



Smart infrastructure. Strong communities.

ASSESSING PUBLIC INPUT AND CONSIDERATION OF GREEN INFRASTRUCTURE IN NJ CSO REPORTS

REVIEW OF 25 CSO DEVELOPMENT AND
EVALUATION OF ALTERNATIVES REPORTS
MAY 2020

Issued by the Jersey Water Works Combined
Sewer Overflow Committee.

This report was prepared by the Jersey Water
Works CSO committee and does not reflect the
position of the New Jersey Department of
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1. Executive Summary

The purpose of this paper is to assess how well the Combined Sewer Overflow (CSO) Development and Evaluation of Alternatives Reports meet the Jersey Water Works (JWW) goals for “Smart CSO Plans.” The review focused on three categories:

1. The CSO control approach and alternatives evaluated
2. The evaluation of green infrastructure as a CSO control alternative
3. The public participation process used to inform the evaluations reports

Jersey Water Works is a collaborative effort working to transform New Jersey’s inadequate water infrastructure by investing in sustainable, cost-effective solutions that provide communities with clean water and waterways; healthier, safer neighborhoods; local jobs; flood and climate resilience; and economic growth. The goal of the JWW Combined Sewer Overflow (CSO) Committee (“Committee”) is to encourage the 25 permit holders to adopt innovative CSO Long Term Control Plans (LTCPs) with cost-effective solutions that meet or exceed permit requirements and provide multiple community benefits.

The Development and Evaluation of Alternative Reports (DEARs) were submitted to the New Jersey Department of Environmental Protection (NJDEP) in July 2019, with a deadline for the final LTCPs of October 2020. The committee reviewed 24 reports submitted on behalf of 25 permit holders; some reports were consolidated based on regional reports. Nine regional collaborations of sewage treatment plants and municipal permit holders worked together on the development and evaluation of alternatives. Of the 25 permit holders, the City of Trenton was the single permit holder not included in this review because the City has already submitted its LTCP. This paper summarizes the committee’s findings, with focus on the types of alternatives evaluated, green infrastructure considerations, and extent of public participation.

CSO Alternatives. All of the CSO permit holders considered the seven alternatives to reduce CSOs required by NJDEP’s CSO permit. Based on this review, permit holders conducted a cost-benefit analysis for the alternatives that were prioritized as potential options for the Long Term Control Plans. CSO treatment and green infrastructure (nature-based solutions that capture rain before it enters the combined sewer system) were two of those options that were evaluated as options to be included in the Long Term Control Plans in nearly every DEAR. Additionally, all municipal permit holders, except Guttenberg, evaluated storage (increasing capacity in the collection system via tanks and/or tunnels) as an option for the LTCP . Of the 24 reports, only 12 evaluated sewer separation (adding a piping system for stormwater to divert rain from the combined sewer system) and less than half of the reports evaluated sewer system optimization, sewer treatment plant expansion, and inflow and infiltration (I/I) reduction. Two permit holders, Camden County Municipal Utilities Authority and Jersey City Municipal Utilities Authority, considered an innovative “triple bottom line” approach to assess the costs and benefits of green infrastructure such as beautification, heat reduction, and property value increase. Other innovative approaches considered included adaptive management, code enforcement, and strategies for using private land for stormwater management.

Green Infrastructure. Green infrastructure (GI) alternatives reduce the amount of stormwater that enters the sewer system and would therefore reduce the volume of CSO to be treated or stored. Most of the permit holders evaluated GI as a system-wide approach, but most reports did not identify GI project locations. Bioswales were the most common GI technique evaluated, followed by permeable pavement, rain gardens, green roofs, planter boxes, and rain barrels. The “percent impervious cover controlled by GI” evaluated was between 2.5% and 15%, with most permittees evaluating both 5% and 10%. Nine reports identified only one GI scenario, while five evaluated multiple scenarios that relied on different amounts of impervious coverage controlled. The lowest cost estimate given for GI was \$2.5 million to control 5% impervious cover, and the highest was nearly \$1.2 billion, to control 10% impervious cover. Typically, NJ permittees concluded that GI would serve as a supportive alternative to other CSO controls and be used in combination with gray infrastructure techniques like disinfection and storage tanks, which would account for most of the reduction in CSO events.

Public Participation. Per NJDEP’s permit guidelines, the public participation process requires the establishment of a supplemental CSO team that can provide input for consideration in the evaluation of the CSO alternatives and also provide input for the selection of those controls. All 25 permit holders participated in supplemental CSO teams as required, predominantly regional teams. Supplemental CSO regional teams included: Bergen County Utilities Authority, Passaic Valley Sewerage Commission, Middlesex County Utilities Authority, Camden County Utilities Authority, The Joint Meeting of Essex and Union Counties, and North Hudson Sewerage Authority. In addition to the regional teams, five municipal permit holders participated in their own municipal teams to extend their public outreach. Though the supplemental CSO team requirement was met, only four group reports, representing 16 permit holders, included comments from either the supplemental CSO team or the public. Thus, a third of the permit holders have not explicitly documented or responded to public input in the DEARs. All 24 reports indicated some forms of public outreach in addition to participation in the supplemental CSO team, which include methods such as educational programs and/or event outreach, website information, brochures/flyers, news releases, and signage.

Recommendations. Based on our review, the committee recommends the following:

- The next phase of the LTCP should have a more robust inclusion of public participation and public input should be part of both the evaluation and selection of alternatives.
 - Each CSO permit holder should release draft LTCPs to the public and supplemental CSO team for comments and hold at least one in-person or virtual public meeting on the draft plans before the LTCPs are submitted to NJDEP.
 - Each CSO permit holder should use multiple platforms to get information out to the public and to publicize meetings. Examples include, but are not limited to, social media, message boards, flyers, and working with local community groups to disseminate information.
 - CSO permit holders should continue to meet with their supplemental CSO teams on a quarterly basis while the LTCPs are reviewed by NJDEP to continue to engage the group in public outreach and to get feedback on the financing and siting of gray and green infrastructure projects.

- NJDEP should include more specific and enforceable requirements on public input and outreach for permit holders in the next permit cycle. For example, require a minimum number of meetings to be held at a time that the general public can attend and that the opportunity to do so is well-advertised and posted at least two weeks in advance of the meeting.
- NJDEP should expand the conversation on green versus gray infrastructure, including costs versus long term benefits, community involvement and collaboration, and the understanding that there is no one-size-fits-all solution when using GI.
- Permittees should use triple bottom line methods which consider projects based on the social, environmental and economic benefits that tend to weigh both green and gray alternatives in the selection and evaluation of CSO controls. See JWW's [Balancing Green and Gray Solutions to CSO Management report](#).¹
- Permittees should consider implementation of a stormwater fee as part of their CSO Long Term Control Plans. A stormwater fee could raise revenue to offset the cost of implementation of the LTCP and/or incentivize private owners to undertake green infrastructure on their property to reduce their stormwater input and their corresponding fees.
- NJDEP should require green infrastructure projects (when feasible) to be integrated into solutions to fix flooding issues during the next five-year permit process in order to reduce the cost and size of gray infrastructure projects.

NJDEP should make sure that environmental justice communities are protected and prioritized in the LTCPs.

- NJDEP should require flooding to be eliminated in all residential areas, especially low-income communities. Lower-income communities should be considered first for implementation in the CSO Long Term Control Plans.

NJDEP should strongly encourage permittees to provide summaries of sewer system and CSO cleaning and inspection activities to help document the proper operation and maintenance (O&M) of the sewer collection. NJDEP and the United States Environmental Protection Agency (US EPA) should increase the frequency of comprehensive CSO inspections and document implementation of the sewer system and CSO O&M activities. The use of existing infrastructure should be optimized before investing more money to address regulations the JWW developed: [Hidden Capacity: How Proper Maintenance and Cleaning of Sewer Systems Can Have Huge Benefits](#)² highlights the importance of sewer cleaning and inspection as critical elements of a proper and effective sewer system operation and maintenance program.

- NJDEP should update future New Jersey Pollutant Discharge Elimination System (NJDES) CSO permit requirements to:

¹ <https://www.jerseywaterworks.org/wp-content/uploads/2018/12/Balancing-Green-and-Gray-CSO-FINAL.pdf>

² https://www.jerseywaterworks.org/wp-content/uploads/2019/04/Hidden_Capacity-3.28.19.pdf

- List all sewer systems and CSO infrastructure owned and operated by the permittee.
- Require remote monitoring of key portions of the collection system, such as regulators.
- Require an annual CSO status report, including a summary of O&M activities (including summaries of system cleaning and inspection) and the implementation status of the nine minimum- and long-term CSO controls.

2. Purpose

The purpose of this paper is to assess how well the CSO Evaluation of Alternatives Reports meet the Jersey Water Works (JWW) goals for “Smart CSO Plans.” The JWW CSO committee reviewed the reports based on how well they addressed the first three of the [JWW Goals](#)³ for “Smart CSO Plans.”

Smart CSO Plans: Municipalities and utilities adopt innovative CSO Long Term Control Plans (LTCPs) with cost-effective solutions that meet or exceed permit requirements and provide multiple community benefits.

1. **Balancing Pipes and Parks:** LTCPs incorporate and commit to an optimized balance of green and gray infrastructure to achieve the goals of the Clean Water Act.
2. **Reducing Combined Sewer Flows:** LTCPs prioritize proven approaches that reduce combined sewer system flows, such as inflow and infiltration (I&I) reduction, green stormwater infrastructure, and water conservation.
3. **Serving Host Communities:** Implementation of the LTCPs reflects early input of community stakeholders and delivers significant additional community benefits including improved public health, green space, economic revitalization, and local jobs.

The committee will review the fourth goal, **Affordable CSO Solutions**, at a future date.

The review focused on three categories:

1. The CSO control approach and alternatives evaluated
2. The evaluation of green infrastructure as a CSO control alternative
3. The public participation process used to inform the evaluation of alternatives

This report builds on several resources developed by JWW and most recently by its CSO committee:

³ <https://www.jerseywaterworks.org/about-the-collaborative/our-shared-goals/>

- The JWW CSO committee developed a worksheet that was used to review the Development and Evaluation of Alternatives reports.
- [Balancing Green and Gray Solutions to CSO Management](#)⁴ recommends ways for Long Term Control Plans to balance green versus gray infrastructure solutions. It also notes several methods to help communities better incorporate green solutions to address CSO issues. (2018)
- [Hidden Capacity: How Proper Maintenance and Cleaning of Sewer Systems Can Have Huge Benefits](#)⁵ highlights the importance of sewer cleaning and inspection as critical elements of a proper and effective sewer system operation and maintenance program. (2018)
- [Water Infrastructure that Works for Cities: Best Practices and Considerations for Preparing Long Term Control Plans to Control Combined Sewer Overflows](#)⁶.
- [Communications resources for NJ communities](#),⁷ including [Unearthing Infrastructure: Communicating Water Infrastructure to New Jersey's Communities and Stakeholders](#),⁸ a guide written to capture the key takeaways from a series of kick-off meetings and workshops held in Fall 2016.
- [Customizable Community Fact Sheets](#).⁹ A series of customizable fact sheets for use by residents, local organizations, and anyone else interested in educating the general public on combined sewer overflows, CSO solutions, and how to navigate the CSO permit.
- [Educational Signs on Combined Sewer Outfalls](#).¹⁰
- Members of the JWW CSO committee provided feedback to the NJDEP regarding guidance on public participation that was released to permit holders and assisted NJDEP in organizing a workshop on public participation.

3. Background: CSO Permits and Evaluation of Alternatives Reports

Jersey Water Works (JWW) is a collaborative effort of many diverse organizations and individuals who embrace the common purpose of transforming New Jersey's inadequate water infrastructure by investing in sustainable, cost-effective solutions that provide communities with clean water and waterways; healthier, safer neighborhoods; local jobs; flood and climate resilience; and economic growth. JWW consists of several committees that advance the actions needed to transform New Jersey's water infrastructure.

The goal of the JWW Combined Sewer Overflow (CSO) Committee ("Committee") is to encourage the 25 permit holders, municipalities and utilities, to adopt innovative CSO Long Term Control

⁴ <https://www.jerseywaterworks.org/wp-content/uploads/2018/12/Balancing-Green-and-Gray-CSO-FINAL.pdf>

⁵ https://www.jerseywaterworks.org/wp-content/uploads/2019/04/Hidden_Capacity-3.28.19.pdf

⁶ <https://www.jerseywaterworks.org/wp-content/uploads/2016/01/Water-Infrastructure-That-Works-for-Cities.pdf>

⁷ <https://www.jerseywaterworks.org/our-work/connecting-stakeholders-make-water-infrastructure-matter/>

⁸ https://www.jerseywaterworks.org/wp-content/uploads/2017/02/unearthing_infrastructure_Feb.2017.pdf

⁹ <https://www.jerseywaterworks.org/our-work/initiatives/customizable-community-fact-sheets/>

¹⁰ <https://www.jerseywaterworks.org/our-work/combined-sewer-overflows-the-basics/educational-signs-combined-sewer-outfalls/>

Plans (LTCPs) with cost-effective solutions that meet or exceed permit requirements and provide multiple community benefits. The committee’s recent accomplishments include the publication of [two white papers](#) that provide these communities and their associated stakeholders with information and recommendations to tailor these plans to fit each community’s needs.

Each of the 25 New Jersey municipalities and sewage treatment plants (STPs) with CSO permits was required to submit a Development and Evaluation of Alternative Report (DEAR) to the NJDEP by July 1, 2019 as part of the CSO permits that were issued in July 2015. The goal of five-year CSO permits is for New Jersey waterways to meet the requirements of the “Clean Water Act and the National CSO Policy by reducing or eliminating the flow from the remaining CSO outfalls in New Jersey.”¹¹ The final LTCPs due on June 1, 2020 will identify the alternatives that have been selected to reduce or eliminate the flow from 217 combined sewer outfalls in New Jersey. Eliminating or reducing combined sewer overflows in New Jersey will improve water quality, access to waterways and reduce localized flooding.

New Jersey municipal and STP permit holders have been working regionally and will be submitting regional LTCPs based on the service area. The DEARs were submitted according to this format. In most cases, regional reports were spearheaded by the publicly owned treatment wastewater treatment plants (WWTPs), and municipal permit holders. Within these, the respective municipal plans are included as separate sections.

Table 3. Regional Report Breakdown by Permit Holder

BCUA
<ul style="list-style-type: none"> • Bergen County Utilities Authority (BCUA) • Hackensack • Ridgefield Park • Fort Lee
CCMUA
<ul style="list-style-type: none"> • Camden County Municipal Utilities Authority (CCMUA) • Camden • Gloucester
JMEUC
<ul style="list-style-type: none"> • Joint Meeting of Essex and Union Counties (JMEUC) • Elizabeth
MCUA
<ul style="list-style-type: none"> • Middlesex County Utilities Authority (MCUA) • Perth Amboy
NBMUA
<ul style="list-style-type: none"> • North Bergen Municipal Utilities Authority (NBMUA) – Woodcliff Sewage Treatment Plant • Guttenberg

¹¹ <https://www.nj.gov/dep/dwq/cso-basics.htm>

NHSA*
<ul style="list-style-type: none"> • North Hudson Sewerage Authority (NHSA) – Adams Street Wastewater Treatment Plant • North Hudson Sewerage Authority (NHSA) – River Road Wastewater Treatment Plant
PVSC
<ul style="list-style-type: none"> • Passaic Valley Sewerage Commission (PVSC) • Bayonne • East Newark • Harrison • Jersey City Municipal Utilities Authority (JCMUA) • Kearny • Newark • North Bergen Municipal Utilities Authority (NBMUA) • Paterson

*NHSA owns the pipes and the treatment plant. The following cities are served by NHSA but are not permit holders: Hoboken, Union City, West New York, and Weehawken.

Please note that the City of Trenton already submitted a Long Term Control Plan.

The reports and NJDEP’s comments are posted on its webpage.

<https://www.nj.gov/dep/dwq/cso-ltcpsubmittals.htm>

Fact sheets summarizing the reports from nine of the reports that were prepared by the Sewage-Free Streets and Rivers campaign and can be found [here](#).¹²

CSO permittees that submitted DEARs utilized information and guidance documents prepared by NJDEP. These included reports and documents addressing sensitive areas within New Jersey, sewer, stormwater and flooding modeling requirements, and technical guidance for evaluating various CSO control technologies such as green infrastructure. They also were required to follow a uniform cost assessment methodology.

The JWW CSO committee used a worksheet to review the regional DEARs.

Reviewers did the following:

- Assessed the reports for consideration of community and environmental benefits
- Reviewed all of the alternatives
- Summarized the cost-benefit analyses

¹² <https://sewagefreenj.org/resources/#factsheets>

The final CSO LTCP reports are due to NJDEP on October 1, 2020. CSO permit holders are currently in the process of selecting alternatives from those identified in the July 2019 reports. They are required to engage the public in this process.¹³

4. Findings

4A. CSO Control Approach: Presumptive Vs. Demonstrative

CSO permit holders are required to select either the Presumptive or the Demonstrative Approach, as defined in the Clean Water Act's CSO policy in the CSO Long Term Control Plans. Both approaches provide permit holders with targets for CSO controls that achieve compliance with the Clean Water Act (CWA). Under the Presumptive Approach, the permit holder implements a minimum level of treatment (e.g. the capture of at least 85% of collected combined sewage overflows or the reduction of overflow events to an average of four events per year) that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise. Under the Demonstrative Approach, the permit holder demonstrates that its plan is adequate to meet the water quality-based requirements of the CWA by conducting analyses using existing water quality data, system performance modeling, etc. Permittees did not select an approach in the DEARs.

4B. Evaluation of Control Alternatives and Cost Estimates

Control Alternatives. Per the permit requirements, all permit holders evaluated the seven required control alternatives, as well as additional innovative control alternatives. The seven controls required by NJDEP for evaluation included green infrastructure, storage, expansion and/or storage at the sewage treatment plant, inflow/infiltration reduction, sewer separation, treatment of CSO discharge, and CSO-related bypass of secondary treatment at a sewage treatment plant.

The DEARs included two levels of evaluation:

1. Evaluation of all of the seven alternatives that were required by the permit.
2. A cost-benefit analysis of alternatives recommended for further evaluation that could be used to select the alternatives for the LTCPs.

A listing of the permittees, the alternatives they studied, and cost estimates can be found in the Appendix (Table 7B). The results are summarized in this section.

The number of permittees that evaluated each alternative varied. For all permittees, st treatment of discharge and green infrastructure were the most commonly evaluated alternatives.

¹³ Contacts for each of the CSO permit holders can be found at the following [link](https://sewagefreenj.org/wp-content/uploads/2019/07/CSO-Directory-2019-UPDATED-7-8-19-Sheet1.pdf), along with website links and information on Supplemental Teams: <https://sewagefreenj.org/wp-content/uploads/2019/07/CSO-Directory-2019-UPDATED-7-8-19-Sheet1.pdf>

Table 4B-1. Control Alternatives

Control Alternative	Description	Usage (by # of permittees)
Storage	Increasing capacity in the collection system via tanks and/or tunnels.	15 (All municipal permit holders except Guttenberg)
Treatment of CSO discharge ¹⁴	Treatment, or “disinfection,” of CSO discharge at the end of the outflow pipe using peracetic acid (PAA) and/or chlorine.	18
Green infrastructure (GI)	Nature-based solutions that capture rain where it falls, before it enters and overwhelms the combined sewer system.	17
Sewer separation	Adding a pipe for stormwater to divert rain from the combined sewer system.	12
Sewer system optimization	Using existing pipes to store stormwater.	7
Increasing plant capacity or storage ¹⁵	Increasing the wet weather capacity at the wastewater treatment plant or bypass of secondary treatment at the sewage treatment plant.	7
Inflow and infiltration (I/I) reduction	Fixing pipe systems so additional water does not come in.	6

Regional and Municipal Alternatives. The alternatives that were selected for further review for the LTCPs are based on ownership of the collection system. For example, increasing plant capacity, or storage,¹⁵ was only evaluated by sewer treatment plants, which own the plants. Likewise, sewer separation, which would be done within municipalities, was evaluated by just the municipal permit holders who own public land. **Innovative Approaches.** Some permit holders employed innovative or unique approaches:

- Triple bottom line approach used to evaluate alternatives (Camden County Municipal Utilities Authority, Jersey City Municipal Utilities Authority)
- Adaptive management, a structured, iterative process of decision making in the face of uncertainty, with an aim at reducing uncertainty over time via system monitoring. (Camden County Municipal Utilities Authority)
- Code enforcement (Town of Kearny)
- Strategies for using private land for stormwater management (Town of Guttenberg)
- Strategies to promote localized GI on a homeowner scale as a program enhancement (Borough of East Newark)

¹⁴ For the disinfection alternative, several innovative technologies were evaluated for end of pipe treatment, including Fuzzy Filters™, sand filters, swirl concentrators, and ballasted floc technologies. Disinfection is based on the use of peracetic acid (PAA), which was piloted in the City of Bayonne by the U.S. Environmental Protection Agency.

¹⁵ Increasing the wet weather capacity of wastewater treatment plants (WWTPs) included effluent blending via the use of CEPT, Actiflow, Densideg, as well as on-site storage.

Recognizing that the use of existing infrastructure should be optimized before investing more money to address regulations, JWW developed the [Hidden Capacity: How Proper Maintenance and Cleaning of Sewer Systems Can Have Huge Benefits](#)¹⁶ report. This report highlights the importance of sewer cleaning and inspection as critical elements of a proper and effective sewer system operation and maintenance program. As such, several reports commented on these maintenance program elements:

- The Camden County Municipal Utilities Authority’s report noted that sewer cleaning activities are ongoing within Camden and would continue through early 2021.
- The Elizabeth and Ridgefield Park reports noted that these municipalities regularly perform sewer cleaning.
- The North Hudson Sewerage Authority - Adams Street DEAR noted that slip lining of the combined sewers was proposed but did not discuss sewer cleaning.

Cost Estimates. Each of the reports also included estimates for capital construction costs that varied widely, depending in part on the level of CSO capture and/or treatment with accuracy ranges from -50 to +100%. The following table shows the ranges of capital cost estimates outlined in the reports reviewed by the committee.

Table 4B-2. Cost Estimates

Alternative	Specific Control	Cost Estimate (Capital Construction)
Storage	Satellite storage tanks	\$23 to \$487M
	Storage tunnel	\$58 M to \$1.2B
Disinfection	PAA disinfection	\$1 to \$22M
	Consolidated end of pipe treatment ¹⁷	\$50 to \$153M
	FlexFilter with PAA disinfection	\$10 to \$865M
Green infrastructure	--	\$0.4 M to \$1.2B
Sewer separation	--	\$6 M to \$1.2B
Sewer system optimization	HRT with ocean outfall (<i>Perth Amboy only</i>)	\$340 M (life cycle cost)
	Regulator modifications	\$0.12 - \$0.35M
	Pump station upgrades	\$6M
Increasing plant capacity	WWTP expansion - HRT ¹⁸ with disinfection	\$27 to \$40M
	WWTP wet weather blending - CEPT	\$65 to \$90M
	WWTP wet weather blending - Ballasted Floc	\$115 to \$161M
	Effluent blending	\$20M
I/I rehabilitation	--	\$14 to \$43M

¹⁶ https://www.jerseywaterworks.org/wp-content/uploads/2019/04/Hidden_Capacity-3.28.19.pdf

¹⁷ PAA and either Screening/Actiflo or FlexFilter

¹⁸ Hydraulic Retention Time

4C. Evaluation of Green Infrastructure Alternatives

Green infrastructure (GI) is one of the seven alternatives that the CSO permit required permit holders to evaluate in developing their LTCPs. A variety of green infrastructure techniques were evaluated, including rain gardens, bioswales, blue roofs, green roofs, permeable pavement, as well as rainwater harvesting techniques like rain barrels and cisterns. Most of the permit holders evaluated GI as a system-wide approach but did not identify GI project locations.

Extent of Green Infrastructure and Balance of Green and Gray Infrastructure. To evaluate green infrastructure, all permit holders based their assessments and cost estimates on the percentage of impervious surface that would be managed by green infrastructure. The percentages evaluated in the reports ranged from 2.5% to 15% of impervious surface. Permit holders were then able to determine, using models, how many CSO events would be reduced or the volume of overflows that would be reduced based on the percentage of impervious surface managed by GI techniques.

Most of the reports prepared by a POTW, which includes a group of municipal permittees, discussed implementing GI techniques in member communities. Exceptions included the NHTSA Adams Street and River Road WPCP¹⁹ service areas, the North Bergen MUA, which indicated that GI improvements would be further evaluated within the Woodcliff WPCP service area, and the CCMUA, which would take a lead role in GI control strategies within Camden and Gloucester.

Balancing green and gray solutions has been a priority of Jersey Water Works and is one of the goals of its CSO committee. The committee defined this balance in the report "[Balancing Green and Gray Solutions to CSO Management](#)."²⁰ "This report uses the word 'balance' in its title, stemming from the concern that a number of CSO programs that have traditionally addressed their issues with gray infrastructure have struggled to figure out the right level of GI to include in order to strike a balance of cost, community acceptance, and performance." Permit holders continued to struggle to find the right balance of green and gray infrastructure in the DEARs. The degree to which permit holders evaluated GI varied. Seven permittees (Camden, Gloucester, Perth Amboy, Guttenberg, NHTSA – Adams St., NHTSA – River Road, Paterson) only evaluated one amount of green infrastructure and eight permittees (Fort Lee, Hackensack, Bayonne, East Newark, Kearny, Jersey City, Newark, and North Bergen) evaluated two. Elizabeth and Harrison each evaluated five GI scenarios. None of the permittees used site-specific modeling, making it difficult to determine if the evaluation was accurate in terms of cost and performance.

¹⁹ WPCP: Water Pollution Control Plant

²⁰ <https://www.jerseywaterworks.org/wp-content/uploads/2018/12/Balancing-Green-and-Gray-CSO-FINAL.pdf>

Table 4C. Green Infrastructure Alternatives - Municipal Permit Holders

Permittee	% of Impervious Cover Managed by GI	Reduction in CSO Events or Volume and % of Total from Baseline				GI NPW ²¹ Estimate (million)	General Approach to GI and Comments
		Events	%	Volume (MG)	%		
BCUA							
Fort Lee	5	1	1.7	2.7	3.3	\$7.7 - \$18.1	Based on bioswales and permeable pavement
	10	0	0	5.5	6.7	\$15.3 - \$36.2	
Hackensack	5	5	8.9	33.2	12.9	\$31.9	Based on bioswales and permeable pavement
	10	5	8.9	38.0	14.8	\$42.6	
Ridgefield Park	2.5	0	0	0.3	0.5	\$2.7	Based on bioswales and permeable pavement
	5	0	0	0.8	1.5	\$6.0	
	7.5	0	0	1.4	2.8	\$9.0	
	10	0	0	2.0	4.0	\$12.0	
CCMUA							
Camden	10				18		Includes but is not limited to rain gardens, bioswales, permeable pavement, green roofs
Gloucester	10						
JMEUC							
Elizabeth	2.5			16.2	1.5	\$77.1	Based on bioswales
	5.0			22.6	2.1	\$150.5	
	7.5			26.6	2.5	\$226.3	
	10			31.3	2.9	\$301.0	
	15			36.0	3.4	\$451.5	
MCUA							
Perth Amboy	10					\$24.3	Based on rain gardens and bioswales in ROW ²²

²¹ NPW: Net Present Worth

²² ROW: Right of Way

Permittee	% of Impervious Cover Managed by GI	Reduction in CSO Events or Volume and % of Total from Baseline				GI NPW ²¹ Estimate (million)	General Approach to GI and Comments
		Events	%	Volume (MG)	%		
NBMUA							
Guttenberg						\$0.73	Based on planter boxes, rain barrels, and green roofs for new construction
NHSA							
North Hudson SA - Adams Street					27	\$134	Based on ROW bioswales and permeable pavement
North Hudson SA - River Road						\$0.4	Based on ROW bioswales and green roofs
PVSC							
Bayonne	5 10	1 1	1.7 1.7	25.2 50.2	3.4 6.7	\$44 - \$311 \$94 - \$622	Localized GI (rainwater harvesting) on a homeowner scale as a program enhancement
East Newark	5 10	1 1	3.1 3.1	4.2 3.9	24.4 22.6	\$2.5 - \$16.3 \$4.9 - \$32.6	GI would be combined with sewer separation on the former BASF Clark Thread site
Harrison	2.5 5.0 7.5 10 15			0.1 0.2 0.3 0.4 0.5		\$6.0 \$12.0 \$18.0 \$23.0 \$35.0	Permeable pavement and bioswales to be included in final evaluation of alternatives

Permittee	% of Impervious Cover Managed by GI	Reduction in CSO Events or Volume and % of Total from Baseline				GI NPW ²¹ Estimate (million)	General Approach to GI and Comments
		Events	%	Volume (MG)	%		
Kearny	5 10	0 1	0 3.3	4.9 10.0	2.2 4.5	\$27.5 - \$57.7 \$58.2 - \$119.9	Based on rain gardens, permeable pavement, and bioswales
PVSC							
Jersey City	7 10			1,387.3 1,356.0	89.1 87.1	\$67 \$97	Based on bioswales and trees
Newark	5 10	0 to 6 0 to 8		97 192	7.4 14.6	\$78 - \$583.3 \$194.4 - \$1,166.7	Based on rain gardens and green roofs
North Bergen	5 10	3 3	5.7 5.7	8 16.1	2.9 5.8	\$76.7	GI has minor impact, but permeable pavement would be considered in final alternatives
Paterson	2.5					\$13.7	Based on ROW bioswales and rain gardens

Green Infrastructure Findings

General Approach to GI

Bioswales were the most common GI option discussed (13 out of 18), followed by permeable pavement (9), rain gardens (6), green roofs (5), planter boxes (1), and rain barrels (1). Bayonne and East Newark did not mention specific examples of GI. The “percent impervious cover controlled by GI” evaluated was between 2.5% and 15%, with most permittees evaluating both 5% and 10%.

Cost of GI

The lowest cost estimate for GI was \$400,000 and the highest was nearly \$1.2 billion. The average cost estimate was about \$68 million using the lowest estimates, and \$144 million using the highest

estimates. Newark's high estimate for 10% impervious cover controlled is an outlier at nearly \$1.2 billion. The next highest estimate was \$622 million for Bayonne, also for 10% cover.

Commonly Cited Limitations of GI

Green roofs were ruled out by most of the permit holders due to their high costs and the old age of public buildings. GI projects on private property or a program to incentivize GI installations on private property were not evaluated in any of the reports. Limitations to implementing GI that were noted in the reports included infiltration issues and the lack of available public land. Some GI techniques or practices were ruled out for further evaluation by the permit holders based on either cost, space available in the public domain (i.e., right-of-way, municipally owned property), maintenance concerns, or a combination of these issues.

Common Conclusions about GI

Typically, permittees concluded that GI would serve as a supportive alternative to other CSO controls and be used in combination with gray infrastructure techniques like disinfection and storage tanks that would account for most of the reduction in CSO events. For example, the City of Bayonne's report grouped GI with alternatives that "are not capable of achieving the major performance objectives, [which] are herein designated secondary CSO-control alternatives." The City of Newark's report noted that, "GI provides a modest amount of CSO reduction, but also delivers ancillary benefits to the community."

Triple Bottom Line Evaluation for GI Cost Benefit Analysis

Two permit holders, CCMUA and JCMUA, used a "triple bottom line" approach to assess costs and benefits. This approach takes into consideration the many benefits of green infrastructure, such as beautification, heat reduction, property value increase, etc., thus producing more favorable comparisons of green solutions to gray ones. CCMUA and JCMUA, the two permit holders that used a triple bottom line perspective to evaluate the alternatives and reported on a more robust public participation process, included higher percentages of GI in their proposed options to reduce sewage overflows.

4D. Evaluation of Public Participation

According to the CSO permits and [related guidance](#),²³ CSO permit holders are required to organize a public participation process that engages the affected public throughout the three phases of the LTCP. One of the requirements entails inviting members of the affected or interested public to establish a supplemental CSO team. The purpose of this team is "to work as an informal work group as a liaison between the general public and the decision makers for the permittee."²³ Additional requirements include conducting outreach using various methods (e.g. public meetings, mailers, and signs) to inform the affected or interested public during the development of the LTCP

²³ https://www.nj.gov/dep/dwq/pdf/CSO_Public_Participation_Resource_Document.pdf

and submitting a Public Participation Process Report.

Most of the DEARs included an update to the Public Participation Process Reports submitted in June 2018. The findings in Table 4D mostly reflect information in the DEARs, as they are the most recent documents. If permittees did not mention the public participation process in their DEAR, the Public Participation Process Report was referenced to find relevant information.

Through reviewing the reports, the committee found varying degrees of community outreach and public input.

Table 4D. Public Participation

Permittee	Supplemental CSO Team? Municipal or Regional?	Describes Comments or Input from Team or Public?	Number of Community Meetings Held (Since June 2018)	Description of Other Types of Outreach
BCUA				
BCUA	Regional Supplemental CSO Team	No	6	Web notice, flyers, provided literature at Earth Day event
Fort Lee	Regional (BCUA) and Municipal Supplemental CSO Team	No	6(BCUA)	Web notice
Hackensack	Regional (BCUA) Supplemental CSO Team	No	6(BCUA)	Webpage, newsletter, handouts, survey (webpage/email)
Ridgefield Park	Regional (BCUA) and Municipal Supplemental CSO Team	No	6(BCUA)	Web notice, flyers, literature at Earth Day event
CCMUA				
Camden & CCMUA	Regional Supplemental CSO Team	Yes (Team)	Not stated	GI events, rain barrel education, mailings, website, brochures

Permittee	Supplemental CSO Team? Municipal or Regional?	Describes Comments or Input from Team or Public?	Number of Community Meetings Held (Since June 2018)	Description of Other Types of Outreach
Gloucester	Regional (CCMUA) and Municipal Supplemental CSO Team	Yes (Team)	Not stated	Web notice, classroom and local business association events
JMEUC				
Elizabeth & JMEUC	Regional Supplemental CSO Team	Yes (Team)	4	Posters, flyers, brochures, handouts, websites, school events, media, signs
MCUA				
Perth Amboy & MCUA	Regional Supplemental CSO Team	Yes (Team)	Not stated	Posters, flyers, handouts, mailings, media
NBMUA				
Guttenberg & NBMUA - Woodcliff STP	Regional (PVSC) Supplemental CSO Team	No	7 (PVSC)	Educational public meetings with handouts
NHSA				
North Hudson SA -Adams Street & River Road	Regional Supplemental CSO Team (A.K.A. CSO Community Advisory Board)	No	3	Web notice, signage
PVSC				
PVSC	Regional Supplemental CSO Team	Yes	7	Public meetings, participation at public events, website, social media
Bayonne	Regional (PVSC) and Municipal Supplemental CSO Team	No	7 (PVSC)	None other than PVSC outreach
East Newark	Regional (PVSC) Supplemental CSO Team	No	7 (PVSC)	None other than PVSC outreach

Permittee	Supplemental CSO Team? Municipal or Regional?	Describes Comments or Input from Team or Public?	Number of Community Meetings Held (Since June 2018)	Description of Other Types of Outreach
Harrison	Regional (PVSC) Supplemental CSO Team	No	7 (PVSC)	Harrison TIDE, town caucus meeting
Jersey City MUA	Regional (PVSC) Supplemental CSO Team	Yes	7 (PVSC)	Educational programs, community meetings
Kearny	Regional (PVSC) Supplemental CSO Team	Yes (Public - local group)	7 (PVSC)	Various public education and outreach programs
Newark	Regional (PVSC) and Municipal Supplemental CSO Team	No	7 (PVSC)	Community meetings, outreach, website, education
North Bergen MUA	Regional (PVSC) Supplemental CSO Team	No	7 (PVSC)	None besides PVSC outreach
Paterson	Regional (PVSC) Supplemental CSO Team	No	7 (PVSC)	None besides PVSC outreach

Public Participation Findings

Supplemental CSO Teams

All of the permit holders participated in supplemental CSO teams, as required. All of the permit holders participated in regional teams and five created additional, separate municipal teams. As mentioned previously, most DEARs included a public participation process update. Exceptions include the North Hudson Sewerage Authority reports (Adams Street and River Road), which did not mention the Supplemental CSO Team in the DEAR at all, and the CCMUA and MUA reports.

Public Meetings

All of the regional supplemental CSO team meetings were open to the public, though the exact number of meetings is unknown. NHTA, JCMUA, Newark, Hackensack, Kearny, and Harrison mentioned public meetings as separate from supplemental CSO team meetings.

Public Input

Although all permit holders participated in regional supplemental CSO teams, only four group reports (CCMUA, JMEUC, MUA, PVSC), representing 16 permit holders, included comments from either the supplemental CSO team or the public. Thus, a third of the permit holders have not explicitly documented or responded to comments from the supplemental CSO team or the public in the DEARs.

Both CCMUA and MUA included comments from the supplemental CSO team throughout the DEAR, while JMEUC included input from the supplemental CSO team and responses to the comments. JMEUC also included notes from each of the meetings held, comments and questions related to the evaluation of alternatives, as well as the results from digital surveys that were used in each of their supplemental CSO team meetings.

Public Outreach

All group reports indicated some forms of public outreach in addition to participation in the supplemental CSO team, but five individual permit holder reports did not explicitly mention outreach. However, the outreach information for those five permit holders may be addressed in their separate Public Participation Process Reports.

The most common form of outreach included educational programs and/or event outreach. The second most common form was website information, whether that meant posting notices on existing websites or creating designated webpages. Other less common types of outreach included papers (i.e. posters, brochures, flyers, handouts), media (i.e. press releases, social media, newsletters), signage, and surveys.

5. Conclusions

Over the past four and half years, the NJDEP, its 25 CSO permit holders, and advocacy groups taking part in the supplemental CSO teams have all experienced the ups and downs of the CSO permit program that began in 2015. As we near the end of those five-year permits, we take a moment to look at the good, the bad, and the potential for improvement in the next round of permits.

1. We saw permittees like the City of Elizabeth/Joint Meeting of Essex and Union Counties work hard to embrace and educate the public in their communities about the challenges and opportunities of addressing the CSO events. Supplemental CSO team meetings in the City of Elizabeth have been some of the most open to group discussion among all of the existing supplemental CSO teams. This is not to say that meetings that are more information-driven are not worthwhile, but that supplemental CSO team members with experience and knowledge who can add valuable input to the process if the permit holder and their consultants allow and encourage active engagement.
2. Some communities had a more accepting review of GI ies. Where other communities were less embracing of GI than others—due mainly to concerns over

cost, labor to maintain, and available space to install GI—they nevertheless made the attempt to incorporate and understand GI and how it could benefit.

3. One of the most common issues we identified was around public input and participation. CSOs are not excited to talk about nor is the process by which they are being addressed. However, CSO solutions will cost ratepayers millions of dollars and affect communities for decades; it is vitally important that the communities affected by CSOs understand what they are, how it affects them, and how they can be a part of the solution.

Jersey Water Works recommends permittees consider the following to improve the public participation process:

1. Utilize avenues that the public regularly uses to disseminate information. For example, social media, message boards, and tapping community groups to announce supplemental CSO team meetings and share educational materials is more effective than less frequently accessed avenues, such as a city webpage.
2. Hold at least some of the meetings at a time and place where the public can more easily attend. It's not necessary to hold every meeting this way, but two or three a year would be a great start. If the supplemental CSO team meetings are all held on weekday mornings, at a location not accessible by public transit, public participation is unfeasible.
3. Encourage community members and partners to join supplemental CSO meetings and aid in planning public meetings. There are many community members with years, or even decades, of experience in the areas affected by CSOs who would gladly share their expertise with permittees if they were asked and it was clear that their feedback would be taken into consideration. This will result in more engaging meetings that will ultimately benefit the community at large.

Improved coordination amongst stormwater management and its impact on CSOs can better inform decisions and policymaking around impervious cover and land use in the 21 affected communities. Our next steps will revolve around taking the lessons learned over the last five years and applying them to a better version of CSO permits in 2020.

6. Recommendations

Based on our review, the committee recommends the following:

- The next phase of the LTCP should have a more robust inclusion of public participation, and public input should be part of both the evaluation and selection of alternatives.
 - Each CSO permit holder should release draft LTCPs to the public and supplemental CSO team for comments and hold at least one in-person or virtual public meeting on the draft plans before the LTCPs are submitted to NJDEP.
 - Each CSO permit holder should use multiple platforms to get information out to the public and to publicize meetings. Examples include but are not limited to social media, message boards, flyers, and working with local community groups to disseminate information.

- CSO permit holders should continue to meet with their supplemental CSO teams on a quarterly basis while the LTCPs are reviewed by NJDEP to continue to engage the group in public outreach and to get feedback on the financing and siting of gray and green infrastructure projects.
 - NJDEP should include more specific and enforceable requirements on public input and outreach for permit holders in the next permit cycle. For example, require a minimum number of meetings to be held at a time that the general public can attend and that the opportunity to do so is well-advertised and posted at least two weeks in advance of the meeting.
- NJDEP should expand the conversation on green versus gray infrastructure, including costs versus long term benefits, community involvement and collaboration, and the understanding that there is no one-size-fits-all solution when using GI.
 - Permittees should use triple bottom line methods that tend to weigh both green and gray alternatives in the selection and evaluation of CSO controls. See JWW's [Balancing Green and Gray Solutions to CSO Management report](#).²⁴
 - Permittees should consider implementation of a stormwater fee as part of their CSO Long Term Control Plans. A stormwater fee could raise revenue to offset the cost of implementation of the LTCP and/or incentivize private owners to undertake green infrastructure on their property to reduce their stormwater input and their corresponding fees.
 - NJDEP should require green infrastructure projects (when feasible) to be integrated into solutions to fix flooding issues during the next five-year permit process in order to reduce the cost and size of gray infrastructure projects.

NJDEP should make sure that environmental justice communities are protected and prioritized in the LTCPs.

- NJDEP should require flooding to be eliminated in all residential areas, especially low-income communities. Lower-income communities should be considered first for implementation in the CSO Long Term Control Plans.

NJDEP should strongly encourage permittees to provide summaries of sewer system and CSO cleaning and inspection activities to help document the proper operation and maintenance (O&M) of the sewer collection. NJDEP and the US EPA should increase the frequency of comprehensive CSO inspections and document implementation of the sewer system and CSO O&M activities. Recognizing that the use of existing infrastructure should be optimized before investing more money to address regulations the JWW developed: [Hidden Capacity: How Proper Maintenance and Cleaning of Sewer Systems Can Have Huge Benefits](#).²⁵ This report highlights the importance

²⁴ <https://www.jerseywaterworks.org/wp-content/uploads/2018/12/Balancing-Green-and-Gray-CSO-FINAL.pdf>

²⁵ https://www.jerseywaterworks.org/wp-content/uploads/2019/04/Hidden_Capacity-3.28.19.pdf

of sewer cleaning and inspection as critical elements of a proper and effective sewer system operation and maintenance program.

- NJDEP should update future New Jersey Pollutant Discharge Elimination System (NJDES) CSO permit requirements to:
 - List all sewer systems and CSO infrastructure owned and operated by the permittee.
 - Require remote monitoring of key portions of the collection system, such as regulators.
 - Require an annual CSO status report, including a summary of O&M activities (including summaries of system cleaning and inspection) and the implementation status of the nine minimum and long term CSO controls.

7. Appendix - Estimated Costs of Potential Alternatives

Municipality/Authority	Potential Alternatives with Estimated Construction Cost
BCUA	
BCUA	<ul style="list-style-type: none"> • Effluent blending at WWTP via chemically enhanced primary treatment - \$64.5 to \$90.2 million • Effluent blending at WWTP via Ballasted Flocculation - \$111.5 to \$161.1 million
Borough of Fort Lee	<ul style="list-style-type: none"> • Disinfection (PAA) - \$85,000 to \$1.35 million • Disinfection (PAA) with FlexFilter filtration - \$9.75 to \$28.95 million • Tank storage - \$11.25 to \$50.64 million • Sewer separation - \$6.25 million (to achieve 85% volume capture) • GI - \$1.58 to \$10.02 million (does not include cost for green roofs)
City of Hackensack	<ul style="list-style-type: none"> • Tunnel storage - \$57.9 to \$78.0 million • Satellite tank storage - \$22.6 to \$51.2 million • Regional tank storage - \$52.3 to \$95.3 million • GI - \$27.8 to \$34.7 million

Municipality/Authority	Potential Alternatives with Estimated Construction Cost
Village of Ridgefield Park	<ul style="list-style-type: none"> • Consolidated storage to pick up outfalls 003A, 004A, 005A and 006A - \$29.1 to \$73.8 million • Consolidate tunnel storage to pick up overflows from all six outfalls - \$62.3 to \$88.4 million • Consolidated end of pipe treatment (includes fine screening, Actiflo and PAA disinfection) - \$49.7 to \$75.2 million • Sewer separation within village - \$192.7 million • GI - \$2.4 to \$10.0 million
CCMUA	
CCMUA	<ul style="list-style-type: none"> • Expand wet weather treatment capacity of WWTP to 220 MGD via effluent blending - \$20 million • An additional 130 MGD wet weather capacity at or near the CCMUA WWTP through a dedicated process train using Ballasted Flocculation or other high rate treatment process to address Cooper River outfall - \$160 million
Camden	<ul style="list-style-type: none"> • Restoration of City of Camden Collection System - ongoing • Phased improvement of GI (10% runoff control) - \$56.1 million • Potential for satellite treatment or storage in Pennsauken, upgrading the Baldwin's Run Pump Station and Force Main to address Delaware River Outfalls - \$16.5 to \$34.4 million
City of Gloucester	<ul style="list-style-type: none"> • Evaluate operation of the Gloucester City PS to 45 MGD during wet weather, as well as regulator modifications and interceptor upsizing - TBD • Potential for satellite treatment or storage facility at Gloucester City - \$16.5 to \$34.4 million
JMEUC	
JMEUC	<ul style="list-style-type: none"> • Satellite treatment facilities (Actiflo with PAA) - \$488.8 to \$865.2 million • Effluent blending at WWTP - \$16.3 to \$46.7 million

Municipality/Authority	Potential Alternatives with Estimated Construction Cost
City of Elizabeth	<ul style="list-style-type: none"> • Sewer separation - \$1,244 million • Satellite storage facilities - \$297.2 to \$1.2 billion • Deep tunnel storage - \$459.8 to \$901.9 million • GI - \$105.6 to \$611.6 million • I/I reduction (50%) - \$594.0 million
MCUA	
MCUA	<ul style="list-style-type: none"> • High rate treatment with disinfection - \$27.3 to \$39.8 million
MCUA	
City of Perth Amboy	<ul style="list-style-type: none"> • Satellite storage - \$156 to \$487 million (life cycle cost) • Tunnel storage - \$316.3 to \$407 million (life cycle cost) • Satellite treatment (screens, ballasted floc, chlor/dechlor) - \$320.9 to \$608.8 million (life cycle cost) • Pump station expansion with satellite storage at select outfalls - \$25.4 to \$143.8 million (life cycle cost) • Pump station expansion with satellite treatment at select outfalls - \$17.7 to \$335.6 million (life cycle cost) • Regulator modifications - \$50,000 per regulator • Alternative C includes 10% GI applied - \$24 million
NBMUA	
NBMUA (Woodcliff STP)	<ul style="list-style-type: none"> • Woodcliff STP upgrade and expansion; wet weather blending to allow for wet weather flows of 10 MGD - \$20 million
Town of Guttenberg	<ul style="list-style-type: none"> • I/I - \$1.5 million • Sewer separation; Galaxy Towers - \$0.6 million • GI - planter boxes - \$0.4 million and rain barrels - \$0.37 million
NHSA	

Municipality/Authority	Potential Alternatives with Estimated Construction Cost
North Hudson Sewerage Authority (Adams Street WWTP)	<ul style="list-style-type: none"> • Storage tank - \$19.8 to \$65.4 million • Satellite treatment - \$7.0 to \$107.0 million • Storage tunnel - \$126.4 million • Increase pump station capacity - \$5.5 to \$5.7 million • Disinfection (includes in-water chlorine contact tank) - \$52.5 to \$221.8 million • GI - \$46.5 million • WWTP improvements - \$4.7 to \$84.3 million • I/I rehabilitation - \$24.6 million
North Hudson Sewerage Authority (River Road WWTP)	<ul style="list-style-type: none"> • Storage tank - \$60.3 to \$82.1 million • Regulator modifications - \$120,000 to \$350,000 • CSO treatment - \$27.7 to \$86.5 million • Storage tunnel - \$171.5 million • GI - \$42.3 million • I/I rehabilitation - \$13.8 million • WWTP improvements - \$11.9 to \$15.4 million
PVSC	
PVSC	<ul style="list-style-type: none"> • Storage tunnel - \$243 million to \$1.2 billion • Newark regulator modifications + parallel interceptor (Newark, Kearny, Harrison, East Newark) + plant expansion to 720 MGD + Jersey City Pipe (146 MGD HCFM)²⁶ - \$460 million • Newark regulator modifications + parallel interceptor (Newark) + plant expansion to 720 MGD + Jersey City pipe (146 MGD HCFM) - \$460 million
Bayonne	<ul style="list-style-type: none"> • PAA disinfection - \$80 to \$202 million (facility constructed at each of 24 outfalls) • Off-line storage - \$132 to \$177 million (based on construction of 9 storage tanks; one at each outfall) • GI - \$33 to \$93 million • Oak Street PS force main - \$9 million • Sewer separation - \$459 million (extended cost using \$/acre)
Borough of East Newark	<ul style="list-style-type: none"> • Partial sewer separation + GI + PAA + FlexFilter - \$11.1 to \$50.5 million • Partial sewer separation + GI + storage tank - \$10.3 to \$37.9 million

²⁶ HCFM: Hudson County Force Main

Municipality/Authority	Potential Alternatives with Estimated Construction Cost
Town of Harrison	<ul style="list-style-type: none"> • Point storage - \$30 to \$65 million at each of 5 outfalls • Consolidated storage - \$32 to \$59 million (one storage tank to handle 4 of 5 outfalls); includes cost of consolidation piping • Tunnel storage - \$107 to \$124 million; includes consolidation piping (eliminated from further evaluation as net present value of tunnels is approximately twice that of consolidated storage tank) • End of pipe (EOP) treatment - \$81 to \$153 million. Includes screening, Actiflo and PAA at each of 5 outfalls • Consolidated EOP treatment - \$57 to \$118 million for construction of 2 EOP treatment facilities and consolidation piping • Sewer separation - \$181 million • GI - \$2 to \$11 million
PVSC	
Jersey City MUA	<ul style="list-style-type: none"> • I/I reduction via pipe replacement - \$130 million • I/I reduction via slip lining - \$43 million • GI via bioswales - \$50 to \$72 million • Tunnel storage - \$243 to \$371 million • Storage tank at 9 locations - \$71 to \$92 million • Bates Street sewer separation - \$13 million
Town of Kearny	<ul style="list-style-type: none"> • Partial sewer separation with FlexFilter and PAA disinfection - \$63 to \$91 million • Partial sewer separation + storage tank - \$66 to \$83 million • Partial sewer separation + storage tunnel - \$94 to \$108 million • Full sewer separation - \$414 million • GI target of 5% to 10% impervious area
City of Newark	<ul style="list-style-type: none"> • Regulator controls - Cost not determined but identified in report as minimal • GI - \$12 to \$455 million • CSO storage tank - \$185 to \$624 million • I/I reduction (daylighting of Branch Brook Lake and the lake in Weequahic Park) - \$22 million • Water conservation: replace old plumbing fixtures with newer, more efficient units - Cost not estimated in report • PAA disinfection with FlexFilter - \$119 to \$558 million • Sewer separation - \$215 million
North Bergen MUA	<ul style="list-style-type: none"> • Sewer separation - \$47 million • FlexFilter with PAA disinfection - \$1.9 to \$9.5 million • Storage tank - \$2.2 to \$10.8 million

Municipality/Authority	Potential Alternatives with Estimated Construction Cost
	<ul style="list-style-type: none"> • GI - \$1.2 to \$7.5 million
City of Paterson	<ul style="list-style-type: none"> • Sewer separation for outfalls 023 and 030 - \$36 million • Sewer separation + GI - \$49 million • Sewer separation + relief sewer + GI + storage tunnel - \$78 million • GI + storage tank or tunnel - \$268 to \$819 million • GI + storage tank or tunnel + treatment - \$227 to \$645 million • GI + treatment - \$172 to \$637 million