floatables entering the CSS while offering an aesthetic improvement.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Leaf Collection</td>
<td>Low</td>
<td>None</td>
<td>Requires additional seasonal labor. Leaf collection maximizes flow capacity and removes nutrients from the collection system.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Recycling Programs</td>
<td>None</td>
<td>None</td>
<td>Most Cities have an ongoing recycling program.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
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### Source Control Technologies

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<tr>
<td><strong>Storage/Loading/Unloading Areas</strong></td>
<td>None</td>
<td>None</td>
<td>Requires industrial &amp; commercial facilities designate and use specific areas for loading/unloading operations. There may be few major commercial or industrial users upstream of CSO regulators.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Industrial Spill Control</strong></td>
<td>Low</td>
<td>None</td>
<td>The POTW has established a pretreatment program for industrial users subject to the Federal Categorical Pretreatment Standards 40 CFR 403.1.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Green Roofs</strong></td>
<td>None</td>
<td>Medium</td>
<td>Adds modest cost to new construction; not applicable to all retrofits; low operational resource demand; will require the Permittee or private owners to implement; requires regular cleaning of gutters &amp; pipes; upkeep of roof vegetation. Portions of Cities have densely populated areas, but this technology is limited to rooftops. Can be difficult to require on private properties.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Blue Roofs</strong></td>
<td>None</td>
<td>Medium</td>
<td>Adds modest cost to new construction; not applicable to all retrofits; low operational resource demand; will require the Permittees or private owners to implement; requires regular cleaning of gutters &amp; pipes; upkeep of roof debris. Portions of the Cities have densely populated areas, but this technology is limited to rooftops. Can be difficult to require on private properties.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Rainwater Harvesting</strong></td>
<td>None</td>
<td>Medium</td>
<td>Simple to install and operate; low operational resource demand; will require the Permittees or private owners to implement; requires regular cleaning of gutters &amp; pipes. Portions of the Cities have densely populated areas, but this technology is limited to capturing rooftop drainage. Capture is limited to available storage, which can vary on rainwater use. Can be difficult to require on private properties.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Permeable Pavements</strong></td>
<td>Low</td>
<td>Medium</td>
<td>Not durable and clogs in winter; oil and grease will clog; significant O&amp;M requirements with vacuuming and replacing deteriorated surfaces; can be very effective in parking lots, lanes and sidewalks. Maintenance requirements could be reduced if located in low-traffic areas, and can utilize underground infiltration beds or detention tanks to increase storage.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Planter Boxes</strong></td>
<td>Low</td>
<td>Medium</td>
<td>Site specific; good BMP; minimal vegetation &amp; mulch O&amp;M requirements with regular overflow and underdrain cleaning; effective at containing, infiltrating and evaporating runoff in developed areas. Flexible and can be implemented even on a small-scale to any high-priority drainage areas. Underground infiltration beds or detention tanks can be utilized to increase storage.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Bioswales</strong></td>
<td>Low</td>
<td>Low</td>
<td>Site specific; good BMP; minimal vegetation &amp; mulch O&amp;M requirements; not as flexible or infiltrate as much stormwater as planter boxes. Technology requires open space and is primarily a surface conveyance technology with additional storage &amp; infiltration benefits. Can be modified with check dams to slow water flow. Limited open space in most Cities means land can be utilized in more effective ways with the existing infrastructure.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
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<tr>
<td></td>
<td></td>
<td>Bacteria Reduction</td>
<td>Volume Reduction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free-Form Rain Gardens</td>
<td>Low</td>
<td>Medium</td>
<td>Site specific; good BMP; minimal vegetation &amp; mulch O&amp;M requirements with regular overflow and underdrain cleaning; effective at containing, infiltrating and evapotranspirating diverted runoff. Rain Gardens are flexible and can be modified to fit into the previous areas. Underground infiltration beds or detention tanks can be utilized to increase storage.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
## Table 4-2. Collection System Technologies

<table>
<thead>
<tr>
<th>Technology Group</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bacteria</td>
<td>Volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation and Maintenance</td>
<td>I/I Reduction</td>
<td>Low</td>
<td>Medium</td>
<td>Requires labor intensive work; changes to the conveyance system require temporary pumping measures; repairs on private property required by homeowners. Reduces the volume of flow and frequency; Provides additional capacity for future growth; House laterals account for 1/2 the sewer system length and significant sources of I/I in the sanitary sewer.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Advanced System Inspection &amp; Maintenance</td>
<td>Low</td>
<td>Low</td>
<td>Requires additional resources towards regular inspection and maintenance work. Inspection and maintenance programs can provide detailed information about the condition and future performance of infrastructure. Offers relatively small advances towards goals of the LTCP.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Combined Sewer Flushing</td>
<td>Low</td>
<td>Low</td>
<td>Requires inspection after every flush; no changes to the existing conveyance system needed; requires flushing water source. Ongoing: CSO Operational Plan; maximizes existing collection system; reduces first flush effect.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Catch Basin Cleaning</td>
<td>Low</td>
<td>None</td>
<td>Labor intensive; requires specialized equipment. Catch Basin Cleaning reduces litter and floatables but will have no effect on flow and little effect on bacteria and BOD levels.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Combined Sewer Separation</td>
<td>Roof Leader Disconnection</td>
<td>Low</td>
<td>Low</td>
<td>Site specific; includes area drains and roof leaders; new storm sewers may be required; requires home and business owner participation. The Cities are densely populated and disconnected roof leaders have limited options for discharge to pervious space. Disconnection may be coupled with other GI technologies but is not considered an effective standalone option.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Sump Pump Disconnection</td>
<td>Low</td>
<td>Low</td>
<td>Site specific; more applicable to separate sanitary system; new storm sewers may be required; interaction with homeowners required. The Cities are densely populated and disconnected sump pumps have limited options for discharge to pervious space. Disconnection may be coupled with other GI technologies but is not considered an effective standalone option.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Combined Sewer Separation</td>
<td>High</td>
<td>High</td>
<td>Very disruptive to affected areas; requires homeowner participation; sewer asset renewal achieved at the same time; labor intensive.</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Additional Conveyance</td>
<td>High</td>
<td>High</td>
<td>Additional conveyance can be costly and would require additional maintenance to keep new structures and pipelines operating.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Regulator Modifications</td>
<td>Medium</td>
<td>Medium</td>
<td>Relatively easy to implement with existing regulators; mechanical controls requires O&amp;M. May increase risk of upstream flooding. Permittees have an ongoing O&amp;M program and system wide replacement program for CSO regulators and tide gates.</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
### Table 4-2. Collection System Technologies

<table>
<thead>
<tr>
<th>Technology Group</th>
<th>Practice</th>
<th>Primary Goals</th>
<th>Implementation &amp; Operation Factors</th>
<th>Consider Combining w/ Other Technologies</th>
<th>Being Implemented</th>
<th>Evaluated in this Report</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bacteria Reduction</td>
<td>Volume Reduction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outfall Consolidation/Relocation</td>
<td>High</td>
<td>High</td>
<td>Lower operational requirements; may reduce permitting/monitoring; can be used in conjunction with storage &amp; treatment technologies. Combining and relocating outfalls may lower operating costs and CSO flows. It can also direct flow away from specific areas.</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Real Time Control</td>
<td>High</td>
<td>High</td>
<td>Requires periodic inspection of flow elements; highly automated system; increased potential for sewer backups. RTC is only effective if additional storage capacity is present in the system.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
## Storage and Treatment Technologies

<table>
<thead>
<tr>
<th>Technology Group</th>
<th>Practice</th>
<th>Primary Goals</th>
<th>Implementation &amp; Operation Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bacteria</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volume</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction</td>
<td></td>
</tr>
<tr>
<td>Linear Storage</td>
<td>Pipeline</td>
<td>High</td>
<td>Can only be implemented if in-line storage potential exists in the system; increased potential for</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>basement flooding if not properly designed; maximizes use of existing facilities. Pipe storage for</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a CSS typically requires large diameter pipes to have a significant effect on reducing CSOs. This</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>typically requires large open trenches and temporary closure of streets to install.</td>
</tr>
<tr>
<td></td>
<td>Tunnel</td>
<td>High</td>
<td>Requires small area at ground level relative to storage basins; disruptive at shaft locations;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>increased O&amp;M burden.</td>
</tr>
<tr>
<td></td>
<td>Tank (Above or Below</td>
<td>High</td>
<td>Storage tanks typically require pumps to return wet weather flow to the system which will require</td>
</tr>
<tr>
<td></td>
<td>Ground)</td>
<td></td>
<td>additional O&amp;M; disruptive to affected areas during construction. Several CSO outfalls have space</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>available for tank storage. There may be existing tanks in abandoned commercial and industrial areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>to be converted to hold stormwater. Tanks are an effective technology to reduce wet weather CSO's.</td>
</tr>
<tr>
<td></td>
<td>Industrial Discharge</td>
<td>High</td>
<td>Requires cooperation with industrial users; more resources devoted to enforcement; depends on IUs to</td>
</tr>
<tr>
<td></td>
<td>Detention</td>
<td></td>
<td>maintain storage basins. IUs hold stormwater or combined sewage until wet weather flows subside;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>there may be commercial or industrial users upstream of CSO regulators.</td>
</tr>
<tr>
<td>Treatment-CSO Facility</td>
<td>Vortex Separators</td>
<td>None</td>
<td>Space required; challenging controls for intermittent and highly variable wet weather flows. Vortex</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>separators would remove floatables and suspended solids when installed. It does not address volume,</td>
</tr>
<tr>
<td></td>
<td>Screens and Trash Racks</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Prone to clogging; requires manual maintenance; requires suitable physical configuration; increased</td>
</tr>
<tr>
<td></td>
<td>Netting</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contaminant Booms</td>
<td>None</td>
<td>Difficult to maintain requiring additional resources. Contaminant booms will only address floatables.</td>
</tr>
<tr>
<td></td>
<td>Baffles</td>
<td>None</td>
<td>Very low maintenance; easy to install; requires proper hydraulic configuration; long lifespan.</td>
</tr>
<tr>
<td></td>
<td>Disinfection &amp; Satellite</td>
<td>High</td>
<td>Requires additional flow stabilizing measures; requires additional resources for maintenance;</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td>requires additional system analysis. Disinfection is an effective control to reduce bacteria and BOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>in CSO's.</td>
</tr>
</tbody>
</table>
### Table 4-3. Storage and Treatment Technologies

<table>
<thead>
<tr>
<th>Technology Group</th>
<th>Practice</th>
<th>Primary Goals</th>
<th>Implementation &amp; Operation Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bacteria</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction</td>
<td></td>
</tr>
<tr>
<td>High Rate Physical/Chemical Treatment (High Rate Clarification Process - ActiFlo)</td>
<td>None</td>
<td>None</td>
<td>Challenging controls for intermittent and highly variable wet weather flows; smaller footprint than conventional methods. This technology primarily focuses on TSS &amp; BOD removal, but does not help reduce the bacteria or CSO discharge volume.</td>
</tr>
<tr>
<td>High Rate Physical (FlexFilter)</td>
<td>None</td>
<td>None</td>
<td>Relatively low O&amp;M requirements; smaller footprint than traditional filtration methods. This technology primarily focuses on TSS removal, but does not help reduce the bacteria or CSO discharge volume.</td>
</tr>
<tr>
<td>Treatment-WRTIP</td>
<td></td>
<td>High</td>
<td>May require additional space; increased O&amp;M burden.</td>
</tr>
<tr>
<td>Wet Weather Blending</td>
<td>Low</td>
<td>High</td>
<td>Requires upgrading the capacity of influent pumping, primary treatment and disinfection processes; increased O&amp;M burden. Wet weather blending does not address bacteria reduction, as it is a secondary treatment bypass for the POTW. Permittee must demonstrate there are no feasible alternatives to the diversion for this to be implemented.</td>
</tr>
<tr>
<td>Treatment-Industrial</td>
<td>Low</td>
<td>Low</td>
<td>Requires cooperation with Industrial User's; more resources devoted to enforcement; depends on IU's to maintain treatment standards. May require Permits.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consider Combining w/ Other Technologies</th>
<th>Being Implemented</th>
<th>Evaluated in this Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<td>No</td>
<td>No</td>
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<td>Yes</td>
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<td>Yes</td>
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<td>No</td>
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<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
5 Costing

Costing was developed as a Class 5 Estimate with a range -50% to +100%. The purchase of land was not included in the costs because there is no land in the vicinity of the regulators available for use. Cost analysis was performed based on the following assumptions:

1. Sewer Separation Costs
   a. Capital costs based on a bid cost for partial separation from 2006 and developed into a unit cost and applied to the 954 acres of CSO drainage area. To convert to 2018 costs, a ratio of 10817:7630 was applied herein, based on the Engineering News Record (ENR) Construction Cost Index (CCI) values for 2018 and 2006, respectively.
   b. O&M costs are estimated at based on 2% of the capital cost (2019c, G&H).

2. Treatment Costs
   a. Capital and O&M costs for PAA disinfection are based on the latest available guidance for permittees (2018, G&H).

3. Storage Tank Costs
   a. Capital costs for tank-storage solutions are based on the latest available guidance for permittees (2018, G&H).
   b. O&M costs for tanks were compiled in accordance with the latest available guidance for permittees (2019c, G&H).

4. Green Infrastructure Costs
   a. Capital costs for various GI solutions are based on the latest available guidance for permittees (2018, G&H).
   b. O&M costs for Bioretention GI solutions were provided as $8,000 per managed acre (2019c, G&H).
   c. O&M costs for Porous Pavement GI solutions were assumed to be $1,250 per managed acre (2018, DEP).

5. Additional Cost Factors
   a. Present-value (PV) of life-cycle costs based on a 20-year period and an interest rate of 2.75% in accordance with the latest available guidance for permittees (2019a, G&H).
b. Based on experience on other similar CSO LTCP projects, HDR applied a capital-cost factor of 2.5 to calculate the probable total project cost (PTPC) of implementing each technology. The PTPC accounts for installation, non-component (electrical, piping, etc.), and indirect costs (freight, permits, etc.) for all storage and disinfection. A breakdown of how this factor was calculated is shown below.

i. Installation was estimated at 20% of equipment costs based on historic data experienced by HDR and industry standards for typical plants of similar size and complexity.

ii. Non-component costs including: electrical (10%), piping (10%), instrumentation and controls ($15,000), and civil site work (25%) were estimated based on factors or percentages of equipment costs. These factors account for standard installation commodities, accessories, steel supports and standard testing support.

iii. Freight was estimated at a lump sum of $20,000.

iv. Sales tax was estimates at 8%

v. Permits were estimated at $20,000

vi. Start up, performance testing, operator training and O&M manual were estimated at $50,000

vii. Contract overhead and profit includes 29% for the following:

   a. Part time – Project management support, project controls, procurement, quality and safety support.

   b. Full time – Site construction manager (CM), site administration, standard CM travel pack.

viii. Engineering, administration and legal fees were estimated at 10%

ix. A contingency of 10% is included for the remaining equipment items and non-component costs
Available Land Analysis

The current netting chambers and pump stations for Bluff Road and Palisade Avenue/Lower Main are located on small parcels of land or rights of way. Bluff Road, which accounts for 95% of the discharged CSO, is located on a narrow (20 feet wide) strip of land on the Palisades shown in Figure 6-1. Large additional facilities cannot be located on these sites. The Bluff Road site is located on a narrow right of way at the end of Manatauck Avenue located along side but above Route 5 and the Palisades shown on Figure 6-2. Locating facilities at another distant site would require a large pumping station (30 to 85 mgd) to pump CSO to the tank. Also, Palisades bedrock, shown on Figure 6-3, is throughout the town and would increase the cost of construction.

Figure 6-1. Bluff Road Netting Facility Site
Figure 6-2. Fort Lee Zoning Map
Figure 6-3. Bedrock Map of New York and Parts of Kings and Queens Counties, New York and Bergen and Hudson Counties, New Jersey
7 Alternatives Evaluation

7.1 Introduction

CSO treatment alternatives were investigated in the 2007 LTCP effort. For the current evaluation the 2007 model was updated to account for new developments and CSO improvements. The model was run to provide baseline results and alternatives were evaluated.

7.1.1 Targeted CSO Control Goal

The CSO control goals were:

- 85% CSO Capture;
- 20 CSO overflows per year;
- 12 CSO overflows per year;
- 8 CSO overflows per year; and
- 4 CSO overflows per year.

The control methods were sized to achieve these goals and costs were estimated based on the 2018 Technical Guidance Manual.

7.1.2 Single or Group Overflows

In the 2007 Preliminary Long Term Control Plan disinfection was selected as the preferred alternative if additional CSO control was required. Now, in this LTCP we are in some ways repeating the 2007 analysis but also performing water quality analyses to determine where CSO control or disinfection might be necessary.

7.1.3 Siting Issues

Siting is commonly a subject of most public debate on CSO control projects. Therefore, one of the key considerations in assessing the overall feasibility of a CSO control alternative is the identification of an appropriate site for new facilities. The Borough of Fort Lee is fully developed with not much available open space. Land availability can be an issue as most of the controls are preferred to be located near the waterfront, which is expensive and mostly developed in much of the city. It is recognized that issues involving facility location, land takings, and easements in both public and private lands can lead to disagreements among various stakeholders. Therefore, this alternatives evaluation focuses on the use of the city-owned available sites which have minimal impact on sensitive stakeholders, to be less likely controversial. The environmental, political,
socioeconomic, and regulatory impacts of locating a facility at a designated site will need to be evaluated in detail during the facilities planning and design phase.

Facilities siting in this evaluation is preliminary in nature and it is based on the space requirements. A buffer for roadways and access, potential conflicts with above ground existing utilities at the site, highways, and local streets are also part of the preliminary facility siting considerations.

### 7.1.4 Institutional Issues

Institutional constraints include matters related to political issues, public opinion, and other non-technical factors that could impact project approval. Institutional and political factors can influence CSO control projects as most part of such project is generally funded by tax payers or sewer rate payers. The general public must be convinced that the proposed project is cost-effective and for the public good, so that possible public rejection is minimized. This is important to support the fundraising needed for implementation of the project. The Borough of Fort Lee has continued raising public awareness about the LTCP project through ongoing public participation activities with PVSC, as stressed in the NJPDES permit, and EPA policy and related guidance for the LTCP. It is to be noted that the Borough of Fort Lee is a densely developed urban municipality with poverty levels at or above the state average. Therefore, it is acknowledged that negotiations amongst politicians, institutions, and other stakeholders and interested parties are necessary to ensure that CSO control measures that are technically feasible for the Borough of Fort Lee are also financially and politically feasible.

It is to be mentioned that budgetary constraints of the permittee and, indirectly, constituent rate payers are not explicitly considered in this analysis. It is recognized that while certain alternatives may provide measurable benefit within other evaluation criterion, it may be the case that overall costs prove to be prohibitive to implementation for those alternatives.

### 7.1.5 Implementability

In addition to the cost, performance and political and institutional aspects; several other factors can affect implementation of a potential alternative. The following are some of the key implementability issues that have been part of preliminary considerations in the alternatives evaluation, but they have not been reviewed or analyzed in depth. The considerations made in this evaluation are solely based on the available information obtained from various sources.

**Environmental Issues:** These issues may be related to land conservation, use and acquisition, zoning changes, easement, traffic and site access, noise and vibration, floodplains and zoning, wetland buffer zones, utilities relocation and loss of services, and short term impacts water or air quality. The Borough of Fort Lee has waterfront land on the Passaic River which is used to a limited extent
both commercially and for boating recreation. Alternatives that fit with existing land uses and favor City property will receive a positive consideration under this evaluation. Any specific permits that would be required to implement a CSO control alternative would be identified at the facility planning and design phase.

Consideration for no CSO discharges to sensitive areas is a requirement in the evaluation of the CSO control alternatives. The NJDEP approved sensitive area study report identified no such area for the Borough of Fort Lee’s CSO receiving waters. Therefore, CSO discharges to sensitive areas is not an issue for this alternatives evaluation.

**Constructability:** This relates to the ease of construction. Constructability can be impacted by work site subsurface conditions. Adequate geologic data for the subsurface conditions is not currently available at the Borough of Fort Lee, so there is a large amount of uncertainty as to the rock and soil conditions. It is anticipated that alternatives with unsuitable soils, extensive rock or high groundwater requiring extensive dewatering or rerouting of drainage patterns may impose construction challenges. Alternatives involving complex designs and specialized construction would tend to drive up costs. Therefore, alternatives with few constructability issues will be preferred.

**Reliability:** Reliability of CSO control alternatives is a significant technical issue. The operating history of existing similar installations can help predict the reliability of a proposed solution. System components must function properly when required, particularly for CSO facilities that operate only on an intermittent basis. Alternatives that rely on simpler or less complex equipment and automation are inherently more reliable. Alternatives involving systems with unknown or poor track records will not be favored.

**Ease of Operations:** Operability issues involve both process and personnel related considerations. Alternatives involving equipment and system components that are relatively easy to operate and require reasonable operator assistance will be preferred. Unfavorable alternatives would involve highly specialized systems that require extensive training and staffing requirements.

**Multiple Use Considerations:** Multiple-use CSO control facilities can help to gain public and institutional acceptance. An alternative would be considered advantageous if it can serve another beneficial purpose while also mitigating CSOs. Examples include parking facilities over storage/treatment tanks, and recreational opportunities such as constructing bike paths over the routes of consolidation conduits or improving river access, which are possible enhancements that have been shown to provide additional public benefit.

**Compatibility to Phased Construction:** Given the cost of CSO control facilities, alternatives that can be implemented in smaller parts can be more affordable than a single large project. Phasing can lessen the immediate financial impact on rate payers with some immediate reliefs to CSO problems. Preferable
alternatives will need to meet current needs, but also will adapt to future conditions.

7.1.6 Public Acceptance

Community acceptance of a recommended solution is essential to its success. All permittees are required to involve the public, regulators, and other stakeholders throughout the LTCP development process. As such, the PVSC and the Borough of Fort Lee itself have continued raising public awareness of the LTCP development through ongoing public participation activities, as stressed in the NJPDES permit, and EPA policy and related guidance for the LTCP.

PVSC has held several quarterly regional supplemental CSO team public meetings over the course of the LTCP development effort. Local meetings were held in conjunction with the PVSC’s regional supplemental CSO team meetings. The details of the public participation process and the associated outreach program activities have been documented in the January 2019 revision of the Public Participation Process Report submitted to NJDEP.

Thus far, the regional Supplemental CSO team public meetings have continued being held and the supplemental CSO team members have been encouraged to provide feedback on further LTCP development milestone deliverables, including the Development and Evaluation of Alternatives. Further, the City has presented its CSO alternatives evaluation approach in tandem with other permittees at the March 7, 2019 regional supplemental CSO public meeting (Session-11) held at the NJTPA’s conference room. The majority of comments received thus far have been verbal comments, some of which are related to application of GI. To date, the Borough of Fort Lee has not received any comments on any of the draft LTCP submittals provided to the supplemental CSO team members for review and feedback. It is anticipated that the Borough of Fort Lee will present the results of the alternatives evaluation in one additional regional supplemental CSO team public meeting to discuss and address public comments in the NJDEP submittal as it would be necessary.

7.1.7 Performance

CSO control alternatives are generally evaluated using several measures, ranging from cost and performance to ancillary benefits and qualitative criteria. The EPA’s CSO Policy requires CSO permittees to evaluate a reasonable range of control alternatives to reduce or eliminate CSO discharges to ensure that water quality standards are met. An alternative must include options to address all goals of the LTCP in a cost-effective manner relative to other options. The alternative must also be able to perform well under intermittent and variable flow conditions. A comprehensive set of reasonable alternatives with ranges of CSO control goals for percent capture or number of overflows or pathogen reduction with the ability to beneficially integrate with the hydraulically connected communities are among the considerations in this analysis.
7.2 Preliminary Control Program Alternative

Section 4 described the CSO control technology screening performed to identify the preliminary CSO control measures. The screened control measures were further evaluated and described in the following sections. The following section presents overview of various control alternatives developed for the Borough of Fort Lee. The preliminary alternatives with detailed evaluations are:

- Green infrastructure (GI);
- Storage tanks; and
- Treatment – Disinfection.

7.2.1 Baseline

A baseline analysis was performed to identify annually how many CSO discharge events occur, what volumes of CSO are discharged and what the percent capture of CSO is. 2004 was used as the design rainfall year. The results are shown in Table 7-1 and indicate that FL-001 and FL-002 accomplish 84.7% capture of CSO before any controls are selected.

<table>
<thead>
<tr>
<th>Outfall</th>
<th>FL-001</th>
<th>FL-002</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSO Event Count</td>
<td>58</td>
<td>20</td>
</tr>
<tr>
<td>Volume (MG)</td>
<td>82.48</td>
<td>4.71</td>
</tr>
<tr>
<td>Total CSO Volume (MG)</td>
<td>87.19</td>
<td></td>
</tr>
<tr>
<td>CSO Capture (%)</td>
<td></td>
<td>84.7</td>
</tr>
</tbody>
</table>

There are several ways to compute CSO capture. The way that we computed it defines the wet weather period starting when the accumulated rainfall is greater than 0.1 inches and ends 12 hours after precipitation ends. The flow volume within this period is counted as wet weather. The annual wet weather flow volume is divided by the annual total flow volume to compute the percent capture.

This is the method being used by PVSC. This calculation approach is conservatively low and will produce lower estimates of capture than other methods. As an example using the method that New York City uses (using the total rain volume, not just the volume over 0.1 inches) would produce approximately 90% CSO capture. But regardless of the method used Fort Lee is near or above 85% capture.

The CSO Control Policy says:
“A program that meets any of the criteria listed below would be presumed to provide an adequate level of control to meet the water quality-based requirements of the CWA, provided the permitting authority determines that such presumption is reasonable in light of the data and analysis conducted in the characterization, monitoring, and modeling of the system and the consideration of sensitive areas described above. These criteria are provided because data and modeling of wet weather events often do not give a clear picture of the level of CSO controls necessary to protect WQS.

i. No more than an average of four overflow events per year...

ii. The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis...

iii. The elimination or removal of no less than the mass of pollutants, identified as causing water quality impairment..., for the volumes that would be eliminated or captured for treatment under paragraph ii... ” (Section II.C.4.a.)

By this policy Fort Lee is almost in compliance with the 85% capture criteria. To attain the criteria and be in compliance with the policy Fort Lee will consider implementing some reasonable degree of additional CSO control. The following describes the levels of control that are being considered.

7.2.2 Inflow Control

GI can be used as a complementary CSO control technology in combination with other alternatives. This alternative was evaluated alone to find out if GI could have a significant impact on CSO volume and frequency reduction in the Bluff Road pumping station drainage area. Two different target levels of GI control were evaluated. One of them was to manage 1” of storm water runoff generated from 5% of impervious surfaces, another target level was to manage 1” of storm water runoff generated from 10% of impervious surfaces. Total impervious surface in Bluff Road pumping station drainage area is about 131 acres, GI control area will be about 6.5 acres and 13 acres with 5% and 10% control level respectively. Table 7-2 shows the CSO volume and frequencies before and after the implementation of GI. The CSO volume was reduced about 3% with 5% GI control and was reduced about 7% with 10% GI control comparing with the baseline condition. But the CSO frequencies did not decrease a lot. The type of runoff surface of Fort Lee is rock, there is not much infiltration capacity available for the GI thus the runoff generated will not be intercepted. This alternative will not feasible for CSO control. Because of the relatively small impact achievable with GI, HDR decided to evaluate all alternatives conservatively, without GI, with the assumption that any additional impact of GI, however minor, would be considered in the development of the final selected alternatives.
### 7.2.3 Sewer System Separation

Sewer separation was considered in 2007 and costs were based on bid costs for a section of Fort Lee. These costs were escalated to 2018 costs based on ENR. The 2018 cost is estimated at $400,000,000. It considered rock construction costs because of high bedrock in Fort Lee.

Although this is a cost prohibitive alternative, a smaller sewer separation project(s) could be undertaken to improve Fort Lees CSO capture to 85%. It is estimated that separating approximately 10 acres could accomplish 85% CSO reduction. This cost would be approximately $6,250,000.

### 7.2.4 Satellite Storage

The conceptual evaluation of the storage tank for CSO reduction was performed. It is assumed that a storage tank would be located near the existing outfall and it would be below the ground. Storage tank was evaluated at outfall FL-001 and FL-002. CSO is stored in the tank during wet weather events. The stored CSO is pumped back to the interceptor for conveyance to the BCUA treatment plant during dry weather and when the system capacity is available. Five scenarios were analyzed to size the storage tank in order to achieve CSO frequencies of 0, 4, 8, 12, and 20 overflows per year. For example, in order to achieve 4 CSO events control target citywide per year, the sizing criteria for the storage tank is to capture the 5th biggest rainfall event during the typical year of 2004. Tank dewatering pump back rate is no more than 75% of the total average dry weather flows and the tank can be dewatered within 72 hours except for zero CSO control level at FL-001. Table 7-3 shows the size of the tank required at each CSO control level. Table 7-4 summarizes the CSO volumes and number of CSO events not captured and retained in the tank at each level of control. Storage tank alternative is considered as a primary solution for the CSO frequencies control because it is able to reach frequency control target without combining with other control alternatives.
### Table 7-3. Storage Tank Size (MG) at Each Level of Control

<table>
<thead>
<tr>
<th>CSO Event Target/yr</th>
<th>FL-001</th>
<th>FL-002</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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</tr>
<tr>
<td>20</td>
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### Table 7-4. Overflow Volumes and Events with Storage Tank Alternative

<table>
<thead>
<tr>
<th>CSO Event Target/yr</th>
<th>CSO Volume (MG)</th>
<th>CSO Events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FL-001</td>
<td>FL-002</td>
</tr>
<tr>
<td>Baseline</td>
<td>82.5</td>
<td>4.7</td>
</tr>
<tr>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
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<td>1.8</td>
</tr>
<tr>
<td>12</td>
<td>20.0</td>
<td>2.9</td>
</tr>
<tr>
<td>20</td>
<td>34.0</td>
<td>4.7</td>
</tr>
</tbody>
</table>

### 7.2.5 Treatment - Disinfection

Disinfection of combined sewer overflows is another option in the Borough of Fort Lee. Disinfection by Peracetic Acid (PAA) serves as the basis in the evaluation. Pathogens represent the primary pollutant of concern for CSO discharges. Disinfection facilities are sized based on the maximum CSO discharge flow rate for each event to fully treat all but 4, 8, 12, and 20 CSO discharges per year. For the target of 4 CSO events per year, the 5th largest storm in the typical year will be captured and disinfected. For the storm events larger than the 5th event, CSO discharges will be partially treated, full treatment is achieved only during times that CSO discharges are less than the maximum discharge rate. Where full treatment is achieved, disinfection is assumed to remove 99.9% of pathogens (a “3-log kill.”). This preliminary disinfection alternative assumes that PAA disinfection will be implemented at locations between the existing regulators and the existing outfalls. Table 7-5 presents the peak flow rates at each CSO control target and Table 7-6 summarizes the volume of partially treated overflows at each target.

### Table 7-5. CSO Peak Flow Rates (MGD) at Each Level of Control
### Table 7-6. Partially Treated CSO Volumes (MG) at Each Control Target

<table>
<thead>
<tr>
<th>CSO Event Target/yr</th>
<th>FL-001</th>
<th>FL-002</th>
<th>Total</th>
<th>Volume Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>82.5</td>
<td>4.7</td>
<td>87.2</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>100%</td>
</tr>
<tr>
<td>4</td>
<td>3.6</td>
<td>0.3</td>
<td>3.9</td>
<td>96%</td>
</tr>
<tr>
<td>8</td>
<td>11.3</td>
<td>2.1</td>
<td>13.4</td>
<td>85%</td>
</tr>
<tr>
<td>12</td>
<td>15.8</td>
<td>2.1</td>
<td>18.0</td>
<td>79%</td>
</tr>
<tr>
<td>20</td>
<td>20.2</td>
<td>4.0</td>
<td>24.2</td>
<td>72%</td>
</tr>
</tbody>
</table>

It is possible that suspended solids removal may be required before disinfection is applied. Fort Lee’s CSO’s are very dilute with TSS ranging from 20 to 80 mg/L, so the added value of filtration may be investigated by bench and pilot testing. We have made cost estimates for disinfection and high rate suspended solids removal (FlexFilter). If we can meet the treatment objective without filtration then Fort Lee will use the lower cost treatment process of PAA disinfection alone.

### 7.3 Preliminary Selection of Alternative

Cost analysis was performed for GI, storage tank, and PAA disinfection with and without pretreatment (solids removal) in the Borough of Fort Lee. Assumptions used to estimate capital and O&M costs are described as follows.

1. **Sewer Separation Costs**
   a. Capital costs for sewer separation of the 935 acres combined area is about $400,000,000. This is based on a normalized cost of $235,233 per acre (2006, HMM). To convert to 2018 costs, a ratio of 10817:7630 was applied herein, based on the Engineering News Record (ENR) Construction Cost Index (CCI) values for 2018 and 2006, respectively.
b. O&M costs are estimated at $8,000,000 which is based on 2% of the capital cost (2019c, G&H).

2. Treatment Costs
   a. Capital and O&M costs for PAA disinfection with high rate filtration are based on the latest available guidance for permittees (2018, G&H) and are in Table 7-7.

3. Storage Tank Costs
   a. Capital costs for tank-storage solutions are based on the latest available guidance for permittees (2018, G&H) and are in Table 7-7.
   b. O&M costs for tanks are based on operational costs at $235,000 and maintenance costs at 3% of the construction cost, in accordance with the latest available guidance for permittees (2019c, G&H) and are in Table 7-7.

4. Green Infrastructure Costs
   a. Capital costs for various GI solutions are based on the latest available guidance for permittees (2018, G&H) and are in Table 7-8.
   b. O&M costs for Bioretention GI solutions were provided as $8,000 per managed acre (2019c, G&H) and are in Table 7-8.
   c. O&M costs for Porous Pavement GI solutions were assumed to be $1,250 per managed acre (2018, DEP) and are in Table 7-8.

5. Additional Cost Factors
   a. Present-value (PV) of life-cycle costs based on a 20-year period and an interest rate of 2.75% in accordance with the latest available guidance for permittees (2019a, G&H).
   b. Based on experiences on other similar CSO LTCP projects, HDR applied a capital-cost factor of 2.5 to calculate the probable total project cost (PTPC) of implementing each technology. The PTPC accounts for installation, non-component (electrical, piping, etc.), and indirect costs (freight, permits, etc.) for all storage and disinfection. A breakdown of how this factor was calculated is shown below.
      i. Installation was estimated at 20% of equipment costs based on historic data experienced by HDR and industry standards for typical plants of similar size and complexity.
      ii. Non-component costs including: electrical (10%), piping (10%), instrumentation and controls ($15,000),
and civil site work (25%) were estimated based on factors or percentages of equipment costs. These factors account for standard installation commodities, accessories, steal supports and standard testing support.

iii. Freight was estimated at a lump sum of $20,000.

iv. Sales tax was estimated at 8%.

v. Permits were estimated at $20,000.

vi. Start up, performance testing, operator training and O&M manual were estimated at $50,000.

vii. Contract overhead and profit includes 29% for the following:

1. Part time – Project management support, project controls, procurement, quality and safety support.
2. Full time – Site construction manager (CM), site administration, standard CM travel pack.

viii. Engineering, administration and legal fees were estimated at 10%.

ix. A contingency of 10% is included for the remaining equipment items and non-component costs.
### Table 7-7. Total Capital Cost, Total 20-yr O&M Cost, Raw and PTPC as 20-yr Present Value

<table>
<thead>
<tr>
<th></th>
<th>PAA Only</th>
<th>PAA w/ FlexFilter</th>
<th>Tanks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0 CSOs per year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw Capital Cost (SM)</td>
<td>$1.35</td>
<td>$28.95</td>
<td>$50.64</td>
</tr>
<tr>
<td>20 yr PV O&amp;M Cost (SM)</td>
<td>$3.90</td>
<td>$5.75</td>
<td>$30.29</td>
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<tr>
<td>Total 20 yr PV Cost (SM)</td>
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<td>$34.71</td>
<td>$80.94</td>
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<tr>
<td>Probable Total 20 yr PV Cost (SM)</td>
<td>$7.27</td>
<td>$78.14</td>
<td>$156.90</td>
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<tr>
<td><strong>4 CSOs per year</strong></td>
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<tr>
<td>Capital Cost (SM)</td>
<td>$1.77</td>
<td>$24.57</td>
<td>$22.60</td>
</tr>
<tr>
<td>20 yr PV O&amp;M Cost (SM)</td>
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<td>$5.01</td>
<td>$17.48</td>
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<tr>
<td>Total 20 yr PV Cost (SM)</td>
<td>$4.67</td>
<td>$29.58</td>
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<tr>
<td>Probable Total 20 yr PV Cost (SM)</td>
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<td>$66.68</td>
<td>$73.97</td>
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<td><strong>8 CSOs per year</strong></td>
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<tr>
<td>Capital Cost (SM)</td>
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<tr>
<td>Total 20 yr PV Cost (SM)</td>
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<td>$19.63</td>
<td>$36.45</td>
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<tr>
<td>Probable Total 20 yr PV Cost (SM)</td>
<td>$5.05</td>
<td>$43.87</td>
<td>$66.61</td>
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<tr>
<td><strong>12 CSOs per year</strong></td>
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<tr>
<td>Capital Cost (SM)</td>
<td>$1.00</td>
<td>$12.97</td>
<td>$16.31</td>
</tr>
<tr>
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<tr>
<td>Total 20 yr PV Cost (SM)</td>
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<td>$15.85</td>
<td>$30.91</td>
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<tr>
<td>Probable Total 20 yr PV Cost (SM)</td>
<td>$4.50</td>
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<td>$55.37</td>
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<tr>
<td><strong>20 CSOs per year</strong></td>
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<tr>
<td>Capital Cost (SM)</td>
<td>$0.85</td>
<td>$9.75</td>
<td>$11.25</td>
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<tr>
<td>20 yr PV O&amp;M Cost (SM)</td>
<td>$1.60</td>
<td>$2.79</td>
<td>$8.72</td>
</tr>
<tr>
<td>Total 20 yr PV Cost (SM)</td>
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<td>$12.04</td>
<td>$19.97</td>
</tr>
<tr>
<td>Probable Total 20 yr PV Cost (SM)</td>
<td>$3.77</td>
<td>$26.66</td>
<td>$36.85</td>
</tr>
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### Table 7-8. Cost Summary for Green Infrastructure to Control 5% and 10% of Impervious Cover

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<th></th>
<th></th>
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<th></th>
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</thead>
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<tr>
<td><strong>5% GI (~&gt;6.5 Acres)</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rain Garden</td>
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<td>$0.80</td>
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<td>$9.01</td>
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<td>$0.80</td>
<td>$8.68</td>
<td>$40.88</td>
</tr>
<tr>
<td>Porous Asphalt</td>
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<td>$8.95</td>
<td>$0.13</td>
<td>$4.40</td>
<td>$9.08</td>
</tr>
<tr>
<td>Pervious concrete</td>
<td>$5.01</td>
<td>$10.02</td>
<td>$0.13</td>
<td>$5.13</td>
<td>$10.14</td>
</tr>
<tr>
<td>Permeable Interlocking Concrete Pavers</td>
<td>$2.14</td>
<td>$6.08</td>
<td>$0.13</td>
<td>$2.26</td>
<td>$6.20</td>
</tr>
<tr>
<td><strong>10% GI (~&lt;13 Acres)</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rain Garden</td>
<td>$3.35</td>
<td>$10.02</td>
<td>$1.60</td>
<td>$4.75</td>
<td>$11.62</td>
</tr>
<tr>
<td>Right-of-Way Bioswale</td>
<td>$4.93</td>
<td>$16.43</td>
<td>$1.60</td>
<td>$6.53</td>
<td>$18.03</td>
</tr>
<tr>
<td>Green Roof</td>
<td>$15.77</td>
<td>$80.16</td>
<td>$1.60</td>
<td>$17.37</td>
<td>$81.76</td>
</tr>
<tr>
<td>Porous Asphalt</td>
<td>$8.54</td>
<td>$17.90</td>
<td>$0.25</td>
<td>$8.79</td>
<td>$18.15</td>
</tr>
<tr>
<td>Pervious concrete</td>
<td>$10.02</td>
<td>$20.04</td>
<td>$0.25</td>
<td>$10.27</td>
<td>$20.29</td>
</tr>
<tr>
<td>Permeable Interlocking Concrete Pavers</td>
<td>$4.27</td>
<td>$12.16</td>
<td>$0.25</td>
<td>$4.52</td>
<td>$12.41</td>
</tr>
</tbody>
</table>
For the cost of GI, the latest guidance available to permittees (2018, G&H and 2019c, G&H) provides capital and O&M costs for a variety of GI technologies, O&M costs are available for porous-pavement technologies from the NJDEP (2018, NJDEP). As widespread implementation of GI could involve a variety of GI technologies depending on specific site conditions, a range of costs is provided in Tables 7-8 and Table 7-9. Table 7-7 shows the capital costs, O&M costs, and raw total 20-yr present value cost for each GI technology for implementation at 5% and 10% of impervious surfaces. Table 7-8 shows the raw and PTPC cost range of green infrastructure reported as $M/MG CSO controlled and $M/impervious acre controlled.

### Table 7-9. Normalized Green Infrastructure Cost Ranges

<table>
<thead>
<tr>
<th>Green Infrastructure Type</th>
<th>Min $ Million/MG CSO Reduced</th>
<th>Max $ Million/MG CSO Reduced</th>
<th>Min $ Million/Acre GI</th>
<th>Max $ Million/Acre GI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain Garden</td>
<td>$0.53</td>
<td>$1.04</td>
<td>$0.22</td>
<td>$0.43</td>
</tr>
<tr>
<td>Right-of-Way Bioswale</td>
<td>$0.66</td>
<td>$1.51</td>
<td>$0.27</td>
<td>$0.62</td>
</tr>
<tr>
<td>Green Roof</td>
<td>$1.46</td>
<td>$6.23</td>
<td>$0.60</td>
<td>$2.56</td>
</tr>
<tr>
<td>Porous Asphalt</td>
<td>$0.68</td>
<td>$1.37</td>
<td>$0.28</td>
<td>$0.56</td>
</tr>
<tr>
<td>Pervious concrete</td>
<td>$0.79</td>
<td>$1.53</td>
<td>$0.32</td>
<td>$0.63</td>
</tr>
<tr>
<td>Permeable Interlocking Concrete Pavers</td>
<td>$0.36</td>
<td>$0.95</td>
<td>$0.15</td>
<td>$0.39</td>
</tr>
</tbody>
</table>

### 7.3.1 Evaluation Factors

This preliminary evaluation considered several factors to gauge the technical feasibility and applicability for CSO controls in the Borough of Fort Lee in conjunction with the hydraulically connected communities. In general, the alternatives evaluation factors included but not limited to receiving water quality standards and uses and LTCP goals, sewer system characteristics and optimization opportunities, wet weather flow characteristics, hydraulic and pollutant loading, climate, implementation requirements (land, neighborhood, noise, disruption), and maintenance requirements. Pathogen reduction in CSO discharges and the frequency and volume of untreated CSO discharges are priorities for all alternatives along with their potential cost implications, and public acceptance and interests. The other significant factors considered in alternatives evaluation are:

- Performance capabilities and effectiveness under future (baseline) conditions.
- Applicability at a single CSO outfall or at grouped outfalls and capability to minimize number of new facilities required.
• Capability to beneficially integrate with hydraulically connected communities and the constraints involved.
• Community benefits (GI, as an example), and potential Social and environmental impacts.
• Risk and potential safety hazards to operators and public.
• LTCP Regulatory (EPA and NJSPDES) requirements

7.3.2 Regulatory Compliance

The alternatives evaluation included in the report was prepared in compliance with the LTCP regulatory (EPA and NJSPDES) requirements and associated guidance documents. The analysis was conducted in cooperation with PVSC and the permittees within the PVSC Sewer District. The evaluation considered a wide range of BMPs and CSO control measures, including all specified in Part IV G.4.e of the NJPDES permit, to identify the preliminary alternatives that will provide the levels of CSO controls necessary to develop a LTCP as required by the State and Federal regulations. The selection of the preliminary alternatives is based on multiple considerations including public input, water quality benefits and designated use, costs, and other aspects as previously outlined. The preliminary alternatives will result in full attainment of the existing pathogen water quality criteria providing the maximum bacterial reduction reasonably attainable. The remaining CSO discharges will not preclude the attainment of the water quality standards for bacteria or the designated uses of the receiving waters.

Further refinement and modifications of the alternatives is expected as the City further develops the LTCP through selection of the compliance approach in cooperation with the PVSC and hydraulically connected communities.

7.3.3 Selection of Preliminary Alternatives

The evaluation and screening of the range of control alternatives described above resulted in a trend toward the use of storage or disinfection technologies as the preliminary solutions based on the effectiveness of CSO volume and frequency control. Table 7-10 presents a summary of CSO volume and CSO events for disinfection and tank storage.

The lifecycle cost for achieving 85% capture by sewer separation or GI ranges from $6,250,000 to $10,000,000. We have also computed the lifecycle costs for 0 to 20 CSO overflows per year shown in Table 7-11. For tank storage, the most expensive CSO control alternative considered, the range is $47,000,000 to $167,000,000. For filtration with disinfection the cost range from $36,000,000 to $85,000,000. If disinfection alone proves to be a viable option then costs may
range from $3,720,000 to $7,270,000. These evaluations of alternatives will serve as a base for the consideration and development of final selected CSO control plan in Fort Lee. We believe the most cost effective solution for meeting water quality objectives and complying with the EPA CSO control policy will be GI, sewer separation or disinfection with PAA.

Table 7-10. CSO Event and Volume reduction for the CSO Control Alternatives

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>FL-001 AAOV(MG)</th>
<th>FL-002 AAOV(MG)</th>
<th>Total CSO (MG)</th>
<th>Volume Reduction Beyond 84.7% Capture</th>
<th>CSO Capture (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CSO Event</td>
<td>CSO Event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline(Future)</td>
<td>82.5</td>
<td>4.7</td>
<td>87.2</td>
<td>0</td>
<td>84.7%</td>
</tr>
<tr>
<td>0 CSO-Tanks</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>4 CSOs-Tanks</td>
<td>8.6</td>
<td>1</td>
<td>9.6</td>
<td>89.00%</td>
<td>98.32%</td>
</tr>
<tr>
<td>8 CSOs-Tanks</td>
<td>11.1</td>
<td>1.8</td>
<td>13</td>
<td>85.10%</td>
<td>97.72%</td>
</tr>
<tr>
<td>12 CSOs-Tanks</td>
<td>20</td>
<td>2.9</td>
<td>23</td>
<td>73.70%</td>
<td>95.98%</td>
</tr>
<tr>
<td>20 CSOs-Tanks</td>
<td>34</td>
<td>4.7</td>
<td>38.7</td>
<td>55.60%</td>
<td>93.21%</td>
</tr>
<tr>
<td>0 CSO-PAA</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>4 CSOs-PAA</td>
<td>3.6</td>
<td>0.3</td>
<td>3.9</td>
<td>95.50%</td>
<td>99.31%</td>
</tr>
<tr>
<td>8 CSOs-PAA</td>
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<td>2.1</td>
<td>13.4</td>
<td>84.60%</td>
<td>97.64%</td>
</tr>
<tr>
<td>12 CSOs-PAA</td>
<td>15.9</td>
<td>2.1</td>
<td>18</td>
<td>79.40%</td>
<td>96.85%</td>
</tr>
<tr>
<td>20 CSOs-PAA</td>
<td>20.2</td>
<td>4</td>
<td>24.2</td>
<td>72.20%</td>
<td>95.75%</td>
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Table 7-11. PV Cost Range for CSO Control Alternatives

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<th>CSO Event Target/yr</th>
<th>Maximum PV Cost ($M)</th>
<th>Minimum PV Cost ($M)</th>
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<tr>
<td></td>
<td>Tank Storage</td>
<td>GI of 5% of Impervious Surface</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>0</td>
<td>$ 156.90</td>
<td>$ 10.14</td>
</tr>
<tr>
<td>4</td>
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<td>8</td>
<td>$ 66.61</td>
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<td>12</td>
<td>$ 55.37</td>
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<td>20</td>
<td>$ 36.85</td>
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